Jurnal Kejuruteraan 38(4) 2026: 1557-1566
https://doi.org/10.17576/jkukm-2026-38(4)-02

Design and Ergonomic Analysis of Active Sitting Chair for Malaysian Office

Dian Darina Indah Daruis* & Atal Arif Mohamad Shah Selly Joko Setiono

Universiti Pertahanan Nasional Malaysia, Kem Sg. Besi, 57000 Kuala Lumpur

**Corresponding author: dian@upnm.edu.my*

Received 15 October 2025, Received in revised form 10 March 2026
Accepted 10 April 2026, Available online 30 July 2026

ABSTRACT

Prolonged sitting in office environments can cause health issues such as back pain. As an alternative, active sitting chair encourages movement and better posture, providing a potential solution. This study focuses on the design and analysis of an active sitting chair for Malaysian office workspaces, ensuring ergonomic benefits, user comfort and structural strength of the design. The specific objectives are (a) to redesign an active sitting chair tailored for Malaysian office workers, and (b) to conduct a preliminary ergonomic screening of the prototype. A questionnaire survey was distributed to gather user preferences, followed by stakeholder analysis and product design specifications. A House of Quality (HoQ) framework was utilized to ensure user needs are aligned with technical requirements. During conceptual design, various ideas were explored through 3 benchmarking, 14 sketching of ideas, and anthropometric study. A prototype was created through iterative improvements to an existing product design and assessed for usability and comfort through ergonomic screening and dimensional compliance based on NIOSH Malaysia anthropometric data. Failure Modes and Effects Analysis (FMEA) suggested that engineering analysis should focus on the wobbly mechanism. However Finite Elements Analysis (FEA) performed in SolidWorks under a static load of 100kg indicated that the leg rest was the most critical component exhibiting a factor of safety of 1.2. Postural comparison between sitting on conventional static office chairs and the active sitting chair was administered using Rapid Upper Limb Assessment tool (RULA). The preliminary ergonomic screening using the RULA across seven Malaysian office workers interacting with the prototype with predefined tasks observed that the Active Sitting Chair supports ergonomic posture, with the assessment score decreasing from 3 pre-design refinement to 2 post-refinement, indicating lower postural risk.

Keywords: Prevention through Design (PtD); ergonomics; anthropometry; postural analysis; workstation design

INTRODUCTION

Office workers often face health risks due to prolonged sitting, which can lead to back pain and discomfort (Kuster et al. 2020). The principle of ergonomics at the workplaces recommends work system and products need to fit the human, comfortable, safe, and effective.

From engineering ergonomic perspective, improvements could be in terms of adjustable table (encourage alternating between sitting and standing at the workstation) or supportive chairs. Supportive chairs help maintain a neutral spine position and reduce pressure on the lower back (Chaléat-Valayer et al. 2019) . Such chairs are designed to support the body's natural alignment, particularly the spine, minimizing strain on the back, neck, and shoulders Ergonomic chairs typically include adjustable features like lumbar support, armrests, seat height, and tilt mechanisms, allowing users to personalize the chair to their body dimensions and preferences.

By encouraging proper posture, these chairs evenly distribute body weight, relieve pressure points, and prevent chronic pain or discomfort from extended sitting. As most of prolonged sitting issue at the office resulted from static posture, the recent solution goes beyond providing conventional ergonomic office chair (Noguchi et al. 2023). It introduces to the new concept of chair, by using active sitting posture. It encourages small movements and core engagement to reduce the negative effects of sitting too long (hence introduce pressure and heavy loads to lumbar discs) (Triglav et al. 2019). Examples of active sitting furniture include stability balls, kneeling chairs, and dynamic seating surfaces, all aimed at improving posture, muscle use, and blood circulation (Andrew et al. 2024).

