Heart Rate Trend of Composite Manufacturing Workers in Hand Layup Process

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ABSTRACT – Hand layup is considered as a manual labour process which uses physical strength while working. During work, heart rate is the simplest tracker of a human physical state. Thus, in this paper, heart rate is collected in between work tasks. The aim of this paper is to investigate the effect of hand layup process on the heart rate behaviour of workers in a composite industry. Results show that more than 40% of the workers in one of the composite manufacturers in Malaysia, had heart rate level that was out of the normal resting heart rate level at 62 to 78 bpm. The trend illustrated that the workers' average heart rate had nearly exceeded the boundary of normal heart rate level. In conclusion, the hand layup process can be classified under the moderate intensity activity according to the average heart rate data obtained.

1. INTRODUCTION

Heart rate (HR) is one of the indicators of human health, where physicians can determine the level of humans' physical health. Previous research found that a normal person with no serious disease will have normal resting HR of 66 to 82 beats per minute (bpm) [1]. In most cases, HR data is collected to calculate energy expenditure of a human or to validate stress level in psychological factor of humans in the working environment. According to Fuller et al. [2], HR data with other parameters showed a main effect of fatigue. Studies conducted by several other sources indicate that HR level is one of the methods to validate risk of health in manufacturing sectors [3].

This study is conducted at a composite manufacturing industry which covers on hand layup process. Hand layup process (as in Figure 1) had been identified as manual material handling (MMH) as mentioned in Rayme et al. [4]. In MMH, the working task was considered risky and often led to musculoskeletal disorder (MSD). This paper covers the partial section of overall research. The problem statement obtained from the industry was there was an increasing number of absenteeism due to a backache problem.

Moreover, according to Morken et al. [5], absenteeism among blue-collar workers are related to MSD. MSD is any related disease related to the muscular system. Henceforth proved that the activity needs investigation in the ergonomics part. This paper aims to investigate the effect of hand layup process on the heart rate behaviour of workers in a hand layup process manufacturing of composite and it is the continuation of research done by Rayme et. al [4].

2. METHODOLOGY

In this paper, HR value act as an indicator in calculating the intensity of the process. This is because excessive exercise or forced exercise activity will impose great treats to health. The tools that were used to obtain the HR value of the respondent was using a microcomputer as suggested by Karvonen and Vuorimaa [6]. Next, for the reliability of data set, equipment calibrations, consent from respondents, and ethics approval were done and obtained beforehand. Data were collected at four different hours with a similar duration of time at; 9.00 to 10.00 am, 12.00 – 1.00 pm, 2.30 – 3.30 pm and 4.30 – 5.30 pm, consequently per respondents and experiment was repeated for 3 days to get average HR level of a respondent. The maximum respondents for one day are 10 people per one-hour session. Calculation of maximum HR for work intensity was using the formula in equation 1 as in She et al. [7].

$$HR_{max} = 220 - Age \quad (1)$$

From World Health Organization [8] stated that during moderate intensity activity the normal level your HR_{max} is in range of 50-69% and during vigorous-intensity activity is 70-90%.

3. RESULTS AND DISCUSSION

From the data collection, the HR_{max} and minimum and maximum value of average HR are calculated and illustrated in Figure 2. The HR max differs with max average HR value. It shows that at the time of the day, the average heart rate is 75 bpm and 81 bpm. In this data analysis, the average age of the workers is 21 years old, hence the HR_{max} to be compared with is 199 bpm. This is set as a benchmark of the shaded region in Figure 2 to identify the average HR level of the workers falls into categories. This shows the outcome of HR level is still in the range of normal level which is resting, however, it is already nearing the bar of the moderate intensity activity level. Furthermore, the 75 bpm data is collected at the early stage of the day was supposedly the HR level of a human should be at a low. This data collection may support the hypothesis that the process falls into moderate intense activity. From Figure 2 the results show that maximum average HR is at a time "after lunch hour" is the highest at 120 bpm.

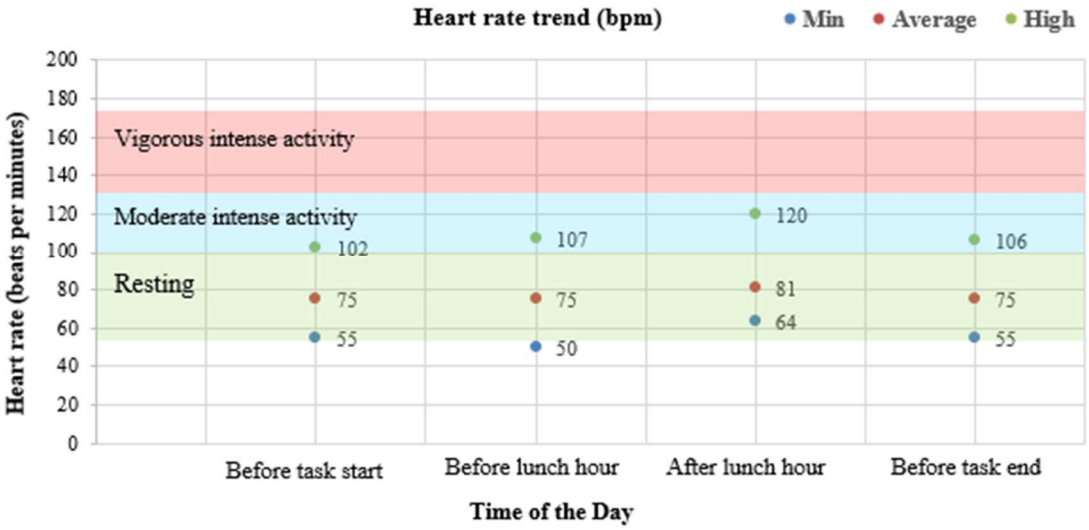

Figure 2 Heart rate trend graph

Through simple calculation, the percentage of HR is at 60.3% of the HR $_{max}$. This HR level had fall moderate intensity activity category, where the prolonged intense activity will deprive the health state of a person. Some of the workers had been in this condition where the average HR level fell into the unhealthy state. However, the number of beats of the human heart are different from one another thus, this result shows that there is in need of a thorough investigation of the section. HR also states the mental stress where the Central Nervous System (CNS) is affected. As mention by Ali [9], prolonged exercise leads to fatigue of the CNS in the human brain where the human feels tired. The effects of fatigue of CNS can include numbness and the absence of pain feeling after being doing the tasks for a while. During the data collection HR, some small interviews were done and some supports the statement that they had not felt the pain after a while.

4. CONCLUSIONS

Conclusively, heart rate (HR) level can display ones' physical state by analyzing the heart beats per minutes as in this research HR level indicates the intensity of the manual labour towards the workers and this study shows that hand layup process had fallen into moderate intense activity.

As for recommendation, the study should be separated and go further on the impact of central nervous system (CNS) and based on the maximum average heart rate of 120 bpm, it should be lowered up to 17% at least to achieve heart rate in the resting state to avoid fatigue in prolonged hand layup activity.

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