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Effect of Driver Behavior on the Coal Truck Trips Movement on Coal Haul Roads

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Abstract--- *The pattern of coal hauling travel is highly dependent on driver behaviour. Drivers who have experiences and skills in driving big trucks on coal haul roads make them more comfortable during the trip. Good work motivation will reduce the driver habits wasting time traveling in certain places. The use of the right time will affect driver behavior, including rest, sleep, normal work and social contact. The research to analyze effect of driver behavior on truck trips movement and use of travel time on coal haul roads. The research methods are field study, observations, and questionnaires with analytical statistics. The results indicates that coal truck driver behavior very influenced by work-motivation, road and vehicle conditions. This directly affects the pattern of truck trips movement from the stockpile to the port. The stopping duration at certain places such as stalls, roadside and workshops causes the travel time duration to increase, thereby reducing timeliness. The good vehicle condition adds to the truck drivers work motivation. Damaged road conditions and excess loads increase alertness, are not comfortable, thereby reducing travel speed. Transportation companies and coal haul drivers must maintain the safety, smooth distribution of goods and periodic maintenance of vehicles to stay excellent.*

Keywords--- *Impact, Drivers Behavior, Travel Timeliness, Truck, Coal Roads.*

I. INTRODUCTION

Time is a valuable and limited resource for individuals and businesses. Every individual always has an attachment to the problem of travel time in making a productive trip or not. Disruption of travel time will cause problems for everyone in achieving goals. For this reason, everyone needs the method used to manage travel time as efficiently as possible. Transportation policies can affect the way we use time.

Something that has been understood together that travel timeliness has a close relationship with various determinants, including driver behaviour, and determines one's certainty in achieving travel timeliness. The location of departure and destination is also part of the determinants that need to be considered when wanting to achieve timeliness.

The method of travel time reliability is important for road service users so that people will be better prepared to estimate the travel time on each trip. The travel time reliability method based on consideration of the results of the calculation of reliability or variability which then encourages road service users to try to be more concerned with a series of problems. Goods transportation activities on land transportation in Borneo generally use trucks because of their flexibility and broader cruising than using trains, ships or airplanes, and regional topographic factors. Truck has carried out its functions for decades as the main pillar of logistics distribution in the context of equitable distribution

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of national development to remote areas for the welfare of the Indonesian people. The trucking activities frequency is the main barometer in responding to national economic growth.

The research to analyses the driver characteristics with the field facts, the driver perception with seven variables (discipline, motivation, responsibility, rewarding work environment, road conditions and conditions) and drivers behaviour based on internal factors (work motivation, work operations, social conditions, and health conditions) and external factors (road infrastructure conditions, vehicle conditions, and weather) on the travel timeliness.

II. Related Literature

2.1. Travel Time Reliability

The travel time value contributed 18% of the goods value by World Bank (2016). In the logistics system, transportation is a logistical system framework part, integrating the concepts of distribution and transportation management. According to the study by Chen et al. (2012) results, it is evident that travel time reliability use is indeed beneficial to facilitate transportation service facilities for drivers of public vehicles, private vehicle drivers, pedestrians and others. Recker et al. (2005) suggested that a good understanding of the reliability of travel time helped planners of the public transportation system to be more prudent in deciding various appropriate policies to reduce congestion and other incidents.

The coal transportation using tronton on special coal haul roads does not use tarps to cover material and is generally overloaded so that it has many vulnerabilities in the shipping process, both dust and coal debris from coal coming out of the tub, the material gets wet due to rain or burning due to hot weather. Transportation will be longer due to the driver behavior who often stop either on the roadsides, stalls or workshops so that the delivery frequency is only three times the transportation from the stockpile to the port.

2.2. Characteristics and behavior of the coal truck drivers

Coal as a mining sector that supports Borneo Economic Corridor (MP3EI), so it must take precedence. The driver is one of the human resources that support MP3EI activities. Reliable driver behavior, expertise, discipline, motivation, and professionalism can lead to accurate time calculations for each mining transportation activity to avoid successive delays that are equal to successive losses for the company.