Traditional office chairs often encourage static and sustained postures, which can lead to increased musculoskeletal discomfort, muscular fatigue, and long-term health implications. For instance, prolonged periods of sitting without regular muscle engagement have been shown to significantly increase back muscle stiffness and elevate the risk of low back pain (Kett et al. 2021). Additionally, static seating that is commonly occurring at office settings, reduces opportunity for posture adjustment, causing localized loading on spinal structures and contributing to user fatigue (Cardoso et al. 2021). In contrast, the proposed active chair offers an alternative seating solution: it supports uninterrupted work while enabling dynamic, ergonomic posture. The design emphasizes active sitting, integrating controlled tilting and micro-movement to continuously engage core muscles. A biomechanical comparison found active chairs promote greater postural sway and increased activation of external obliques, which aids in distributing muscular load and reducing gluteal discomfort when compared to static chairs (Cardoso et al. 2021). A recent review of active workstations proved these benefits, noting that allowing users to initiate movement fosters healthier spinal alignment, enhanced trunk posture, and alleviated discomfort (Pearse et al. 2024).

This study aims to redesign and analyse an active sitting chair for office use based on local anthropometry data. In achieving this aim, two objectives were defined: (a) to redesign an active sitting chair tailored for Malaysian office workers and (b) to conduct a preliminary ergonomic evaluation of the prototype, focusing on design compliance and postural risk screening during limited user interaction. The development process involves using SolidWorks 2024 for design and structural analysis while RULA (McAtamney & Corlett, 1993) as the tool for evaluating postural structure. To demonstrate feasibility, the prototype will be built using readily available components, ensuring ease of assembly and cost-effectiveness.

METHODOLOGY

The methodology for this paper involves several key steps. First, a customers' preferences questionnaire survey was conducted, followed by stakeholder analysis and Product Design Specifications (PDS) development. Sixty respondents between 19-60 years old whom primarily engaged in prolonged seated work answered the customers' preferences questionnaire survey online. The main objective of the survey is to acquire the Voice of Customers (VoC) that will be translated into Technical Specifications. The survey gathered data on respondents' working hours and the duration of time spent seated, as well as the characteristics of their current chairs – categorised as standard, ergonomic or gaming chair models available on the market. Additional information included the length of chair usage, the presence and type of adjustable features, and respondents' complaints and suggestions regarding their chairs. The survey also addressed any discomfort or pain associated with prolonged seated postures and explored preferences for alternative active seating options, such as rocking or saddle chairs, wobble or swivel chairs and bouncing chairs. This is important in design stage as clear and precise product definitions ensure that designers and engineers fully grasp customer expectations and needs (Soares 2021).

A House of Quality (HoQ) tool was used to help align the user needs and the technical requirements up until the selection of the final design. The initial phase of the HoQ involves analysing the VoC, calculating the total importance ratings derived from respondents' feedback, and determining the relative weights assigned to the corresponding technical specifications. Based on the frequency of the data, it is normalized to a total of 100%. Further details on this process can be found in Setiono (2025).

For conceptual design, various ideas were explored through 3 benchmarking, 14 initial ideas sketched, then final and detail design were decided based on Malaysian adult anthropometry (NIOSH Malaysia, n.d.). Benchmarking is also an important stage in building the initial part of HoQ. The competitive assessment evaluates how three products perform in meeting respondents needs, assigning scores on a scale of 1 to 3, where 3 represents the highest level of satisfaction.

The most viable concept was developed into a detailed drawing and subsequently refined using Failure Mode and Effect Analysis (FMEA) and analysed through Finite Element Analysis (FEA) in SolidWorks. FMEA helped highlight issues that need attention to reduce risks and the focus in this study is on the key components such as the gas lift (lever), wobble mechanism, and base stability. FEA in SolidWorks helped examine stress distribution, deformation and factor of safety for crucial parts like the base, the wobble mechanism and the backrest as these parts bear the primary load of the seated body. Based on the classic anthropometric data by Dempster and Gaughran (1967), Approximately 50% of total body weight is supported by the torso when seated, while the lower limbs accounts for about 16.7%. More recent empirical studies such as Nag et al. (2008) and Thokchom et al. (2022) indicated that 75-85% of body weight is borne by the seat pan during upright sitting. However, due to the limited accessibility to these more recent datasets during the study period, and for consistency with traditional segmental weight assumptions, the FEA was conducted using the 50% figure. These data helped with the calculation of the force applied on each of the above crucial parts.

