

## Ergonomics Study of Rostrum Design

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**ABSTRACT** – Ergonomics design has been demanded and considered the main effective factor in preventing ergonomics hazards for the user for the last several decades. The design of a product should be based on human factors and anthropometry to ensure a good fit between the product and people. It is also to increase comfort and safety. The purpose of this study is to evaluate the element of ergonomics in the rostrum design used in the school in Kulim Kedah, Malaysia. There are four (4) ergonomic dimension criteria that were used to check the fifteen (15) samples of the rostrum. The rostrum dimensions are compared to the ergonomic dimensions range of the workbench for standing operation from the previous study and established guidelines. The results are described in frequencies and percentages. The result shows that 80% of the rostrum meets the ergonomics design criteria. To achieve a 100% ergonomic rostrum, the product designers must be knowledgeable about ergonomic design and aware of its significance for the user.

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## INTRODUCTION

The rostrum is a platform that somebody stands on to make a public speech, etc. [1]. A rostrum is a raised surface on which a person making a speech, or a music conductor stands [2]. It means that rostrums are usually used by speakers, leaders, and celebrities to speak formally and to deliver messages to the audience through formal events such as political campaigns, meetings, award ceremonies, etc. The events can occur in any scene, such as seminar halls, classrooms, shopping complexes, and playing fields. Using a rostrum is one of the most effective ways to convey any information to the public audience who will listen once the speaker is on the podium. The rostrum can be seen in any organisation whether government or non-government agencies. Hence, the rostrum is recognised as a necessary tool for all organisations in the world [3].

The rostrum design must be attractive with aesthetic values to entice the audience to focus on the speaker while he or she delivers the information or messages [4]. Presently, the organisation is encouraged to consider the social and technical aspects while selecting the rostrum design because the event or speech will be easily telecast online with thousands of views. An effective product look has an impact on a company's corporate identity. The competitive position of an organisation can be significantly impacted by the product's image, which is influenced by its design concept, functionality, and technology [5]. Those aspects such as design, special features, size, and functionality are important but ergonomics design is one of the aspects that are always not considered in the design process. The rostrum can be considered similar to a workbench in the workstation, and the speaker is the worker in a standing position. The design of the rostrum is better to be considered to provide space for the speaker to place the notes, laptop, microphone, a glass of drink, and any other materials. It can ensure that the event will run professionally and smoothly without any interruptions. The rostrum can be made of wood, metal, plastic, or a combination of these materials. The selection of materials will be based on the rostrum design. Most rostrums currently available on the Malaysian market generally have a fixed height position.

Anthropometric data can be used to design workspaces, including work-space envelopes and products. Anthropometry takes into account physical size, postures that can be adopted, and tasks that can be performed to achieve an ergonomic design [6]. However, some designs of workbenches or rostrums cannot meet the ergonomics requirements due to a lack of data collection. Moreover, most workbenches and rostrums are designed based on the designer's experience or benchmarking from similar workbenches or rostrums without considering anthropometry. The anthropometric database must be considered in workplace design to ensure the safety and health of those who use it [7]. Anthropometry has been used in ergonomics studies as the foundation for designing various situations such as household products, tools, workstations, and workbenches [8]. The design of a product should be based on human factors and anthropometry to ensure a good fit between the product and people, and to increase the comfort, safety, and performance of a product or an environment [9].

There are four (4) main factors of anthropometry that need to be considered in design that is clearance, reach, posture, and strength [10]. The clearance and reach are the factors that will be considered in designing the rostrum. Firstly, in designing a workstation, it is very important to provide adequate headroom, elbow room, leg room, etc. [10]. The user must be provided with adequate access and circulation space. Secondly, reach is very useful for determining the location of any object in the convenient zone at work. For example, by determining the arm's length of workers, the objects can be placed in the right position in the workplace so that the work can be done efficiently and comfortably.

A well-designed workplace combined with a well-designed job allows the worker to work in a balanced position without putting undue strain on the body. Although the worker's actual performance of the task is dependent on how the worker stands, moves, or lifts, work practises can make the job safer or more hazardous. Workers who sit or stand at a poorly designed workbench or rostrum while performing a routine job may spend the majority of their time bent over while working, which can have negative safety and health implications for the human body, such as spinal discomfort, back pain, and cognitive function [11]. Prolonged standing working positions can cause bodily pain, discomfort, and even health problems, particularly upper extremity musculoskeletal disorders (UEMD) and lower extremity musculoskeletal disorders (LEMD [12]. This situation will result in spine problems, back pain, neck pain, and a decrease in physical health. The workbench or rostrum should be redesigned and set at a level at which a worker can be more comfortable and safe at work to reduce the risk of ergonomic hazards. Workers frequently adopt a standing position while carrying out their jobs. An ergonomic workstation always meets occupational safety and health requirements.

