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# The relation between the discomfort level of automotive industries operators towards their workstation design and work environment

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**Industrial management and organisation**

## ABSTRACT

**Purpose:** Study was carried out to analyze the key factor that contributes towards worker productivity by determining the correlation, relationship and interactional features between comfort level, environmental factors (noise, heat and lighting) and workstation dimension. The identification of discomfort level was carried out among the operators of three automotive companies in Malaysia.

**Design/methodology/approach:** Study was carried out to assess discomfort level based on ergonomical factors and to determine the distribution of body discomfort in relation to the tasks performed. The study was carried out based on questionnaire responses from the participating factories and the collected data was analyzed through the SPSS software.

**Findings:** Findings from the analyzed data shows that the left arm is the most commonly used body part for activities involving lifting, pulling, twisting, carrying and holding. Furthermore, heat discomfort in the working environment is the dominant factor associated with worker productivity due to body discomfort arising from sweat. Developments towards improving the comfort level, environmental factors (noise, heat and lighting) and workstation dimension of the operators must be made to avoid further discomfort.

**Research limitations/implications:** Work environment factors studied in this research are heat/sweat, cold environment, brightness/light, high level of noise, chemical radiation, thermal conductivity and work tool vibration. In addition, activities performed by the operators while working were also linked as the cause of body aches.

**Originality/value:** It can be concluced that working enviroment that caused heat /sweat is the most significant discomfort in the job satisfaction analysis. Furthermore, through correlation analysis, the relationship and interactional features between comfort level, environmental factors (noise, heat and lighting), workstation dimension and activities performed by the operators while working were determined.

**Keywords:** Heat; Noise; Lighting; Productivity

## 1. Introduction

An optimum workstation design which can ensure the comfort of its operator must provide adequate postural support, proper weight distribution of the body/limbs along with the natural positioning of the body/limbs, which should require minimal force when performing a maximum reach. Normally, user acceptance and operator motivation are the main psychological objectives of an industrial workstation layout and these can be achieved if the workstation is simple, convenient, well organized, attractive, reliable and safe. Furthermore, environmental factors surrounding the work area such as illumination, temperature, ventilation, noise and vibration must also be taken into consideration. Workstation dimension should be compatible with the anthropometric characteristics of the anticipated user. The relation between the operator and the dimensional factors that influence the industrial workplace layout which should be considered are postural control and distribution of body weight, reach envelope of hands and eye position with regard to display area [1].

Industrial workers are generally confined to a small working area of the plant in workstation. Often the terms workplace or work environment are used interchangeably and include regular and protective clothing, lighting, climate, chairs, machines, tools, and the actual product. In designing the industrial workplace, the relationship in terms of distances and the other linear dimensions, is often of major importance, especially from the viewpoint of production efficiency and operator physical and mental well being [5].

Job satisfaction has been defined as a pleasurable emotional state resulting from the appraisal of one's job or an affective reaction to one's job and an attitude towards one's job. This positive feeling is a common perception of a self-fulfilling task which can lead to a more important position in a certain field, and whether these factors are compatible with the person's need. These factors are commonly referred to one's desire and achievement, where job satisfaction could be regarded as consideration of work level which is related to remuneration [4].

[2] prepared a survey questionnaire concerning employee satisfaction which covers nine work satisfaction areas from various fields to test their hypotheses. In the questionnaire, each of the different employee satisfaction areas was measured by at least two standardized statements using a 5-point rating scale (from 1 ¼ very satisfied to 5 ¼ very dissatisfied). Overall employee satisfaction was measured using a 100 percent scale. Both these selected areas and the item-variables used were derived from well developed and empirically tested scales to measure employee satisfaction proposed in the literature.