Transportation is very dependent on the behavior of the driver who provides services in the form of timeliness and safety in driving. The characteristics of coal truck drivers are different from other transport drivers because coal truck drivers carry bulk coal loads (increase in ambient temperature) with large trucks, expensive commodity prices, full of dust, high workload, low road quality, and under target pressure. Driving is more difficult when they have to drive in damaged road conditions or in night conditions with less street lighting. Truck drivers also have a high mental workload, because they are required to drive large vehicles with full concentration and high levels of alertness every day for a considerable period of time. Undisciplined driver behavior, lack of knowledge and experience, carelessness, fatigue, drowsiness, cell phone use, long layover times and lack of motivation/work ethic are some of the driver's behaviors that lead to ineffective travel time, increased travel costs and reduced availability of coal.

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2.3 Perception of coal truck drivers on hauling coal special roads using Analytic Hierarchy Process (AHP)

Perception is a response or acceptance directly from someone. Perception is the experience of objects, events, or relationships obtained by deducing information and interpreting messages. In terms of psychology, it is said that a person's behavior is a function of his appearance, therefore, to change a person's behavior, it must begin by changing his perception.

This study analyzes driver perception as a companion for analysis of driver behavior. So that multi-criteria decision making with the Analytic Hierarchy Process (AHP) used to choose the right variable. Some areas where AHP has been successfully used include the selection of one alternative from many, allocation of resources, forecasting. The advantage of this decision support tool is that the final rank is obtained based on relative partner evaluation for the criteria and options provided by the user. The AHP approach is used because of rational and understandable logic, and the computational process is relatively easy.

Saaty (1990) introduces a fundamental scale that shows the intensity of interest on an absolute scale. This scale is used to compare alternatives and criteria. The scale consists of verbal judgments of preferences ranging from the same to the extreme (same, moderate, strong, very strong, very important) with appropriate numerical judgments (1, 3, 5, 7, 9), as well as values between two judgments. Alternative pairing matrices for alternatives are filled with numerical valuation and the elements fulfill reciprocal properties, which means if my activity has one of the non-zero numbers above given to him compared to y activities, then j has reciprocal value when compared to I ($a_{ji} = 1 / a_{ij}$).

After the matrix is built, then calculate the priority vector. Comparison of elements based on a single property to construct paired comparison matrices for criteria along with pairwise comparison matrices for alternatives allows computing local and global priorities and alternative rankings. Priorities from paired comparisons can be calculated using: eigenvector method, geometric mean method or arithmetic mean method. According to Saaty (1990), priority elements can be estimated by finding the main eigenvectors of the matrix A, $AW = \lambda_{max}W$, where the maximum eigenvalue of the matrix A. When the vector W is normalized, it becomes a priority vector of one level elements with respect to the elements at the top level. While building each paired comparison matrix involved in the decision-making process, it is necessary to examine consistency by calculating the consistency ratio (CR) as the ratio of the Consistency Index (CI) and Random Index (RI). Inconsistency can be tolerated and reliable results can be expected from AHP if $CR < 0.1$. Random Inconsistency Index (RI) for small problems (n = 1, 2, 3 ... 10) is given in Table 1 (Saaty, 1980, Saaty, 1990). The consistency index is calculated as $(\lambda_{max} - n)/(n - 1)$.

Table 1: Random Inconsistency Index (RI) for n=1, 2... 10

N	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.4 Literature review

Based on previous research related to this study such as Recker et al. (2005), examining behavioral considerations in travel time reliability, Eboli, L. et al., 2016 tried to combine the speed and acceleration of car users to determine unsafe driving behavior or not secure. Then Eboli. et al. (2017) examine the investigation of driving behavior of car users through speed analysis. Chen et al. (2012) examined the reliability of travel time as a measure of service, Davidovic et al. (2018) analyzing driver fatigue. Iselanda et al (2018) analyzed assignments and training to drivers so as to increase awareness while driving and developing driving capacity.