The design of the workbench or rostrum also aims to set up the user's work in a comfortable and pleasant environment [13]. The specifications that apply to a workbench or rostrum are first and foremost of a technical nature. Standing at work is advised when the work area is too big to comfortably reach while seated, and standing is preferred when a person cannot comfortably arrange her legs under the work table due to a barrier [14]. Workstations used in a standing position must have adequate foot clearance. When there is insufficient foot clearance, the worker is forced to stand further away from the workspace and leans forward in an unhealthy, awkward posture.

The ergonomic risk of standing while working can be reduced by frequent and sufficient rest breaks. Some requirements must be taken into account for ergonomic design, such as adequate freedom of movement; suitable working surface; and individual working height for standing and seated positions [13]. The workbench or rostrum must be appropriate for the task at hand. Designing a workstation with recommended clearance will help to ensure that the worker has enough space to move, shift their body weight, and change their posture when working standing. As stated, the rostrum is considered similar to a workbench in standing operation, therefore, the purpose of this study is to evaluate the element of ergonomics in the rostrum design used in the school in Kulim Kedah, Malaysia. Therefore, the percentage of the rostrum that fulfills the ergonomic design criteria can be determined.

## METHODOLOGY

In this study, fifteen (15) samples of rostrum were taken from fifteen (15) schools in Kulim Kedah, Malaysia. The measurement of related dimensions was measured in the school, and the data collected is not used in the actual name of the school but refers to 1 to 15. The rostrum dimensions are compared to the ergonomic dimensions range of the workbench for standing operation from the standing workstation guidelines [15] and a previous study [16-19] and are described in frequencies and percentages. When designing standing workstations, it is important to provide space for the worker's toes and knees [15]. Workbenches with the recommended clearances help to ensure that workers have enough space to move, shift their body weight, change postures, and reduce discomfort while standing and working at the workbench. Recommended foot clearance space is 15 cm deep, 15 cm high, and 50 cm wide [16], which will be used in this study.

The recommended knee clearance space is more than 10 cm [17]. The recommended normal reach zone on the work surface is 100 cm in width and 25 cm in front of the user, and the maximum reach zone is 160 cm in width and 50 cm in front of the user [17]. Design standing workbenches so that all frequent reaches are kept within the user's normal reach zone. Reaches beyond the normal reach zone but less than the maximum reach distance should only be performed infrequently. The user should not be required to perform any reaching beyond the maximum reach zone. Although the width of the normal reach zone is half, it is considered similar to the study desk, which does not require many hand movements. The recommended work surface of the study desk for a university student in Bangladesh is 61 cm in length and 45 cm in width [18]. Hence, the checklist reach zone dimension for the rostrum work surface that is used in this study is taken as the range of length is 50 to 100 cm and 25 to 50 cm for the width.

The height of the workbench should be tailored to the body height and the elbow height as shown in Figure 1. This is used to determine the ergonomics of the workbench height. The recommended average elbow height for Malaysian male and female workers is 96.4 cm and 90.24 cm, respectively [19]. The recommended dimensions height workbench for standing work can be divided into three types of work; 1) precision work – 10-20 cm above elbow height; 2) light work – 5-10 cm below elbow height; 3) heavier work – 10-20 below elbow height [15]. The type of work the speaker does while performing reading and writing tasks on the work surface is considered light work. The minimum and maximum dimensions for the workbench used in this study are based on a previous study which are 80.24 cm and 91.4 cm, respectively [14] [19]. However, an adjustable height workbench with performing reading and writing tasks on the work surface can be adjusted between 86 cm to 117 cm [15]. Hence, the checklist dimension height for the rostrum that is used in this study is taken as the minimum is 80.24 cm and 117.0 cm for the maximum value. The summary of the ergonomics criteria and dimension checklist for the rostrum are shown in Table 1 and Figure 2.

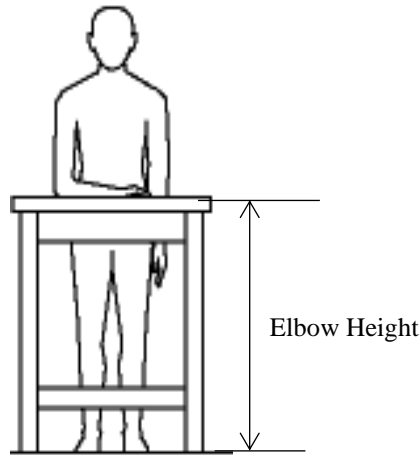


Figure 1: Workbench and elbow height

Table 1: Ergonomics rostrum criteria and dimension

No	Item	Dimension (cm)
1	Foot clearance	$> (15) L_f \times (50) W_f \times (15) H_f$
2	Knee clearance	$> (10) W_k$
3	Work surface	$(50 - 100) L_w \times (25 - 50) W_w$
4	Elbow height	$(80.24 - 117) H_e$

