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Cardiovascular Load on Analyzing the Effect of Work Schedule among Intercity Travel Drivers' Physical Workload in East Kalimantan

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Abstract. *High physical workload is often closely related to fatigue, especially when exposed to tasks that require heavy, repetitive and long-duration physical activity. Fatigue has become a major factor in traffic accidents in the transportation sector. Data shows the increasing number of accidents by 6.2% from 2015 to 2022. This study aims to measure the physical workload of travel drivers at Kanguru Travel, an intercity automobile travel service in East Kalimantan. Work physiology approach is used with Cardiovascular Load (CVL) method. Meanwhile, data analysis uses the Kruskal-Wallis test. The study sample consisted of 21 drivers ranged between 30 – 65 years old. The results of the study showed that the night work schedule made a greater impact on physical workload than the morning and afternoon work schedules. However, drivers' workload at Kanguru Travel falls under light category.*

Keywords: *physical workload; working schedule, transportation; intercity travel service, cardiovascular load.*

I. INTRODUCTION

High physical workload is often closely related to fatigue (Cropley et al., 2020; Maulana et al., 2023). When an individual is exposed to tasks that require heavy and repetitive physical activities such as working in long hours or irregular schedules, the risk of fatigue shall increase significantly. In transportation sector, fatigue is the major risk factor that can cause traffic accidents (Apsil et al., 2023; Zhang et al., 2020). Statistical data shows that the number of traffic accidents has increased by 6.2% each year from 2015 to 2022 (Badan Pusat Statistik, 2024). Fatigue has become the factor that cause 30%-45% of all traffic accidents (Zhang et al., 2020). It can reduce cognitive and motor abilities as the effect of excessive physical activity or high workloads (Agustinawati et al., 2019; Syamsul & Rahmansyah, 2023). Work schedules also become an adhere factor that induce fatigue. Night work schedules tend to cause higher level of fatigue than others (Agustiana et al., 2023).

Travel driver is a vulnerable job for being exposed to high level of workload (Fitria et al., 2023). Drivers often have to cover long periods of time, long distances while face varied weather and road conditions. Kanguru Travel is an intercity travel service located in Balikpapan, East Kalimantan, that provide travel routes from Balikpapan to Samarinda vice versa. Based on initial interviews with drivers, they got exhausted in certain conditions due to driving for quite lengthy distances and time (Sun et al., 2022). The travel agency also said that in the last five years, several traffic accidents due to exhaustion were happened.

Unfortunately, drivers' physical workload management in many cases doesn't get that much consideration from the company, including Kanguru Travel. Although this kind of job requires high levels of physical activity, companies do not have the knowledge and effective programs to manage and reduce their employee's workload. Therefore, measuring the physical workload based on work schedule of intercity travel drivers is absolutely necessary, with Kanguru Travel as the object of analysis. It can help Kanguru Travel and other similar companies to find out the physical workload of drivers based on work schedules, which later shall be used as a basis for

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developing proper improvement strategies to reduce the level of physical workload and driver safety. Moreover, it can help the government to reduce the number of traffic accidents.

The approach used to solve this problem is work physiology approach with Cardiovascular Load (CVL) method. CVL assesses workload levels from cardiovascular load percentage. The value is obtained by calculating the increase in working pulse rate compared to the maximum pulse rate. With CVL, the level of physical workload on the driver can be measured and classified (Dias et al., 2023; Kurnia et al., 2021). The advantage of CVL compared to other methods is that it can be used for a quick physical workloads measurement in real time with simple equipment, as well as cheaper costs as the benefit (Handika et al., 2020).

The measurement of physical workload levels in transportation sector has been done before. For example, research on measuring physical workload on Inter-City Inter-Province Bus Services drivers from Yogyakarta to Surabaya using the CVL method (Rohmah & Zulhadi, 2019), physical workload assessment on online drivers using the CVL method (Mubarok & Rusindiyanto, 2023; Nugroho & Suryadi, 2023; Suryadi et al., 2023), and physical workload assessment on truck drivers using the Heart Rate Reserve method (Prawajianto et al., 2016). However, those previous research only focuses on discussing the classification of physical workload levels without considering the influential factors on the levels of physical workload in low to high range, for example is work schedules. In fact, many studies beyond the transportation industry sector, which is the focus of this research, have stated that work schedules is a major influence on the physical workload level experienced by workers (Esmaily et al., 2021; Russeng et al., 2021; Septiari, 2020; Sumardiyono et al., 2023). As an illustration, a research conducted by Sumardiyono concluded that work schedules are the most influential variables on the physical workload of production operators out of the three variables measured (Sumardiyono et al., 2023), which means that there is still a knowledge gap in workload measurement in the transportation sector. This research offers novelty both in terms of the subjects and the variables. The subjects of this study were intercity travel drivers in East Kalimantan, which is a rare subject for a research focus. This study is relevant with the inadequate road conditions in East Kalimantan as the significant factor (Junaidi et al., 2020).