Finally, a prototype is developed as a proof of concept by modifying an existing stool to assess usability and evaluate key ergonomics elements. Usability was considered in terms of ease of adjustment, posture support and alignment with user requirement mapped in the House of Quality. Whilst, comfort was evaluated qualitatively through observation and ensuring compliance with anthropometric data from the NIOSH database. Sitting postures for both conventional and active chairs were analysed using RULA as part of the preliminary ergonomic evaluation. The interactions between subjects and the prototype help identify potential ergonomic risks (Shokrolahi and Mououdi, 2024). Seven male subjects between 23-24 years old with average height of 1.68±0.59 m and 75±15 kg, seated on two different office chairs on different days: (a) a normal static office chair without any adjustable features and (b) an active sitting chair. The images were captured from a lateral view to analyze the sitting posture. Each participant is required to engage in a computer-based task for a continuous duration of 10 minutes while maintaining their natural sitting posture. Before beginning the task, a 2-minute preparation period is provided, allowing them to adjust their seating position and ensure they are comfortable. The distance between iPhone 8 mobile phone camera and the seated participant was one meter and from floor was 0.8 meter.

RESULT AND DISCUSSION

Table 1 presents the Voice of Customers (from the survey) that established part of the House of Quality. These key concepts were further categorized into PDS categories, for example, from the survey, the feedback is lack of cushion comfort or poor posture support, these are categorised as Performance, Safety and Health. Then, the description of the PDS was finalized based on the survey and information from benchmarking as well as literature search as shown in Table 2.

Figure 1 illustrates a part of the HOQ which systematically translate user needs into technical requirements. It includes an assessment of three existing products as design benchmarking: a bouncing sitting chair, a rocking chair and a swivel & wobble chair. Based on the initial analysis of the HoQ, the swivel or wobble active chair appeared to align most closely with the identified technical specifications, followed by the rocking chair and the bouncing chair. Consequently, for the purpose of this study, the redesign of the active chair will primarily be ideated from the wobble or swivel chair concept.

Concept generation is used to generate several concepts that can be used in the production of this chair. Parameters such as the type of adjustable height, the wobble mechanism for active sitting and the type of base were used in morphological matrix. Table 3 depicts the morphological matrix for the chair mechanism. There were 14 concepts generated from the morphological analysis. Figure 2 shows 3 concepts from three different categories: using ball, using disc and using spring, as the “active” chair mechanism. The rest of the categories were variations from these three categories, with options to use gas lift or screw-like adjustments, and round flat base or wheeled-legs.

Table 4 shows the chair fit dimensions (Abdulkadir et al. 2018) and anthropometric measurement for the redesigned active sitting chair, considering inclusivity and comfort. Anthropometry data was based on NIOSH database (NIOSH Malaysia, n.d.) where percentile-based data including the 5th and 95th percentiles of the Malaysian working adult population were provided (Hamadan et al. 2021). Since this new design is an active chair, which aims is to support short-term sitting but allowed maximum movement, there are dimensions that are more important than the other. For example, cushion width is to support hip breadth. Ideally, a large cushion (from the 95th percentile female data) can support most, from small to wide hip. However, cushion length which is based on hip-to-under the knees (buttock to popliteal length) must be taken from the 5th percentile of the female (i.e. dimension from the smallest person) so that the legs will not be hanging when they are seated (because of their short popliteal).

From Figure 4 and Figure 5, concept 5 was chosen as the final concept design which received the highest ranking score, 3.94. It uses gas lift for height adjustment, disc as the wobbly mechanism and castors leg as its base. Next, a detail drawing was created using Solidwork. Figure 5 illustrates the prototype with its specification.

The first engineering analysis carried out was FMEA, although it introduces a degree of subjectivity, it allows the application of standardized guidelines to evaluate the design at the early stage to identify critical risks. The main components were listed and each component was analysed for possible failures, their effects on functionality and associated risks. Severity (S), occurrence (O) and detection (D) ratings were assigned based on 1-10 scales, and the Risk Priority Number (RPN) was calculated as shown in Table 5.

After FMEA, FEA simulation was conducted on each expected parts that would fail under loading with the assumption that the weight of the sitter was 100kg. Stainless steel AISI 340 was selected as the material for the backrest frame, Aluminium 6061 Alloy for the chair base and leg rest, and AISI 1045 Steel for the wobble mechanism. The results of the analysis is shown in Table 6. The FMEA results indicated that the wobble mechanism carried the highest RPN, suggesting it as the most critical component in terms of potential failure modes and associated risks. However, the FEA of the critical components revealed that the leg rest is the weakest under static loading as its maximum stress slightly exceeded the allowable stress threshold. These results represent estimations based on design assumptions and simulated conditions and Figure 6 illustrates snapshots of the FEA of the wobble mechanism and the leg rest. For manufacturing of the product, iterative prototyping and physical testing are required to validate the functional and structural reliability and performance.

