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# Comfort Temperature and Lighting Intensity: Ergonomics of Laboratory Room Machine Tools

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**Abstract:** Laboratories that meet ergonomic standards will support the learning process, both academically and technically, to facilitate the growth and development of skills. This study aims to uncover and provide an overview and information about laboratory ergonomics standards which include thermal comfort (temperature), workspace laboratory lighting. This study uses a quantitative approach with a survey method carried out in the Machine Tool Unit Laboratory of the Department of Mechanical Engineering Education with a population of 60 students who are carrying out practicum. Techniques using direct observation and measurement. Lux Meter to measure lighting and then Digital Thermometer which functions to measure temperature at the observation point in the laboratory. Data collection starting at 07.00 until 12.00 and in the afternoon starting from 13.00 to 16.00, which is the time to do work activities. Measurements made at ten observation points the results showed that; (1) thermal comfort (temperature) with a value of 30.44 degrees Celsius, while the ideal practical standard ranges from 24 – 27 degrees Celsius; (2) Lighting with a value of 422.14 Lux while the ideal practice standard ranges from 500 – 1000 Lux. These results indicate that there is a tendency for temperature and lighting in laboratory rooms under conditions that are less than the standard set. To increase work productivity, these factors can cause less concentration and stress at work.

**Keywords:** Human Thermal, Productivity, Physical Condition, Workplace Design, Work Environment.

## 1. Introduction

Every day humans are involved in a different work environment condition where the different conditions significantly affect human ability [1]. Humans will be able to carry out their activities well and achieve optimal results if the work environment is supportive. Humans will be able to carry out their work well if supported by a pleasant work environment. A working environment condition said to be the right work environment if humans can carry out their activities optimally with a healthy, safe, and safe [2].

Irregularities in the work environment be a result for a long time. Furthermore, adverse environmental conditions can require more energy and time, which certainly does not support obtaining an efficient and productive work system design [3]. Workers need a comfortable work environment to be able to work

optimally and productively; therefore the work environment must handle and designed so that it is conducive for workers to carry out activities in a safe and comfortable atmosphere [4].

The environmental evaluation carried out by measuring workplace conditions and knowing workers' responses to exposure to the work environment [5]. The planning and design of work systems need to consider factors that can affect working environment conditions such as noise, lighting, temperature, and others. A working environment said to be good if, under certain conditions, humans can carry out their activities optimally [6]. Incompatibility of the work environment with humans who work in the environment can see its impact within a specified period. Work environment factors, tools, and methods significantly affect productivity. To get high

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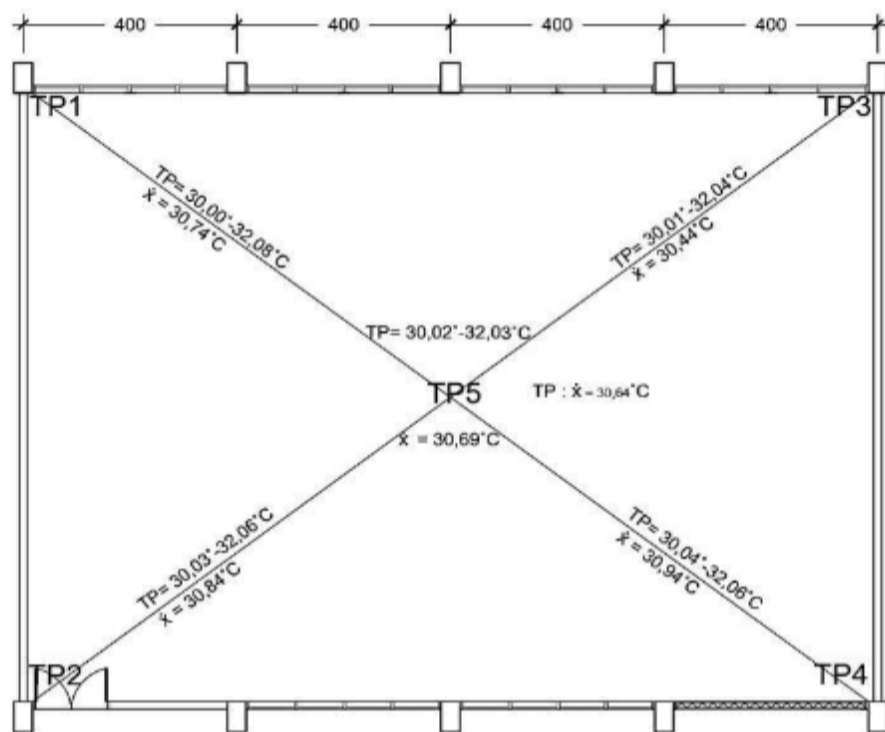


data, measurements made at ten observation points in the machine laboratory room.

