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Optimization Of a Smart GPS Tracker System to Measure Truck Speed Performance

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ABSTRACT

Smart GPS v 3.3" offers features that traditional systems lack, such as real-time monitoring and advanced travel behavior analysis. This study evaluates the speed of trucks and travel performance using Smart GPS v 3.3 and a tracking system from the stockpile to the port (93.89 km). The methods used were field observation and data collection through smart GPS software. The results show that the trucks average speed/month is 31 km/h for loaded trucks and 57 km/h for empty trucks. The average travel time for loaded trucks is 3:05:36, while for empty trucks it is 2:13:48. In the morning, the travel time for loaded trucks is 2:50:49, and at night it is 3:31:28. The travel time for empty trucks in the morning is 2:50:49 and at night is 2:29:11. The use of GPS serves as an evaluation tool for the coal transport for companies to streamline distribution.

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1. INTRODUCTION

The main minimg commodity in Indonesia is coal, which is found in certain areas. Coal also boosts the Indonesian economy by serving as an export commodity. To improve the performance of coal, a reliable distribution is also necessary, especially during travel time. In relation to travel time, this is closely connected to the performance of transportation speed, particularly trucks behavior that play a role in loading from the stockpile. The pattern of travel behavior and driver activities depends on the activity, duration, type, and sequence that affect travel time. and using a base-tour model. [1] [2] [3].

The utilization of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) has become important in journey surveys and has rapidly developed [4] [5]. The rapid advancement in mobile technology has influenced travel behavior more quickly and has been very helpful [6][7] and GPS can develop freight performance measures [8][9][10].

Besides that, companies are required to hire reliable drivers and establish effective and efficient routes according to the scheduled times. Drivers are the key to successful travel time optimization [11][12]. Overall, the cost of coal provision, including mining and transportation costs, is greatly influenced by the distance differences between one mining location and another. Mining roads have distinct topographical characteristics. The performance of trucks conducted in this study includes the existing travel time (travel time and idle time) and travel

speed based on mining road conditions. From this data, travel time and trip time will be maximized. Research on travel time, idle time, and waiting time has been widely conducted. [13] [14].

Effective travel time is crucial in increasing the number of travel cycles [15] [16]. Research has been conducted on speed analysis for car driving behavior [17] and factors speeding behavior [18]. Additionally, travel time and travel speed such as vehicle operational speed significantly impact geometric optimization [19][20]. The utilization of travel time reliability is essential to facilitate transportation services for road users [21] [22]. Research conducted of travel time unreliability on freeways [23], and the need to estimate the arrival time of the truck [24] [25].

This study focuses on the use of smart GPS trackers to measure the speed performance of coal trucks, evaluate the delivery cycle from storage to the port, and ensure good transportation. This research presents a new topic by using tools and software in the form of smart GPS version 3.3 and a tracker installed in coal trucks that traverse mining roads. Subjectively, the contract drivers have low qualifications and minimal job security, making it very interesting to study, and there is much to be gained as ongoing research. In addition, this study measures and evaluates the speed performance and travel time of coal trucks, which is rarely researched due to the difficulty in accessing permits and information there. This research is very challenging and significant to study.

The novelty of this research is the use of GPS trackers and smart GPS v 3.3 software to detect and measure the speed and travel time performance of coal trucks, a method that other researchers rarely employ due to limited access to locations, expensive instruments, and the closed policies of coal companies, thus the researchers are enthusiastic about investigating this topic to enrich knowledge.

2. RESEARCH METHOD

This research is based on coal mining locations in Angsana District, Tanah Bumbu Rgency, South Borneo Province, Indonesia. The method of research used is survey and quantitative methods. Data were collected in July 2024 using a smart GPS tracking application that is already installed on the target trucks. The route used is the Bunati road which is 93.89 km. The results of the coal truck movement during the one-month survey period on the truck with specifications Hino 500 FM 260 Ti used for transporting coal from the stockpile to the port via the mining road. The research location is in Bunati, Angsana District, Tanah Bumbu Regency, South Borneo, Indonesia as shown in Figure 1 and the route of the journey (source smart GPS system) during the survey is shown in Figure 2.

Figure 1. The research location is in Bunati, Angsana District, Tanah Bumbu Regency, South Borneo, Indonesia (Source : google map, 2024)

The distribution of coal trucks from the stockpile to the Bunati port, which is a vital center for coal loading and unloading activities, also faces environmental and operational challenges. The Bunati coal port is designed as a place for coal loading and unloading, carried out by various shipping companies. This activity involves transferring cargo from barges to large ships through the ship to ship method, considering the port's depth limitations for larger vessels.