Figure 7 is an example of the ergonomic risks evaluations when a subject interacting with (a) a normal static chair and (b) an active sitting chair. Figure 7 clearly illustrates that arm posture represent the most notable difference between the two seating conditions. While the desks shown may require adjustments to improve leg clearance, the active chair offers a distinct advantage by enabling the users to engage their body core and maintain dynamic movement even while seated. This feature helps mitigate sustained static postures, which are recognized as a significant ergonomic risk factor.

The RULA analysis showed an average score of 3 for the conventional chair and 2 for the active sitting chair as detailed in Table 7 for the seven subjects. Since the static office chair lacks adjustability, the lower arms had to be raised to perform task on the desk positioned slightly above the neutral 90^{o} posture resulting a score of (+2). Further, if posture mainly static (held >10 minutes) score (+1) is added to Posture Score from Table A. In contrast, the active chair allowed height adjustment according to users' preference and during this evaluation, all participants were able to maintain optimal lower arm positions, reflected by a score of (+1). Although it shows only a slight improvement, the reduction from 3 to 2 indicates the active chair supports better ergonomic posture and reduces prolonged static sitting. Furthermore, its limited backrest and absence of armrests encourage users particularly in the office environments to take the recommended ergonomic breaks every 20-30 minutes and to incorporate body movement, thereby lowering the risk of musculoskeletal strain. Even though small-scale usability testing with seven participants can help uncover critical design issues such as argued by Faulkner (2003) and Cazanas et al. (2017), particularly on qualitative insights, such samples are inadequate for statistical analysis or for commercial application. Larger samples of 40-50 subjects are required when precise confidence intervals are needed before going into production stage.

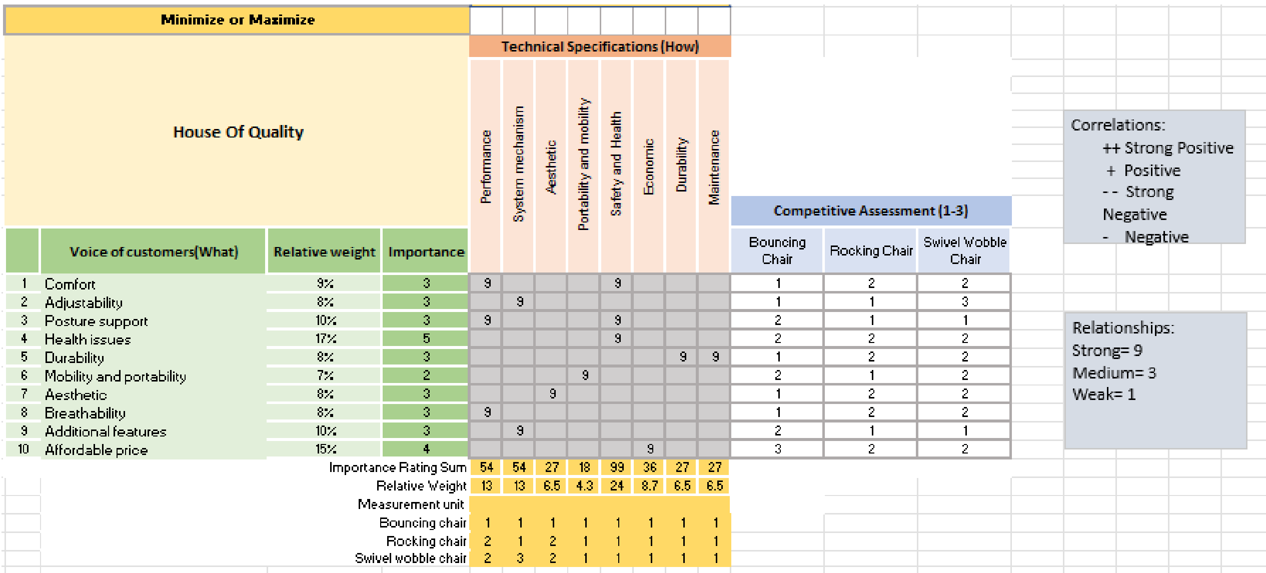
RULA was applied to assess postural risk during prototype interaction and not a product usability evaluation. In order to conclude for a usability evaluation or testing, a formal Usability Survey study such as the Cornell Ergonomic Seating evaluation (CESE) (Hedge, 2007) should be conducted. Although it was not conducted at this preliminary stage, the four core component sections from the CESE; namely chair adjustments, seat comfort, ease of use and body support, were considered in the initial survey to establish the Voice of Customers of the HOQ. This is analysed and mapped into a matrix presented in Table 8. The mapping showed strong alignment between design objectives and ergonomic performance criteria. For example, stability requirements were met, with the chair supporting up to 100kg (or more) while allowing controlled wobble, addressing safety concern without compromising active sitting. The anthropometric fit was from a trusted National source that covers the 5^{th} to 95^{th} percentile of Malaysian office workers.