Prasolenko et al. (2015) also examined human factors in traveling, and Zicatet al. (2018) analyzed cognitive functions, namely the relationship between driving, attitudes, personality, and cognition of young drivers. Dinges (2005) examines the drowsiness factors relationship to accidents which are usually due to workload and lack of rest time. Kirti, M. et al. (2018) discusses drivers, work-lifestyle patterns and intensive payments to truck drivers. Moghaddam et al. (2017) analyzes the influence of travel time information, and service level on driver protection using a driving simulator.

Uchida (2014) analyzes two network models which simultaneously estimate the value of travel time and travel time reliability based on the risk-averse driver's route choice behavior. Fosgerau et al. (2011) about the value of travel time variability under scheduling preferences that are defined in terms of linearly time varying utility rates associated with being at the origin and at the destination

III. METHODOLOGY

3.1. Participants and measures

In this study, there were three discussions, namely the characteristics of the driver, the behavior of the coal truck driver with 116 drivers and the perception of the driver as many as 11 drivers who worked in coal companies in Rantau District, South Kalimantan, Indonesia by using special coal-hauling roads. This research was conducted in the period from September 2018 - March 2019.

3.2 Statistical analysis

The database of responses was formed and the data were analyzed using SPSS statistics version 23.0. In order to determine the impact strength of the seven main factors including work motivation (X_1), operational work (X_2), social conditions (X_3), health conditions (X_4), transportation infrastructure conditions (X_5), vehicle conditions (X_6) and weather (X_7) the travel timeliness (Y).

The survey for driver behavior uses a questionnaire of 42 indicators. We performed some statistical analysis (descriptive, nonparametric test and correlation). Assessment based questionnaire on a Likert scale strongly disagree-strongly agree (value one to five). While the driver's perception survey uses the Analytic Hierarchy Process (AHP) on a scale of 1-9.

IV. RESULTS AND DISCUSSION

4.1 Coal driver characteristic

The coal transport drivers behavior surveyed was based on driver characteristics (age, ethnicity, education, marital status, knowledge, work experience, income, vehicle age).

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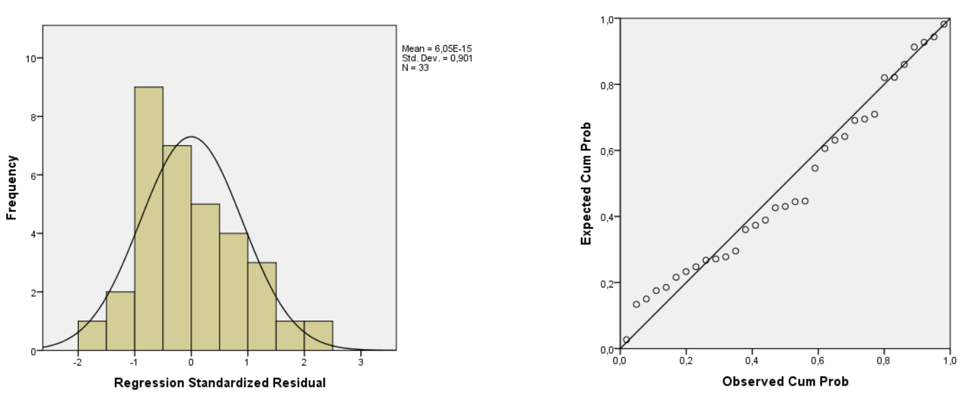
Table 2: Demographic characteristics (N=116)

Variabel	N	%		Variable	N	%
Age				Marital status		
≤ 25 years	9	8		Married	83	72
26-35 years	59	51		Never married/divorced	19	16
36-45 years	33	28		Single	14	12
≥ 45 years	15	13				
Education				Truck driver experience		
≤ junior high school	5	4		≤ 1 year	13	11
Senior High School	96	83		2-4 years	95	82
3-year diploma	12	10		5-7 years	5	4
≥ bachelor	3	3		≥ 8 years	3	3
Population status				Driving duration/day		
Local residents	81	70		Normal, <8 hours	38	33
Outside residents	35	30		Weight, > 8 hours	78	67
Income/month				Driving frequency/day		
≤ 3 million	28	24		≤ 3 times	36	31
3-6 million	67	58		4 times	67	58
≥ 7 million	21	18		5 times	11	9
				> 5 times	2	2