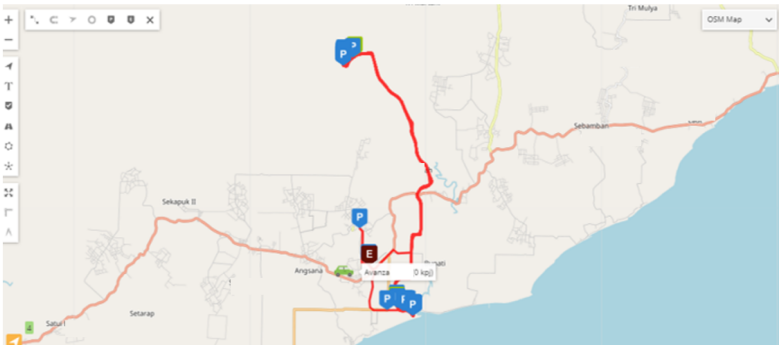

Figure 2. The route of the coal truck in Bun[illegible] Angsana District, Tanah Bumbu Regency

(source: smart GPS tracker system, 2024)

The route in the study with a length of 93.89 km is used as a coal transportation road to the Bunati port, Tanah Bumbu Regency. In the smart GPS tracker system display, all supportive GPS data is presented as data for analysis in the research. Figure 3 shows the condition of the road and the topography of coal transportation. The road, originally designed for normal traffic according to its road class, is burdened by coal transportation, necessitating repairs and maintenance. The coal route condition is shows in Figure 3.

(a) (b) (c)

Figure 3. The coal route condition; (a) truck heading to stockpile; (b) truck heading to the port. (c) Hino 500 FM 260 Ti (object)

2.1 The Concept Of Measurement With Smart Gps V 3.3

The movement of coal trucks began with a search for routes using Garmin GPS to ensure the research route, as special coal routes are not clearly illustrated on the mining maps from the company, even the chosen routes are not yet present on the roads. Once the route was determined, GPS trackers were installed on three trucks for observation over a month. The trucks that were equipped will operate from the stockpile location to the Bunati port simultaneously. The researchers will mark all stopping points with coordinates and the names of the stops.

This off-roadway technology utilizes satellite technology that excels in managing information about position, direction, and speed of movement. In this observation, GPS is used that moves along the mining road and is monitored in real-time from a smart GPS server which is claimed to be accurate and real-time.

The main components of this research are the GPS tracker on the truck, intelligent GPS server software v.3.3, KML, Google Earth Pro. Data from the intelligent GPS tracking system is transferred using Keyhole Markup Language into Google Earth Pro, which displays the geometric paths to be compared according to previous measurements. The GPS signal receiver is a Garmin GPS that communicates in real-time.

GPS trackers function as tools to store travel route data, monitor vehicle conditions via GPS in real-time, determine truck speed, and improve operational efficiency (a)(b). Smart GPS v.3.3 serves as a monitoring and spatial reporting tool. On the screen (c), click on history and enter the date from which data will be retrieved, then the desired view will be opened (d). Right-click to access options to export KML (e). KML files can be opened in applications such as Google Earth Pro (f), allowing users to visually view GPS data (such as routes, coordinate points, measure distances, or travel patterns) on a map and facilitate the integration of GPS data into more complex systems. From the measurements and GPS output results, processed into MS. excel for each speed/duration/condition per day and per month. Then analyzed according to the research objectives and can be recommended based on real field conditions and regulations in force in Indonesia.An illustration of the data processing can be seen in Figure 4.