TABLE 1. Voice of customers

Aspect	Feedback
Comfort	Not comfortable due to lack of cushion.
Adjustability	Not adjustable height.
Posture Support	Does not promote good posture.
Health Issues	Injury and discomfort from prolonged sitting.
Durability	Product breaks down easily.
Mobility	Not easy to move around.
Design	The design is not up to date.
Breathability	Chair material doesn't allow air circulation.
Features	Additional features needed.
Price	Needs to be affordable.

TABLE 2. Product Design Specification description

General req.	Specific req.	Acceptable Performance
Safety and Health	Stability	Can support user up to 100kg with wobble function without falling
	Ergonomic	Able to fit 5th to 95th percentile of Malaysian (based on NIOSH Malaysia database) for both male and female
	Sharp edges	No sharp edges or rough surface
Performance	Comfortable	Able to deliver comfort and allow active sitting.
	Material	Material used for seat foam and backrest
System mechanism	Imbalance mechanism	Wobble between 5° to 15° from conventional sitting plane
	Adjustability	Adjustable height for sit-stand function (cover 5th to 95th percentile Malaysian working adults)
Economic	Low cost and affordable	Cost below RM 500.00
Aesthetic	Attractive	Simple and trendy
Durability	Maintain performance after certain period	Can withstand 8 hours works daily and minimum 5 years
	Robust	Able to withstand weight up to 120 kg
Maintenance	Number of parts	Less parts for easy installation
	Parts of product	Spare parts are easy, affordable and readily available
Portability and Mobility	Weight	Below 10kg
	Dimension	Height (550mm to 980mm) x Length (450mm) x Width (385mm) considering Malaysian office setting

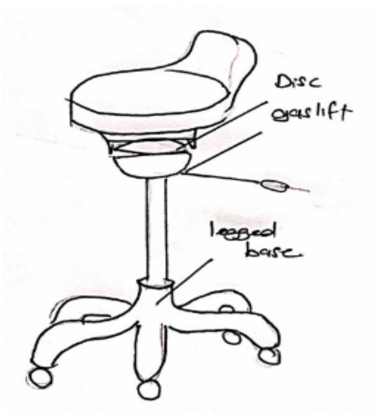


	Voice of customers(What)	Relative weight	Importance	Performance	System mechanism	Aesthetic	Portability and mobility	Safety and Health	Economic	Durability	Maintenance	Bouncing Chair	Rocking Chair	Swivel Wobble Chair
1	Comfort	9%	3	9				9				1	2	2
2	Adjustability	8%	3		9							1	1	3
3	Posture support	10%	3	9				9				2	1	1
4	Health issues	17%	5					9				2	2	2
5	Durability	8%	3							9	9	1	2	2
6	Mobility and portability	7%	2				9					2	1	2
7	Aesthetic	8%	3			9						1	2	2
8	Breathability	8%	3	9								1	2	2
9	Additional features	10%	3		9							2	1	1
10	Affordable price	15%	4						9			3	2	2
			Importance Rating Sum	54	54	27	18	99	36	27	27			
			Relative Weight	13	13	6.5	4.3	24	8.7	6.5	6.5			
			Measurement unit											
			Bouncing chair	1	1	1	1	1	1	1	1			
			Rocking chair	2	1	2	1	1	1	1	1			
			Swivel wobble chair	2	3	2	1	1	1	1	1			