II. RESEARCH METHOD

Sample

The sample in this study consisted of 21 drivers at Kanguru Travel from Balikpapan City as the departure point.

Data Collection

The collected data are consisted of secondary data and primary data. Secondary data is related to gender and age of respondents, while the primary data is related to the driver’s WHR (Working Heart Rate) and RHR (Resting Heart Rate) which are measured with Oximeter. RHR was measured before the driver starts working, then the WHR was measured while the driver is driving. The driver's pulse rate then categorized into three work schedules: the morning work schedule (07.00 - 15.00); afternoon (15.00 - 23.00); and night (23.00 - 07.00).

Figure 1. Oximeter

Figure 2. Heart rate scanning process with oximeter

Data Processing and Analysis

a. Maximum Heart Rate Calculation

After RHR and WHR were measured, the process then continued by calculating Maximum Heart Rate (HR_{Max}). The formula for calculating HR_{Max} is as follows (Kurnia et al., 2021).

$$Male\ HR_{Max} = 220 - Age \qquad \text{..... (1)}$$

$$Female\ HR_{Max} = 200 - Age \qquad \text{..... (2)}$$

b. Calculation of Cardiovascular Load Percentage

Cardiovascular Load Percentage (%CVL) is calculated by comparing the increase in Working Heart Rate value with HR_{Max}. The formula for calculating %CVL is as follows (Kurnia et al., 2021).

$$\%CVL = \frac{100 \times (WHR - RHR)}{HRMax - RHR} \qquad \text{..... (3)}$$

Formula description:

WHR = Working Heart Rate
RHR = Resting Heart Rate
HR_{Max} = Maximum Heart Rate

The results of the %CVL are then compared with the workload classification as in Table 1 below (Fatah & Mahacandra, 2024).

Tabel 1. Workload Categories Based on %CVL Value

%CVL Value	Workload Category
< 30%	Low
30% ≤ CVL ≤ 60%	Moderate
60% ≤ CVL ≤ 80%	Moderately High
80% ≤ CVL ≤ 100%	High
> 100%	Very High

c. Kruskal-Wallis Test

The Kruskal-Wallis is a test to determine the significant difference between physical workloads in terms of work schedule (Suprayitno et al., 2023). If the significance value (p-value) is less than 0.05, then the conclusion is that the difference between physical workload of drivers in terms of work schedule is significant (Riwanti et al., 2020).

Improvement Proposal's Determination

As the basis for improvement proposals, finding potential root causes was carried out to reduce the level of physical workload on drivers. Improvement proposals are determined through Focus Group Discussions (FGD). The research steps can be described with the flowchart in Figure 3.

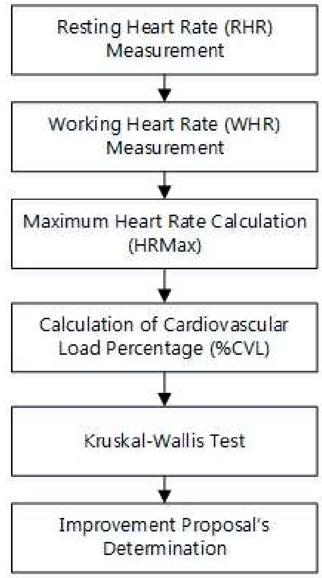

Figure 3. Research flowchart

III. Result and Discussion

Driver's Heart Rate

The driver's heart rate was measured using an Oximeter. Resting Heart Rate (RHR) was measured before the driver started working, while the Working Hear Rate (WHR) was measured while the driver was driving. After the RHR and WHR were obtained, HRMax was calculated using a formula that was adjusted to the driver's gender. The results of the RHR and WHR measurements and the HRMax calculation can be seen in Table 2 and 3.

Calculation of Cardiovascular Load (%CVL)

Physical workload can be determined by measuring driver's %CVL, in which %CVL is calculated using the %CVL formula. The results are in Table 4.