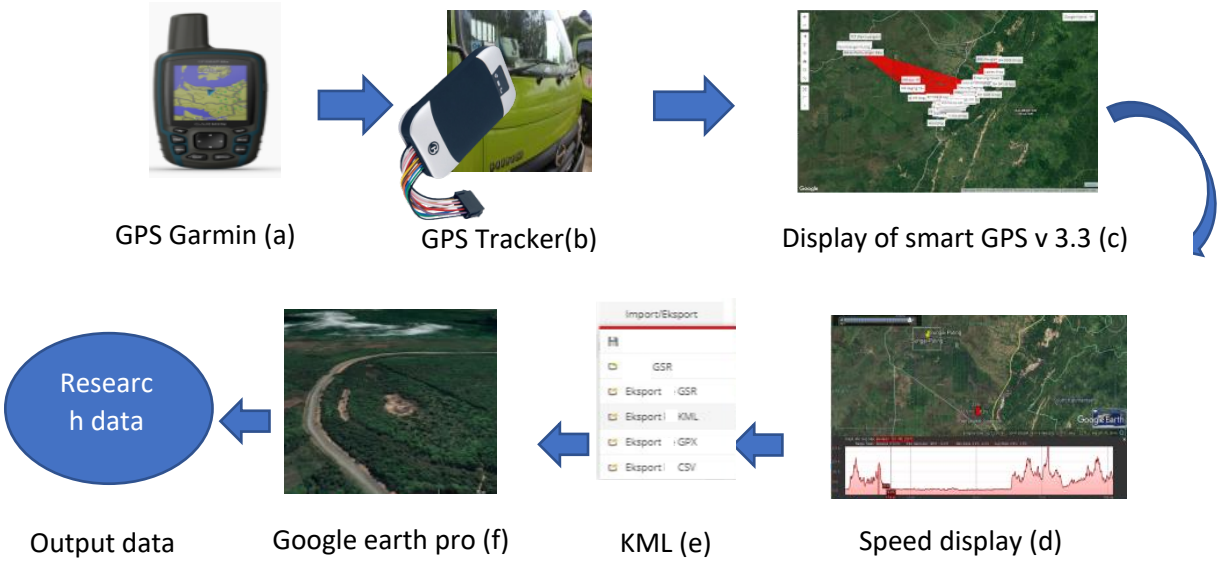

Figure 4. Stages of data collection research

The research design is shown in Figure 5

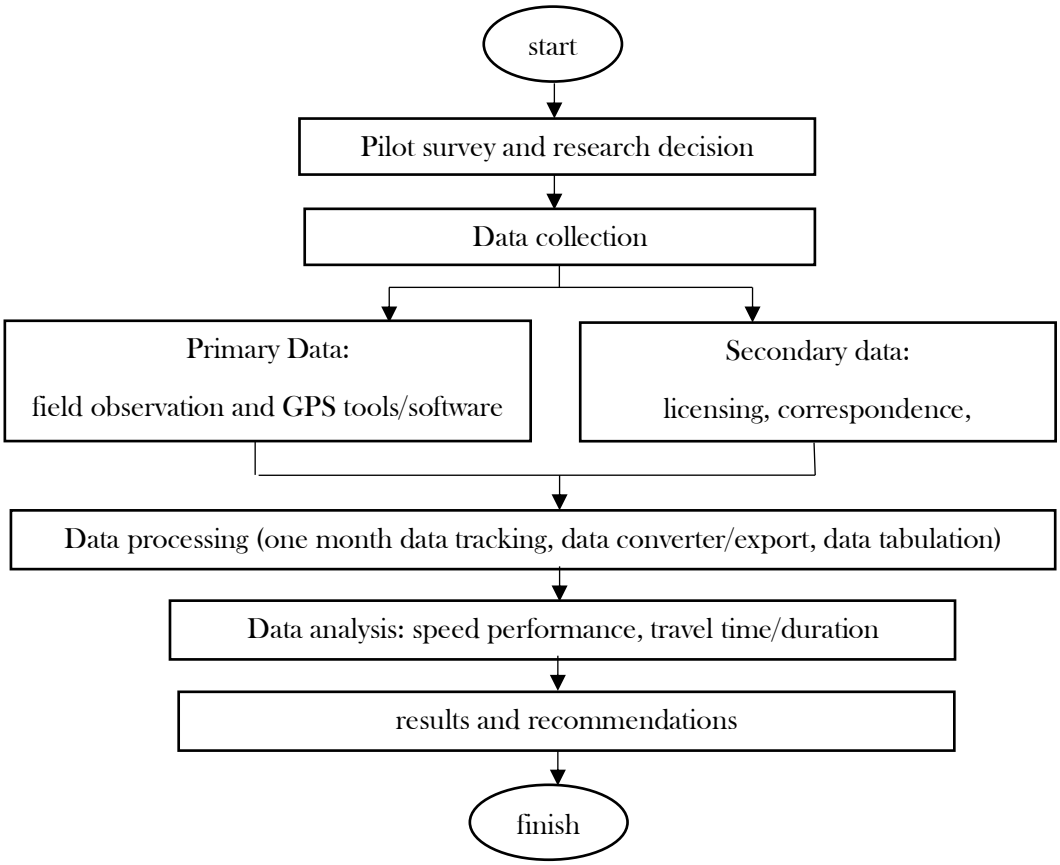

Figure 5. Research design

3. RESULT AND ANALYSIS

3.1 The Speed Performance Based On Smart Gps V. 3.3

The average movement of coal trucks over a period of one month of observation from from July 1 to July 30, 2024, trucks code is BH 5006 (A), BH 534 (B), and BH 536 (C). The software can display the route data taken by the truck, travel coordinates, speeds including average, maximum, minimum, stopping points, weather, and obstacles..

Example of truck speed variation over one week (July 1 - 7, 2024) from 01:00:00 - 12:00:00 taken from smart GPS server 3.3 shown in Figure 6 and the time display of Smart GPS Server 3.3 shown in Figure 6. (original server in Indonesian language).