From the [3] study, a review was done on the principles, methods and models used in environmental ergonomics which covers the thermal effects of heat and cold, vibration, noise and light on the health, comfort and performance of people. Environmental ergonomics is an integral part of the discipline of ergonomics and should be viewed and practiced from that perspective. Humans do not respond to the environment in a way monotonically related to direct measures of the physical environment. There are human characteristics which determine human sensitivities and responses. Practical methods for assessing responses to individual environmental components were presented, as well as responses to 'total' environments and current and proposed International Standards concerned with the ergonomics of the physical environment.

## 2. Research method

The flow chart in Figure 1 illustrates how the study was carried out.

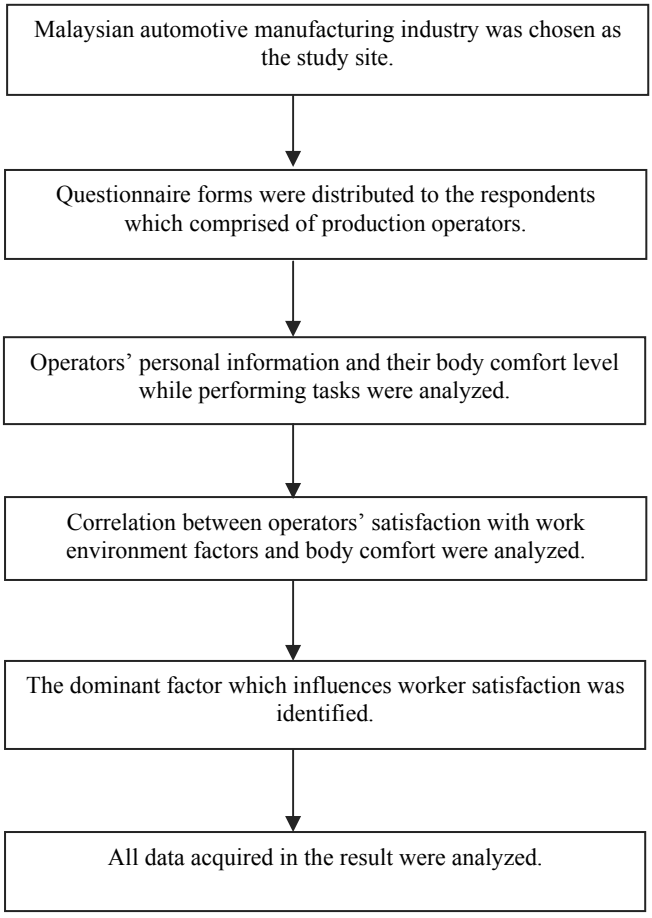


Fig. 1. Flow Chart of the Study

The first step of this academic research was identifying and choosing the Malaysian automotive components assembling industry as the study site, which involved Ingress Engineering Sdn Bhd, SMF Asia Pacific (M) Sdn Bhd and PROTON Holdings Berhad (Tanjung Malim).

In the survey questionnaire, operators were required to answer questions relating to the operators' personal information, work comfort level, factors influencing the operators' satisfaction from the aspect of workstation design and work environment. The

operators' personal information data were then analyzed and the frequency of body aches suffered by the operators within the last working week was studied. In determining the level of pain suffered, a research was done to identify which body part aches the most while working and which needs medical attention.

The correlation between the operators' level of satisfaction with their working environment were also determined. In order to conduct a correlation analysis, relation validity between two factors were determined to get its relationship. Work environment factors studied in this research are heat/sweat, cold environment, brightness/light, high level of noise, chemical radiation, thermal conductivity and work tool vibration. In addition, activities performed by the operators while working were also linked as the cause of body aches.

The dominant factors which influence the operators' satisfaction level were determined through analysis of the data acquired. The data were analyzed to achieve the prescribed objective of the study.

## 3. Result and discussion

The survey questionnaire forms were divided to the 3 participating plants, namely Ingress Engineering Sdn Bhd, SMF Asia Pacific (M) Sdn Bhd and PROTON Holdings Berhad (Tanjung Malim). The number of questionnaire responses collected was 134 (n=134). The operators' personal information data were then classified based on sex, age, weight, height etc.