Table 2 indicates that the age of the driver is still in the productive age with range (25-45 years) by 87%, the largest educational qualification according to recruitment is high school (83%), the largest population status of local residents is 70%, this aims to empower people local/native. Data in the field shows that the driver's income depends on the driving frequency /day. Highest income in the range of 3-6 million (58%) and the driving frequency highest/day is 4 cycles (58%). It means that the driver will get 3-6 million/month if the more 4 times frequency/day. The highest marital status is marriage (72%), with the marriage status, the responsibility is expected to be great. The highest driving experience was in the range of 2-4 years, and the driving duration/day is relatively heavy, namely> 8 hours/day (67%).

4.2 Coal driver behavior and statistical analysis with Classic assumption



(a) (b)

Figure 1: The assumption of normality; (a) Histogram (normal curve); (b) Normal P-P plot of regression standardized residuals

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In Figure 1 (a) illustrated the normality assumption with a normal curve tends to form a symmetrical pattern and (b) residual points tend to spread between diagonal lines so that residuals are declared to be normal spreads. The heteroscedasticity assumption means that there is a variable variance in the regression model that is not constant (the same), conversely if it has a constant variance called homoscedasticity. In order for the model to be said to be good, the regression model must meet homoscedasticity. In this study, the method used to detect residual normality is the Scatter Plot method.

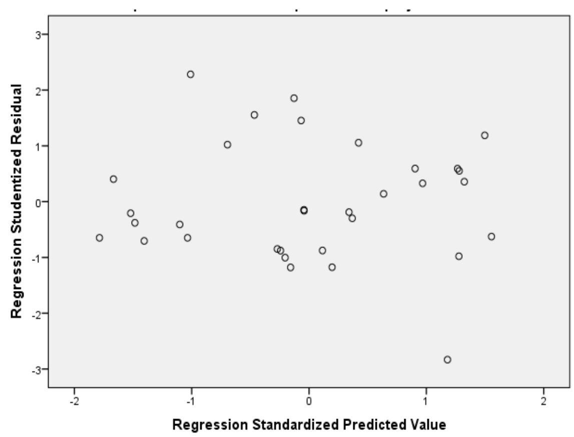

Figure 2: Analysis of the Scatter Plot method

Figure 2 indicates that residual points spread randomly and thus residuals are declared homogeneous. The multicollinearity assumption is the occurrence of a near-perfect linear correlation between two or more independent variables. In this study using the Variance Inflation Factor method (VIF to detect multicollinearity with the criteria of VIF value < 10, there is no multicollinearity and if the VIF value is > 10 then there is multicollinearity. Based on the results of the analysis it is known that the VIF (Variance Inflation Factor) all independent variables < 10 and It can be concluded that X_1, X_2, X_3, X_4, X_5, X_6, and X_7 are indicated not to correlate with each other or multicollinearity does not occur, so that in this study have a representative sample of data. Autocorrelation is a relationship between the residuals of an observation. The purpose of the autocorrelation assumption test is to find out whether there is a correlation between the residual observations and the other residual observations. This study uses the Durbin Watson method to detect autocorrelation.

Table 3: Autocorrelation testing criteria

Durbin Watson Criteria		Information
< dL	< 1,569	There is autocorrelation
dL-dU	1,569-1,719	There is no conclusion
dU-(4-dU)	1,719-2,281	There is no autocorrelation
(4-dU)-(4-dL)	2,281-2,431	There is no conclusion
> (4-dU)	> 2,431	There is autocorrelation

Based on the SPSS output result and table 3, the Durbin Watson value by 1,680 so the DW value is in the interval Durbin Watson dU- (4-dU) criteria. Thus there is no autocorrelation in the regression model formed.