Based on the calculation results presented above, the %CVL value for all respondents is below 30%. This indicates that the physical workload of drivers at Kanguru Travel falls under light category (Fatah & Mahacandra, 2024). The workload level is considered acceptable for the driver's physical condition in the morning,

Tabel 2. Results of RHR Measurement and Driver's HR_{Max} Calculation

No	Respondent	Gender	Age (years)	HR_{Max}	RHR (bpm)		
					Morning	Afternoon	Night
1	Driver 1	Male	48	172	79	84	85
2	Driver 2	Male	61	159	64	75	75
3	Driver 3	Male	48	172	91	88	90
4	Driver 4	Male	49	171	83	85	88
5	Driver 5	Male	62	158	79	79	80
6	Driver 6	Male	57	163	106	90	88
7	Driver 7	Male	58	162	113	87	87
8	Driver 8	Male	45	175	72	70	81
9	Driver 9	Male	55	165	90	95	98
10	Driver 10	Male	53	167	98	96	98
11	Driver 11	Male	63	157	75	79	79
12	Driver 12	Male	57	163	80	91	92
13	Driver 13	Male	55	165	75	89	90
14	Driver 14	Male	64	156	90	95	95
15	Driver 15	Male	53	167	80	82	86
16	Driver 16	Male	63	157	68	65	71
17	Driver 17	Male	52	168	64	68	68
18	Driver 18	Male	33	187	75	90	92
19	Driver 19	Male	60	160	77	84	86
20	Driver 20	Male	43	177	90	89	105
21	Driver 21	Male	40	180	70	76	79

Tabel 3. Result of WHR Measurement and Driver's HR_{Max} Calculation

No	Respondent	Gender	Age (years)	HR_{Max}	WHR (bpm)		
					Morning	Afternoon	Night
1	Driver 1	Male	48	172	88	92	95
2	Driver 2	Male	61	159	70	79	80
3	Driver 3	Male	48	172	95	95	96
4	Driver 4	Male	49	171	88	90	94
5	Driver 5	Male	62	158	85	85	87
6	Driver 6	Male	57	163	111	96	95
7	Driver 7	Male	58	162	117	93	95
8	Driver 8	Male	45	175	80	80	93
9	Driver 9	Male	55	165	95	101	105
10	Driver 10	Male	53	167	101	99	102
11	Driver 11	Male	63	157	80	82	87
12	Driver 12	Male	57	163	87	95	96
13	Driver 13	Male	55	165	82	95	97
14	Driver 14	Male	64	156	94	98	100
15	Driver 15	Male	53	167	85	91	93
16	Driver 16	Male	63	157	75	74	80
17	Driver 17	Male	52	168	70	75	78
18	Driver 18	Male	33	187	85	95	100
19	Driver 19	Male	60	160	80	90	92
20	Driver 20	Male	43	177	94	94	110
21	Driver 21	Male	40	180	83	82	91

afternoon, and night work schedules. Meanwhile, if you look at the average %CVL value for each work schedule, the night work schedule has the highest value of 8.95. This means that the night work schedule make a higher impact on the drivers' physical workload.

Kruskal-Wallis Test

Kruskall-Wallis Test is a statistical test used to determine the effect of work schedules on the physical workload felt by driver (Suprayitno et al., 2023). The test results using Kruskall-Wallis can be seen in Tables 5 and 6.