This research was conducted on a sample of male operators (100%) within the age mode of 20-29 year (73.9%) in the Malaysian automotive components assembling industry. Based on the data acquired, the height mode of the operators is 170 -175cm (30.8%) while their body weight mode is 50 -59kg (38.3%). The height and body weight data acquired is normal since the research is only conducted on male operators. Furthermore, the summary on Table 1 clearly shows that most of the operators have a tendency to work 8 hours a day, in accordance with standard operators working hours. From the survey conducted, it is also understood that as many as 50.7% of the operators are non-smokers. Most of them have been working in the automotive industry for about 5-10 year (23.1%).

Table 1.
Characteristics of the sample

| Characteristics | Category | Percentage % |
|---|---|---|
| Gender | Male | 100 |
| | Female | 0 |
| Age | <20 | 2.2 |
| | 20-29 | 73.9 |
| | 30-39 | 18.7 |
| | 40-49 | 4.5 |
| | >50 | 0.7 |
| Height | < 160 cm | 12.8 |
| | 160 - 165 cm | 26.3 |
| | 166 – 169 cm | 17.3 |
| | 170 – 175 cm | 30.8 |
| | > 175 cm | 12.8 |
| Weight | < 50kg | 6.8 |
| | 50-59kg | 38.3 |
| | 60-69kg | 22.6 |
| | 70-79kg | 14.3 |
| | 80-89kg | 11.3 |
| | >89kg | 6.8 |
| Working hours | 8 hours | 54.5 |
| | 9 hours | 17.9 |
| | 10 hours | 5.2 |
| | 11 hours | 20.1 |
| | >12 hours | 2.2 |
| Smoking | Yes | 49.3 |
| | No | 50.7 |
| Working period | < 3 months | 20.1 |
| | 3 months – 1 years | 14.9 |
| | 1 years – 3 years | 17.9 |
| | 3 years – 5 years | 14.2 |
| | 5 years – 10 years | 23.1 |
| | > 10 years | 9.7 |

### 3.1. Study of factor affecting job satisfaction: workstation design

Part D of the questionnaire focused on how workstation design contributes to the operators' level of satisfaction. 12 variables of workstation design were studied and the analyzed result from the survey was represented in Figure 2.

Analyses made on the level of job satisfaction based on the workstation design factor showed a positive response which indicates that the operators are satisfied with the current design of their workstations. Number 1 to 12 in Table 2 refers to the variables which represent the aspects of a workstation design. This can be referred to the survey questionnaire form in the appendix section.

Cumulatively, for variables 1 to 7, as many as 72.4% respondents feel satisfied and deeply satisfied with their work. As many as 49.7% respondents agreed or totally agreed that the armrest and footrest aspect of the workstation design can gratify work. Apart from that, 54.1% responded in using lifting aids for carrying heavy loads and 54.1% feels that the travel distance between workstations are appropriate. As many as 48.9% respondents agreed or totally agreed with the comfort level of extendibility to the front of their workstations and 54.1% respondents agreed or totally agreed with the seat height of their workstations. 74.4% respondents agreed or totally agreed with the ease to move about within their workstation.

For variable 7, proper head position while performing observations, as many as 50.4% respondent feels that their head

position are unsuitable. As many as 54.9% respondent thinks that the workstation floor in their factory is able to absorb foot stomps, while 50.4% respondent feels that their workstation offers insufficient clearance for legs and thighs. Moreover, 54.2% respondent said there should be safety glass in the workstation during machinery work and as many as 62.4% respondents are satisfied with the clearance of corridor and aisles in carriage area. Lastly, as many as 54.1% respondents agreed that they are able to get products from both side of the conveyors.

Overall, the result for all variables studied showed a job satisfaction level above 50%. The aspect with the highest percentage of satisfaction level on workstation design is 74.4%, which is the ease to freely move about within the workstation.