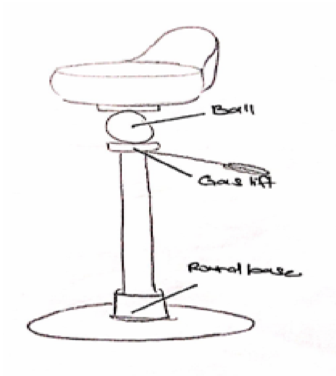
FIGURE 1. Snapshot of part of the House of Quality

TABLE 3. Morphological Method of the Chair Mechanism

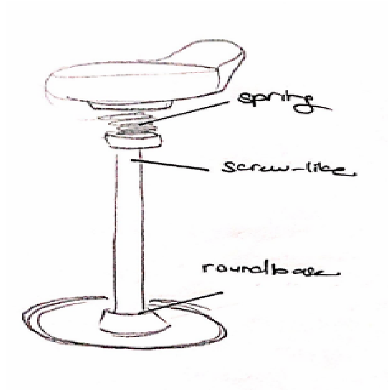
Parameter	Principle			
	1	2	3	4
Type of adjustable height	Gas lift 	Thread 		
Wobble mechanism	Ball 	Disc 	Spring 	Curved based 
Type of bas	Round base 	Legged based 		



Concept 2



Concept 5



Concept 14

FIGURE 2. Three of the 14 Conceptual Designs Considered

TABLE 4. Seat dimensions and related anthropometric measurement

No	Seat dimension	Anthropometric measurement	Estimated value (mm)
1	Cushion width	Hip breadth >95th percentile female	441.79
2	Cushion length	Buttock-to-popliteal <5th percentile female	379.15
3	Seat height	Popliteal height <5th percentile female	358.69
4	Baskrest width	Interscye breadth >95th percentile male	429.00
5	Backrest height	Lumbar height <5th percentile female	300.56

House Of Quality

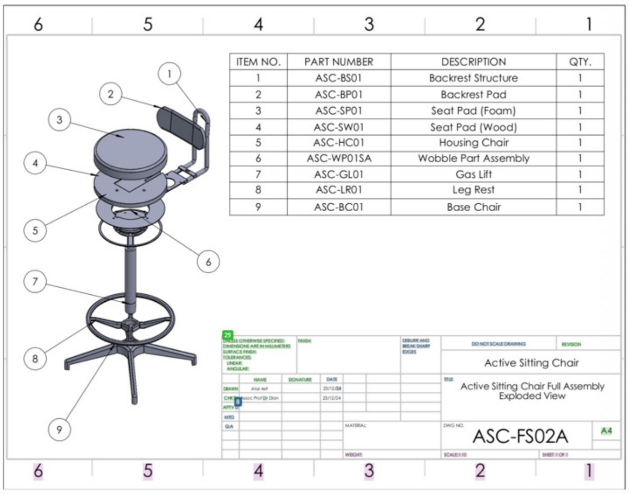
	Criteria	Relative weight	Importance	Concept 1	Score	Concept 2	Score	Concept 3	Score	Concept 4	Score	Concept 5	Score	Concept 6	Score	Concept 7	Score
1	Safety and Health	24.0%	5	4	0.96	4	0.96	4	0.96	4	0.96	5	1.2	5	1.2	5	1.2
2	Performance	13.0%	2.7	5	0.65	4	0.52	4	0.52	4	0.52	5	0.65	5	0.65	4	0.52
3	System mechanism	13.0%	2.7	4	0.52	4	0.52	3	0.39	4	0.52	5	0.65	5	0.65	4	0.52
4	Economic	8.7%	1.8	4	0.35	4	0.35	5	0.44	4	0.35	4	0.35	4	0.35	5	0.44
5	Aesthetic	6.5%	1.4	4	0.26	5	0.33	4	0.26	4	0.26	5	0.33	5	0.33	4	0.26
6	Durability	6.5%	1.4	4	0.26	4	0.26	4	0.26	4	0.26	5	0.33	4	0.26	5	0.33
7	Maintenance	6.5%	1.4	4	0.26	3	0.2	4	0.26	4	0.26	4	0.26	4	0.26	5	0.33
8	Portability and mobility	4.3%	0.9	4	0.17	5	0.22	4	0.17	4	0.17	5	0.22	5	0.22	4	0.17
			Importance Rating Sum	33	3.43	33	3.34	32	3.26	32	3.3	38	3.97	37	3.91	36	3.76
			Rank	9		11		14		12		1		2		4	