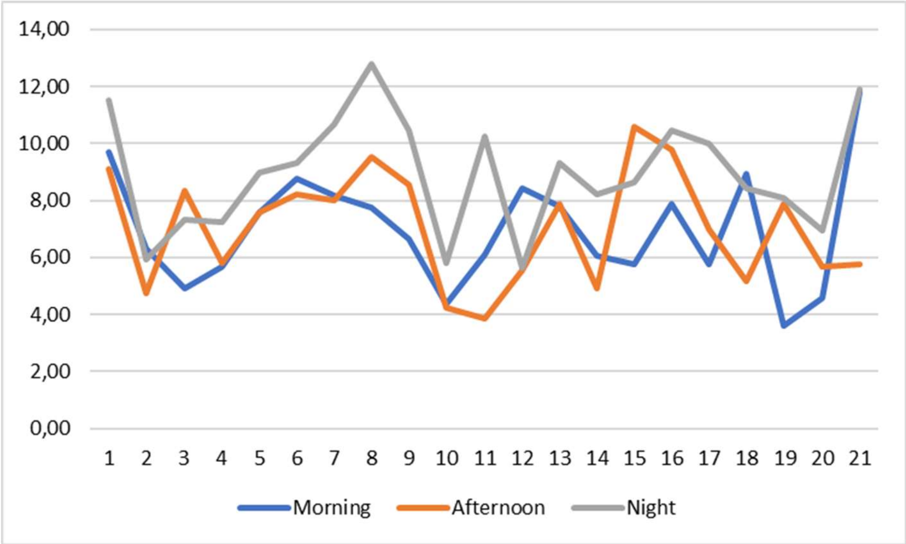

Figure 4. comparison graph of %CVL based on work schedule

The results of the difference test using Kruskall-Wallis in Table 5 show a significance value (p-value) of 0.004 (P <0.05). It indicates a significant difference between driver's physical workload in terms of work schedules. In addition, night work schedule based on Mean Rank value in Table 6 has a value of 42.79. The result is the highest compared to the morning and afternoon work schedules. It shows that night work schedule make a higher impact on the drivers' physical workload. These results are in line with prior research (H. Zhang, Yan, Wu, & Qiu, 2014; Q. Zhang et al., 2020), in which drivers tend to worn out faster in the afternoon to night. In addition, night work schedule also increases the risk of fatigue by 28% and can increase accidents probability (Kacandra, Abdullah, & Arifin, 2024). Therefore, it is important for drivers to get enough rest during this period before driving.

Tabel 4. Result of %CVL Calculation

No	Respondent	%CVL		
		Morning	Afternoon	Night
1	Driver 1	9.68	9.09	11.49
2	Driver 2	6.32	4.76	5.95
3	Driver 3	4.94	8.33	7.32
4	Driver 4	5.68	5.81	7.23
5	Driver 5	7.59	7.59	8.97
6	Driver 6	8.77	8.22	9.33
7	Driver 7	8.16	8.00	10.67
8	Driver 8	7.77	9.52	12.77
9	Driver 9	6.67	8.57	10.45
10	Driver 10	4.35	4.23	5.80
11	Driver 11	6.10	3.85	10.26
12	Driver 12	8.43	5.56	5.63
13	Driver 13	7.78	7.89	9.33
14	Driver 14	6.06	4.92	8.20
15	Driver 15	5.75	10.59	8.64
16	Driver 16	7.87	9.78	10.47
17	Driver 17	5.77	7.00	10.00
18	Driver 18	8.93	5.15	8.42
19	Driver 19	3.61	7.89	8.11
20	Driver 20	4.60	5.68	6.94
21	Driver 21	11.82	5.77	11.88
	Average	6.98	7.06	8.95

Tabel 5. Kruskal-Wallis Test Result

Test Statistics	
	CVL
Chi-Square	10.927
df	2
Asymp. Sig	0.004

Tabel 6. Mean Rank

Ranks			
	Schedule	N	Mean Rank
CVL	Morning	21	26.21
	Afternoon	21	27.00
	Night	21	42.79
	Total	63	

Proposed Improvements

Based on the results of %CVL calculation, the physical workload of drivers at Kanguru Travel is categorized as light, and the physical workload is still acceptable for physically. However, by considering other factors that can increase the physical workload such as age (Aprianto, Rokhim, Basuki, & Sugiyarto, 2021), resting/break time and work duration (Belia & Handayani, 2020; Lupita & Rukayah, 2020), some improvements can be made to minimize the condition that comprised of proposing: 1) Daily working duration should not exceed 8 hours. Driving duration that exceeds the normal limit or is more than 8 hours will have a greater impact on work fatigue (Rachman, Septiyanti, & Mahmud, 2021; Syam, Hasmah, & Nurfaizah, 2024). Fatigue and physiological disorders will not occur if the workload received by the driver is not excessive. 2) The end of each night schedule must be followed by a minimum rest period of 24 hours (Azmy, Arianti, Wulandari, Malau, & Azizi, 2023). 3) Requiring drivers to stop at rest areas around 30 minutes to increase resting time. This is in accordance with the recommended rest periods regulated in Manpower Law No. 13 of 2003. The minimum rest time between working hours is 30 minutes after working for 4 hours continuously (Republik Indonesia, 2003).

IV. CONCLUSION

From the results can be concluded that: 1) work schedules affect drivers' physical workload, in which night schedules have a greater influence compared to morning and afternoon schedules; 2) drivers' physical workload at Kanguru Travel is categorized as light; 3) proposed improvements that can be made to reduce physical workload comprised of 8-hours maximum duration of daily work, the end of each night work schedule should be followed by a minimum rest period of 24 hours, and requiring drivers to rest at rest areas around 30 minutes to increase time of rest.

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