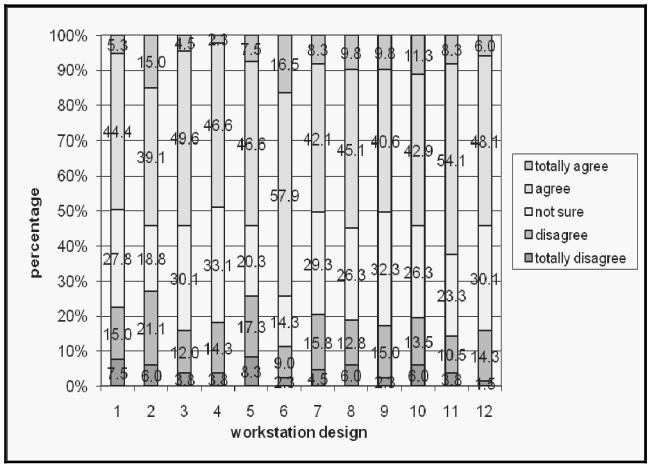


Fig. 2. Percentage distribution of job satisfaction contributed by workstation design

Based on Table 2, it is understood that there is a significant relationship between each variable with the value ρ, for each variable is <0.05 except for the relationship between variable 4, which is extendibility to the front while working in the workstation. The p-value which is less than 0.05 represent a significant relationship between the stated variables and how they are interconnected with one another. The relationship with the highest significant value is the ease to move about in the workstation with the constant correlation value of r=0.296. Based on the correlation table below, it can be concluded that each stated and tested variables does affect the job satisfaction level of the operators.

## 3.2. Study of factor affecting job satisfaction: work environment

Part E of the questionnaire focused on how work environment contributes to the operators' level of satisfaction. 7 variables of work environment were studied and the analyzed result from the survey was represented in Figure 3.

Analyses made on the level of job satisfaction based on the work environment factor showed that 59.1% of the respondents agreed or totally agreed that the heat discomfort in the working environment made them very uncomfortable due to sweat. As many as 15.9% of the respondents feel that their working environment is too cold, while 31.1% respondents feels that the bright light in their workstations are causing eyestrain (eye fatigue).

Table 2.
Correlation between workstation design variables and job satisfaction

| | Variables | | |
|---|---|---|---|
| 1 | Comfortable armrest and footrest | r | 1 |
| | | ρ | |
| 2 | Using lifting aids for heavy load | r | 0.328** |
| | | ρ | 0.000 |
| 3 | Distance of product transfer between workstations | r | 0.298** |
| | | ρ | 0.000 |
| 4 | Extendibility to the front during work | r | -0.014 |
| | | ρ | 0.872 |
| 5 | Proper seat height | r | 0.275** |
| | | ρ | 0.001 |
| 6 | Ease to move about in workstation | r | 0.296** |
| | | ρ | 0.001 |
| 7 | Proper head position | r | 0.178* |
| | | ρ | 0.041 |
| 8 | Stomp absorbing workstation floor | r | 0.243** |
| | | ρ | 0.005 |
| 9 | Insufficient clearance for legs and thighs | r | 0.265** |
| | | ρ | 0.002 |
| 10 | Use of safety glass during machinery process | r | 0.175* |
| | | ρ | 0.044 |
| 11 | Clearance for corridor and aisles in carriage area | r | 0.288** |
| | | ρ | 0.008 |
| 12 | Accessibility of product from the conveyor | r | 0.221* |
| | | ρ | 0.011 |

* Correlation is significant at the 0.05 level (two-tailed)
** Correlation is significant at the 0.01 level (two-tailed)

Data collected for variable 5 shows that as many as 58.3% of the operators feels that their working environment is exposing them to high level of noise. As many as 40.1% respondents agreed or totally agreed that they are exposed to chemical radiation or chemical waste during work. Furthermore, 41.6% respondent thinks that their work environment does not have a proper thermal conductivity and 33.3% of the respondents feel that the work tool vibration can potentially cause harm to their body.

Overall, the highest percentage of discomfort in the working environment is 59.1%, which is the heat discomfort due to body sweat.