### 3. Result and Discussions

#### 3.1. Thermal

Thermal is one of the essential aspects of ergonomics in the work environment both physically and non-physically, which can have an impact on employee performance or productivity [17]. The observation points for temperature measurements that have obtained can be presented in the figure as follows.



**Figure 1.** Temperature Measurement Observation Points at the Machine Laboratory.

Thermal comfort must meet so that students who are doing activities in the environment can be more productive [18]. The results of temperature measurements that have obtained can be presented in the following table.

**Table 1.** Results of Temperature Measurement at the Laboratory of Machines.

No.	Observation Point	Observation Point (°C)				
		TP1	TP2	TP3	TP4	TP5
TT	07.30-08.00	30.00	30.01	30.02	30.01	30.02
TT	08.00-08.30	30.01	30.01	30.01	30.01	30.01
T1	08.30-09.00	30.00	30.00	30.00	30.00	30.00
T1	09.00-09.30	30.01	30.02	30.02	30.01	30.02
T2	09.30-10.00	31.02	31.01	31.02	31.02	31.02
T2	10.00-10.30	31.01	31.02	31.01	31.03	30.02
T3	10.30-11.00	31.04	31.03	30.02	31.04	31.03
T3	11.00-11.30	32.08	32.08	30.05	32.06	32.03
T4	11.30-12.00	32.04	32.03	32.04	32.03	32.02
T4	12.00-12.30	30.08	30.07	30.08	30.04	30.05

standard or recommendation regarding the room temperature threshold value that is allowed in workspace in the industry in accordance with the Regulation of the Indonesian Minister of Health on the standards and requirements for industrial work environment health, then for turning work with an allocation of work and rest time of 50 – 70 percent, with the mild category having a threshold value of 31.0 degrees Celsius, students who do practicums can be categorized as potentially experiencing physiological effects (heat strain) [19].

Indonesia generally acclimatized to a tropical climate with temperatures around 29 – 30 degrees Celsius with humidity of 85 – 95 percent. Acclimatization of heat means an adjustment process that occurs to a person during the first week at work. After the first week of being in a hot place, labor able to work without the influence of heat stress; this depends on the acclimatization of everyone as seen from the workload so that work variations needed.

Geographically, Indonesia is on the equator and has a tropical climate. Tropical regions according to temperature measurements are tropical regions with average temperatures above 20 degrees Celsius, Indonesian regions have average temperatures that can generally reach 35 degrees Celsius. Furthermore, Indonesian territory has a high humidity level, which can reach 85 percent. This situation occurs among others due to the position of Indonesia, which is at the meeting of two extreme climates (due to the position between two continents and two oceans). This condition makes Indonesia less profitable for students in doing work activities because student work productivity tends to decrease or low if it is in a working environment that is too cold or too hot. Comfortable thermal temperatures for Indonesians are in the temperature range of 22.8 – 25.8 degrees Celsius with humidity of 70 percent.

SNI (Indonesian National Standard) [20], states that a comfortable temperature for conducting activities is in the range of 22.80 – 25.80 degrees Celsius. With the measurement results obtained, it is quite far from the

temperature the more the day, the higher. At this temperature, mental activity and responsiveness begin to

Based on the results of measurements and tests, it is known that the average temperature of the work

decrease and tend to make mistakes in work so that it can cause physical fatigue. The heat of the workspace caused by the heat of the production machine and the lack of air ventilation. Incoming sunlight, besides useful as lighting can also increase the room temperature. Too hot temperatures reduce agility, extend reaction time and decision-making time, interfere with the work of the brain, disrupt the coordination of sensory and motor nerves, and make it easier to stimulate.

Conditions of the work environment with inappropriate temperatures can influence performance degradation, but it also influences human psychology in their work [21]. The ways that can do to reduce the condition of hot air, including by improving ventilation and





## Observation Point (Lux)

TP2 TP3 TP4 TP5

TT	07.30-08.00	238	253	244	255	242
TT	08.00-08.30	245	237	245	257	241
T1	08.30-09.00	297	291	294	296	245
T1	09.00-09.30	367	366	368	369	367
T2	09.30-10.00	425	435	453	465	483
T2	10.00-10.30	442	421	437	446	434
T3	10.30-11.00	425	415	414	411	414
T3	11.00-11.30	396	386	379	374	366
T4	11.30-12.00	743	746	733	797	789
T4	12.00-12.30	634	632	615	635	645

Based on the results of measurements and analysis, it is known that the average lighting, if measured from the light intensity of the room in the workshop, is 422.14 Lux which is below the standard threshold value. Based on the work environment quality standard, the lighting for the



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