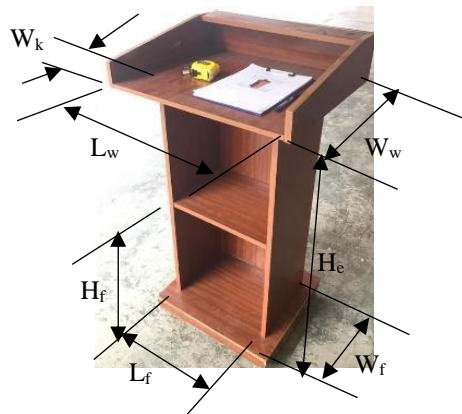


Figure 2: Measured dimension of the rostrum

**RESULTS AND DISCUSSION**

Figure 3 (a, b, and c) shows that three (3) out of fifteen (15) samples were taken in this study, and all the samples had a different design. All rostrums have a fixed height position and the majority are made of wood. The descriptive statistics of the 15 samples of the rostrum are shown in Table 2. All types of rostrums were presented with a fixed height position. The work surface had the highest (93.3%) ergonomics design criteria of the rostrum, while the knee clearance had the lowest (66.7%). The elbow height was the second highest (86.7%) while foot clearance was recorded at 73.3% which fulfilled the ergonomics design criteria. Table 3 shows the summary of ergonomics design criteria and found that the average that fulfilled the ergonomics design criteria was 80.0%. Another word that can be said is ergonomic rostrum. It means that all the rostrums fit the user who will be using them most effectively, and if the rostrum does not fit the user, it does not meet their needs, and the rostrum fails in its purpose. The recommended minimum elbow height is 83.8 cm in an adjustable rostrum design [4], which is within the range of values for this study.



Figure 3: Sample of the rostrum

The workbench height for standing operations used in statistical analysis is 103 cm and it is the recommended dimension of workbench height for Malaysian workers [20]. The value is within the range of values for this study. Although the speaker does not stand for a long time on the rostrum, which is usually 1-2 hours, they can still experience ergonomic hazards. Therefore, to prevent speakers from experiencing ergonomic hazards, the rostrum must be designed to meet ergonomic characteristics. However, from the social aspect which is user satisfaction with the rostrum a result from the previous study shows that the price and storage capacity were the main criteria in the rostrum selection [3]. It means that the design, functionality, and portability did not have a significant relationship with user satisfaction. A wood plastic composite which is considered an environmentally friendly material is suggested to respond to the need for environmental sustainability. It is an easy but more expensive rostrum to meet elbow height requirements by producing an adjustable rostrum so that the users can adjust the rostrum top to suit the elbow height without having to bend their back.

Table 2: Checklist of ergonomics criteria and dimensions of the rostrum

Rostrum number	Foot clearance		Knee clearance		Work surface		Elbow Height	
	Yes (Y)	No (N)	Yes (Y)	No (N)	Yes (Y)	No (N)	Yes (Y)	No (N)
1		N		N	Y		Y	
2		N		N	Y		Y	
3	Y		Y			N	Y	
4	Y		Y		Y		Y	
5	Y		Y		Y		Y	
6	Y		Y		Y		Y	
7	Y		Y		Y		Y	
8		N		N	Y		Y	
9	Y		Y		Y		Y	
10	Y		Y		Y		Y	
11	Y		Y		Y		Y	
12	Y			N	Y			N
13		N	Y		Y			N
14	Y			N	Y		Y	
15	Y		Y		Y		Y	
Total (%)	11 (73.3)	4 (26.7)	10 (66.7)	5 (33.3)	14 (93.3)	1 (6.7)	13 (86.7)	2 (13.3)

Table 3: Ranking of ergonomics criteria

No	Item	Ergonomic fulfillment (%)	Ranking
1	Work surface	93.3	1
2	Elbow height	86.7	2
3	Foot clearance	73.3	3
4	Knee clearance	66.7	4
	Average	80.0	

## CONCLUSION

Ergonomics is an important aspect that must be considered by the designer during the design process. The examples, such as a workstation, workbench, machine, tool, household product, furniture, and rostrum are required to meet an ergonomics design. A rostrum is an important tool for an event. Besides, the rostrum also helps young speakers gain more confidence in delivering their speeches. Hence, the focus of this study is to evaluate the ergonomic elements in the rostrum design used in the school in Kedah, Malaysia. The study found that 80% of the rostrum followed the ergonomics design criteria. Anthropometric data helps designers to design ergonomic products based on the Malaysian population. The product designer must research ergonomic design criteria for the user so that the ergonomic requirement can be achieved at 100% of the ergonomic rostrum. The future expectations of a similar approach in this study are for other household products such as sofas, dining tables and chairs, beds, and lazy chairs.

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