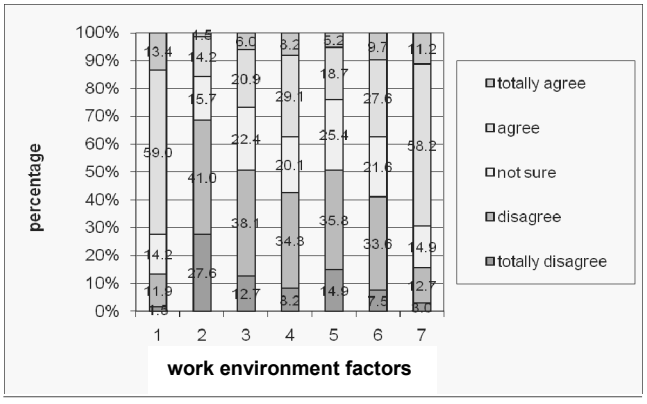


Fig. 3. Percentage distribution of job satisfaction contributed by work environment

Based on Table 3, it is understood that there is no significant relationship between each variable with the value ρ, for each variable is <0.05 except for the relationship between variable 2, heat discomfort due to body sweat, variable 5 which is high level of noise and variable 8 which is work tool vibration. The p-value which is less than 0.05 represent a significant relationship between the stated variables and how they are interconnected with one another. Even though the relationship for variables 3, 4, 6 and 7 does not have any significant value, the relationship between these variables and other variables of the working environment is significant. The relationship with the highest significant value is the heat discomfort due to body sweat with the constant correlation value of r=0.0185. Based on the correlation table below, it can be concluded that each stated and tested variables does affect the job satisfaction level of the operators.

## 4. Conclusions

From the result of this study, it can be concluced that working enviroment that caused heat /sweat is the most significant discomfort in the job satisfaction analysis. Furthermore, through correlation analysis, the relationship and interactional features between comfort level, environmental factors (noise, heat and lighting), workstation dimension and activities performed by the operators while working were determined. Discomfort resulting from heat/sweat showed a significant value of ρ=0.034 with the constant correlation value of r=0.0185.

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The author acknowledge Ingress Engineering Sdn Bhd, SMF Asia Pacific (M) Sdn Bhd and PROTON Holdings Berhad (Tanjung Malim) for their full commitment and cooperation through out this study.

Table 3.
Correlation between work environment variables and job satisfaction

| | Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Job satisfaction | r | 1 | | | | | | |
| | | ρ | | | | | | | |
| 2 | Heat / sweat | r | 0.185* | 1 | | | | | |
| | | ρ | 0.034 | | | | | | |
| 3 | Air conditioning | r | -0.079 | -0.075 | 1 | | | | |
| | | ρ | 0.370 | 0.391 | | | | | |
| 4 | brightness /light | r | 0.074 | 0.281** | 0.203* | 1 | | | |
| | | ρ | 0.397 | 0.001 | 0.020 | | | | |
| 5 | High level of noise | r | 0.172* | 0.441** | 0.140 | 0.356** | 1 | | |
| | | ρ | 0.049 | 0.000 | 0.109 | 0.000 | | | |
| 6 | Chemical radiation | r | -0.019 | 0.282** | 0.342** | 0.350** | 0.536** | 1 | |
| | | ρ | 0.825 | 0.001 | 0.000 | 0.000 | 0.000 | | |
| 7 | Thermal conductivity | r | -0.048 | 0.329** | 0.246** | 0.384** | 0.620** | 0.539** | 1 |
| | | ρ | 0.588 | 0.000 | 0.004 | 0.000 | 0.000 | 0.000 | |
| 8 | Work tool vibration | r | -0.173* | 0.111 | 0.326** | 0.320** | 0.399** | 0.475** | 0.582** |
| | | ρ | 0.048 | 0.207 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

* Correlation is significant at the 0.05 level (two-tailed)
** Correlation is significant at the 0.01 level (two-tailed)

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