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4.3 Equations model of driver behavior to the travel timeliness

Hypothesis

H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$

(there is no significant influence simultaneously X_1, X_2, X_3, X_4, X_5, X_6, and X_7 towards variables Y

H_1: $\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$

(there is significant influence simultaneously X_1, X_2, X_3, X_4, X_5, X_6, and X_7 towards variables Y

Table 4: Results of analysis of the second coefficient

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0,879	0,168		-5,226	0,000
	X_1	0,258	0,049	0,246	5,229	0,000
	X_2	0,078	0,036	0,064	2,160	0,033
	X_3	0,129	0,051	0,143	2,552	0,012
	X_4	0,161	0,055	0,089	2,943	0,004
	X_5	0,245	0,050	0,235	4,933	0,000
	X_6	0,275	0,048	0,331	5,708	0,000
	X_7	0,138	0,600	0,860	2,285	0,024

The results of statistical calculations on F count are 219,058 with a probability of 0,000, while the value of α is 0,05 (5%). This shows that the value of F count> F table or probability is 0,000 <α (5%), so H_0 is rejected. Thus it can be stated that the simultaneous influence of constants X_1, X_2, X_3, X_4, X_5, X_6, and X_7 on variable Y.

Thus partially or individually constants have a significant effect on the timeliness of travel (Y). The results of SPSS 23 show the empirical model Y = -0.879 + 0.258 X_1 + 0.078 X_2 + 12 0.129 X_3 + 0.161 X_4 + 0.245 X_5 + 0.275 X_6 +0.238 X_7 with adj R2 value of 0.934 (93.4%) while the remaining 6, 67% are other contributions not included in the model. From the equation model formed from filling in the questionnaire, it was found that the vehicle condition variable (X_6) had a greater influence on the timeliness of the trip, followed by the motivation variable (X_1) and the third by the road infrastructure condition variable (X_5).

4.4 Driver's perception by using the Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) was introduced and developed by Saaty (1980). AHP is a multi-criteria decision-making approach that implies dividing the problem into a problems hierarchy that must be considered in the work. This methodology considers a set of criteria selected and a range of alternatives including the best solutions that can be found regarding the weight of criteria and alternatives. It should be noted that AHP uses quantitative and qualitative data. AHP is a measurement theory through pairwise comparisons. Pairwise comparison methods are used to compare alternatives and determine their interests with each other. Comparisons are made using absolute rating scales that represent a predominant measure of one element over other elements in relation to the attributes given.

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The driver's perception analysis uses eleven selected driver samples representing other samples to express the driver's opinion about the timeliness of the trip. This perception indicator is the result of interesting observations that were previously filled and validated in the driver's preliminary test and the dominant factors that influence the driver's behavior. The hierarchical structure of the problem needs to be made in the right way by setting goals and determining criteria and alternatives.

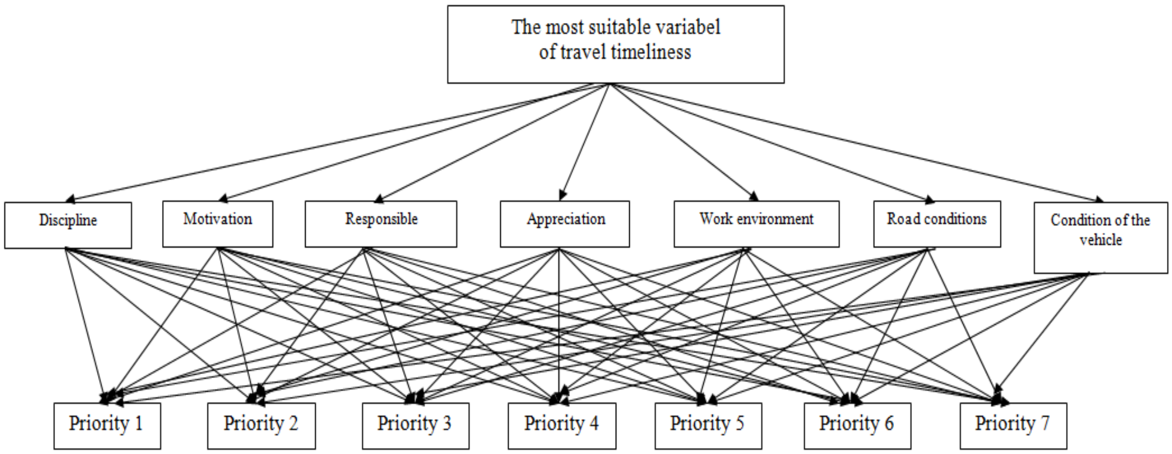

Figure 3: Decomposition of the problem into a hierarchy

There are seven criteria which are the results of the test of desire, namely discipline, work motivation, responsibility, appreciation, work environment, road conditions, and vehicle conditions.