FIGURE 3. Concept Selection Part 1 (Concept 1-9)

House Of Quality

	Criteria	Relative weight	Importance	Concept 8	Score	Concept 9	Score	Concept 10	Score	Concept 11	Score	Concept 12	Score	Concept 13	Score	Concept 14	Score
1	Safety and Health	24.0%	5	4	0.96	5	1.2	4	0.96	4	0.96	4	0.96	5	1.2	4	0.96
2	Performance	13.0%	2.7	4	0.52	5	0.65	5	0.65	4	0.52	4	0.52	4	0.52	4	0.52
3	System mechanism	13.0%	2.7	4	0.52	4	0.52	5	0.65	4	0.52	4	0.52	5	0.65	4	0.52
4	Economic	8.7%	1.8	4	0.35	4	0.35	4	0.35	4	0.35	4	0.35	4	0.35	4	0.35
5	Aesthetic	6.5%	1.4	4	0.26	4	0.26	4	0.26	4	0.26	4	0.26	5	0.33	4	0.26
6	Durability	6.5%	1.4	5	0.33	4	0.26	4	0.26	5	0.33	4	0.26	4	0.26	5	0.33
7	Maintenance	6.5%	1.4	5	0.33	4	0.26	3	0.2	4	0.26	4	0.26	4	0.26	5	0.33
8	Portability and mobility	4.3%	0.9	5	0.22	4	0.17	5	0.22	4	0.17	4	0.17	5	0.22	5	0.22
			Importance Rating Sum	35	3.47	34	3.67	34	3.54	33	3.37	32	3.3	36	3.78	35	3.47
			Rank	7		5		6		10		13		3		8	

FIGURE 4. Concept Selection Part 2 (concept 8 – 14)



Specification	Details
Dimension	Total height with backrest (840 mm) Seat height (550mm to 800mm) Length (450mm) Width (385mm)
Weight	9.7 kg
Wobble mechanism	5º wobble in 360º swivel

FIGURE 5. The redesigned active sitting chair prototype

TABLE 5. Failure Modes and Effects Analysis

Component	Failure mode	Effect	Cause	S	O	D	RPN
Seat & wobble mechanism	Breaks under weight	Collapses	Weak material & aggressive use	9	4	6	216
Backrest	Loose	Wrong posture	Improper assembly	6	5	7	210
Fasteners	Loosen over time	Wobbly (not in a good way)	Vibration	5	8	3	120
Leg rest	Unstable	Limited functionality	Weak joints	5	6	4	120
Base chair	Cracks	Instability	Overloading or poor design	8	3	5	120
Gas lift	Fails to adjust height	Improper sitting height	Hydraulic leak or wear	7	4	6	168

TABLE 6. Finite Element Analysis

Component (Load N)	Yield Strength (MPa)	Max Von Mises (MPa)	Allowable Stress (MPa)	Factor of Safety
Wobble mechanism (490.5)	55.15	11.92	11.99	4.6
Backrest Frame (245.3 each pair)	220.6	48.04	48.00	4.6
Leg rest (163.8)	55.15	46.87	45.96	1.2
Base chair (981.0)	55.15	8.05	8.11	6.8

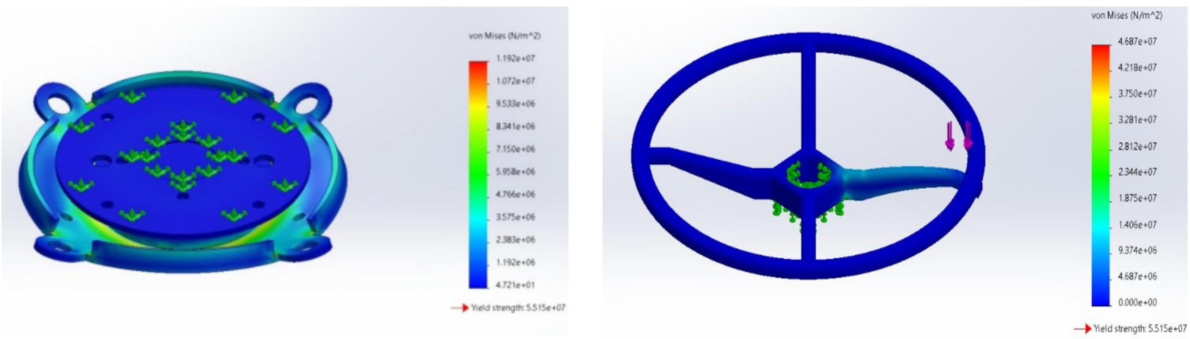


FIGURE 6. Stress Simulations of the Wobble Mechanism on the left and the Leg Rest on the right