Table 5: Pairwise comparison matrix for the first level (Responden 1)

Criteria	Discipli-ne	Motivation	Responsible	Appreciation	Work environment	Road conditions	Vehicle conditions	Priority Vector
Discipline	1	3	$\frac{1}{3}$	5	3	$\frac{1}{2}$	$\frac{1}{2}$	0.139
Motivation	$\frac{1}{3}$	1	$\frac{1}{2}$	5	3	$\frac{1}{3}$	$\frac{1}{3}$	0.097
Responsible	3	2	1	7	3	$\frac{1}{2}$	$\frac{1}{2}$	0.184
Appreciation	$\frac{1}{5}$	$\frac{1}{5}$	0,14	1	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{7}$	0.029
Work environment	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	3	1	$\frac{1}{5}$	$\frac{1}{5}$	0.052
Road conditions	2	3	2	5	5	1	1	0.246
Vehicle Conditions	2	3	2	7	5	1	1	0.254

λ_{max}= 7.386; *CI*= 0.064; *CR*= 1.32

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The pairwise comparisons matrix of the criteria shown in Table 4, along with priority vectors. According to Saaty (1990), the vector is the eigenvector method of the eigenvector of the matrix. Table 4 is the result of AHP analysis with Respondents 1. Respondents were 11 people and the overall results of respondents were shown in Table 6.

Table 6: Priority vector total of responden

Criteria	Res. 1	Res. 2	Res. 3	Res. 4	Res. 5	Res. 6	Res. 7	Res. 8	Res. 9	Res. 10	Res. 11	Total
Discipline	0.139	0.183	0.121	0.286	0.352	0.127	0.141	0.230	0.137	0.19	0.310	0.202
Motivation	0.096	0.089	0.122	0.430	0.293	0.087	0.076	0.075	0.106	0.08	0.230	0.154
Responsible	0.183	0.301	0.151	0.373	0.077	0.077	0.099	0.230	0.051	0.201	0.038	0.162
Appreciation	0.029	0.073	0.127	0.216	0.087	0.087	0.120	0.167	0.201	0.156	0.417	0.153
Work environment	0.052	0.184	0.238	0.030	0.077	0.119	0.110	0.058	0.336	0.060	0.454	0.156
Road conditions	0.246	0.467	0.297	0.122	0.188	0.262	0.227	0.841	0.535	0.369	0.460	0.365
Vehicle conditions	0.254	0.604	0.506	0.288	0.188	0.262	0.333	0.570	0.488	0.372	0.937	**0.436**

By applying the AHP on the problem considered, a solution shown in Table 4 is arrived at. The consistency ratio (CR) in all pairwise comparisons matrices is acceptable (it is less than 10%), which confirms the validity of the solution reached.