FIGURE 7. One of the participants for RULA on (a) normal static chair without adjustable feature on the left, (b) the redesigned active chair on the right

TABLE 7. RULA Scoring for Both Chairs

TABLE A	Static Chair	Active Chair	TABLE B	Static Chair	Active Chair
Upper Arm Score	1	1	Neck Score	1	1
Lower Arm Score	2	1	Trunk Score	1	1
Wrist Score	2	1	Leg Score	1	1
Wrist Twist	+1	+1			
Posture Score A	2	1	Posture Score B	1	1
	+	+		+	+
Muscle Use Score	+1	0	Muscle Use Score	1	1
	+	+		+	+
Force Load Score A	0	0	Force Load Score B	0	0
	=	=		=	=
Wrist & Arm Score	3	1	Neck, Trunk & Leg Score	2	2
			TABLE C. Final RULA Score	3	2

TABLE 8. Ergonomic Validation Aligned to VoC and Cornell Scale

PDS Item	Cornell Dimension(s)	VoC Intent
Stability (supports up to 100kg with wobble)	Body Support; Overall Ergonomic Score	Safe wobble without fear of tipping
Ergonomic fit (5th–95th percentile Malaysians)	Body Support; Seat Comfort	Fits most Malaysian office workers
No sharp edges or rough surfaces	Ease of Use; Comfort	No discomfort from edges
Comfortable; allows active sitting	Seat Comfort; Body Support	Comfort + movement relief
Materials for seat foam/backrest	Seat Comfort; Body Support	Cushioning without heat or bottoming out
Imbalance mechanism (wobble 5°–15°)	Body Support; Overall Ergonomic Score	Enough wobble to promote micro-movements
Adjustable height for sit-stand	Chair Adjustment; Ease of Adjustment	Easy, range covers most users
Simple and trendy	Overall Ergonomic Score (perceived)	Looks modern; not intimidating
Durability (8 hours daily, min 5 years)	Seat Comfort; Body Support	Comfort remains; no sagging
Robust up to 120 kg	Body Support; Safety	Occasional heavier users
Fewer parts; easy install	Ease of Use (Controls)	DIY assembly friendly
Weight < 10 kg	Ease of Use (Mobility)	Easy to move
Dimensions (H 550–980 mm × L 450 mm × W 385 mm)	Body Support; Space Use	Fits workstation

CONCLUSION

The study showed that users prefer office chair that does not look too different from the conventional office chair, but at the same time appreciate that it could relieve them from the sustained posture without leaving the chair. Therefore, based on the design process activities that have been carried out, the active chair that was designed based on the subjects' preferences has a simple lumbar support and wobbly seat pan which allows them to be supported while doing work but still give them the freedom to move their body core. The engineering analyses performed to simulate the potential of failure modes and structural integrity of the design indicated two critical components; the wobble mechanism from FMEA and the leg rest from FEA performed in Solidworks. Factor of safety for the leg rest is 1.2, slightly above 1, the minimum threshold which represents the point where the structure can withstand the expected load without failure. Conversely, the factor of safety calculated for the wobble mechanism is 4.6, comfortably considered very safe and robust compared to the anticipated load.

The prototype meets the intended ergonomic and functional requirements, when RULA scores from 3 for the conventional static chair to 2 for the active chair indicates a modest improvement in ergonomic posture. Future refinement in the prototype should include a large sample of subjects to evaluate the usability of the redesigned chair employing usability testing survey tool and objective measurement such as seat pressure distribution mapping before it could be commercialized and labelled as an ergonomic product.

ACKNOWLEDGEMENT

Authors would like to thank Universiti Pertahanan Nasional Malaysia (UPNM) for supporting this work.

DECLARATION OF COMPETING INTEREST

None.

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