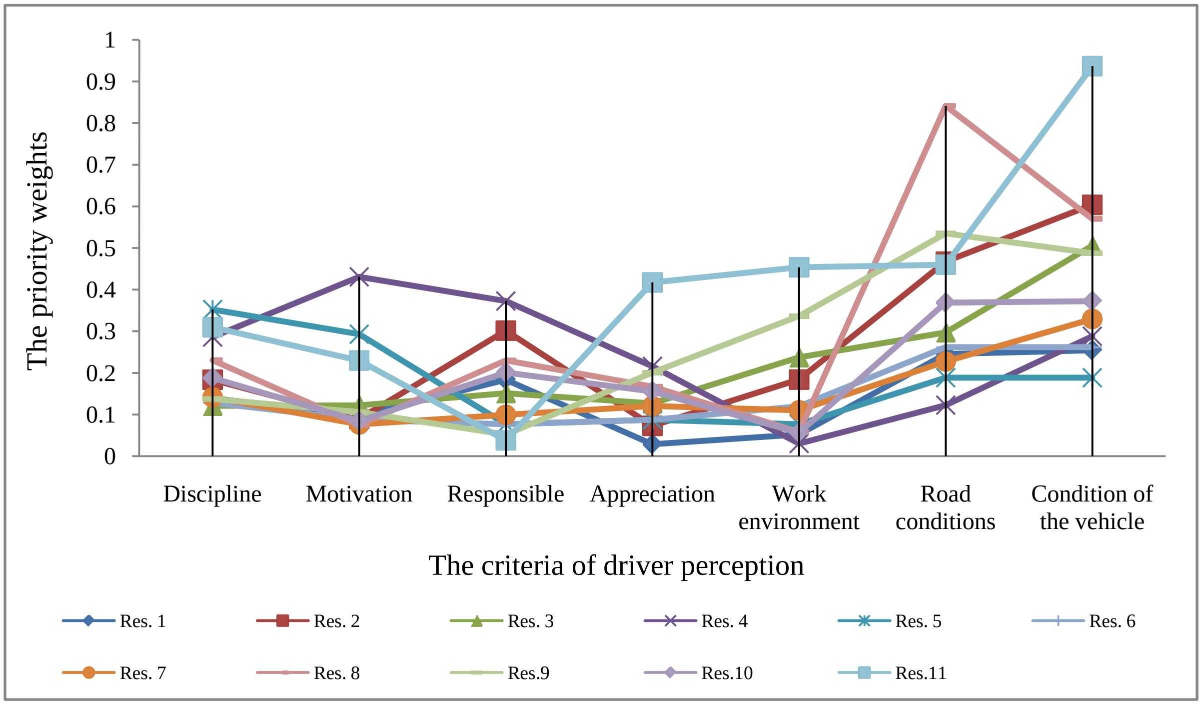

Figure 4: Local and global priority weights each criterion of driver perceptions

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According to AHP in Table 5 and Fig. 4, vehicle condition variables have a considerable influence on travel timeliness. In accordance with the fact that the condition of the vehicle greatly determines the frequency of the trip cycle, checks are carried out by the technician before use and after use/parking at the workshop. Whereas the second priority lies in the condition of road infrastructure, this is related to the condition of the quality of the road surface, the carrying capacity of the land with rain and dry conditions.

V. CONCLUSION AND FUTURE WORK

Change a person's behavior, they must start by changing their perceptions. To get a better understanding of the nature of the driver, it is necessary to examine the variables that influence it. The driver characteristics with facts in the field show harmonious results, such as the driver's income depending on the driving frequency (cycle), age and education according to the requirements. Perception results with seven variables (discipline, motivation, responsibility, work environment appreciation, road conditions, and vehicle conditions) indicate that the condition of the vehicle is a priority variable. The perception results are in line with the results of the driver behavior equation model, namely the main vehicle condition variable because it is a means/means of transportation. The poor condition of the vehicle can hamper travel. Conditions for tires, brakes, truck safety, fuel, tub, age of the truck, all parts, and licensing must be checked periodically to maintain the safety of drivers and other truck users on special roads. The choice of the truck type must be adjusted to the load, terrain/road conditions, and durability in transportation. The condition of the prime vehicle externally influences the driver's work motivation and directly affects the timeliness of the trip.

Other variables are the condition of road infrastructures such as the quality of road/bridge surfaces, good drainage, periodic watering, adequate lighting, good road equipment, technical traffic signs and good soil carrying capacity. The third level is work motivation such as how to have high enthusiasm to achieve success; to be responsible; trust; struggle and diligent in achieving better goals; creative and always set realistic goals.

From the study results, it can be continued to optimize the behavior of coal truck drivers by using a logical fuzzy approach to obtain several suitable and optimal scenarios. In addition, recruitment requirements indicators are suitable for coal driver employees so that they bring huge profits to the company.

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