Figure 6. Display of The variation in speed of truck A (BH 5006) one week on observation from 01:00:00 - 12:00:00

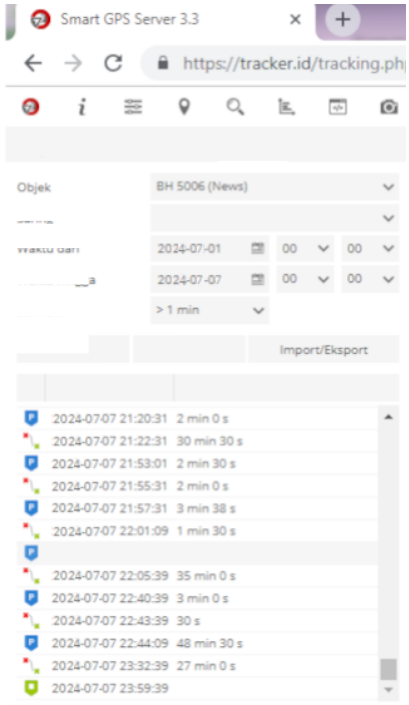

Figure 7. Display of software GPS one week observation

Figure 6 and 7 show the speed fluctuations one week show a maximum speed of 65 km/h and an average speed of 27 km/h. Visually in the field, the speed fluctuations during the travel cycle include various turns, topographic conditions, road surface damage, road narrowing, and weather.

The average speed data over a month for loaded trucks and empty trucks is shown in Figures 8 and 9.

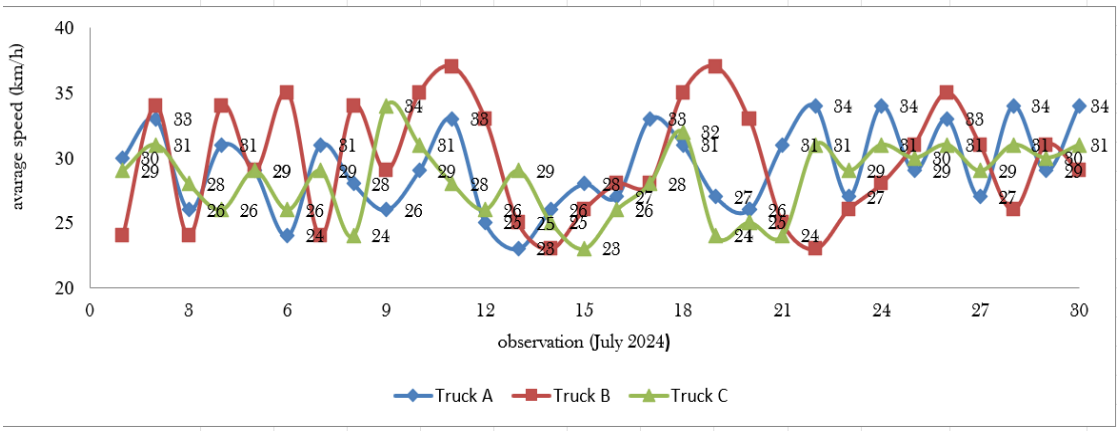

Figure 8. The average speed data over a month for loaded trucks

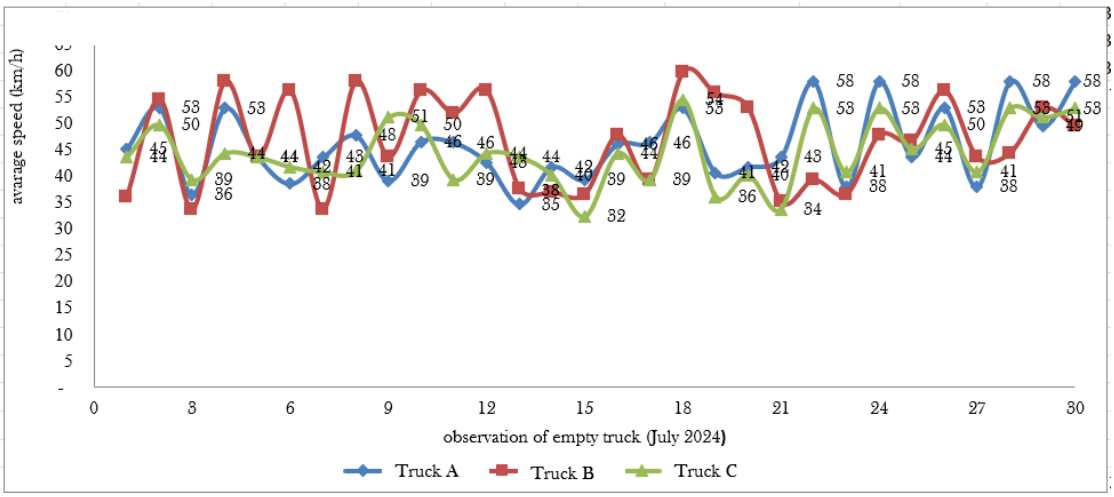

Figure 9. The average speed data over a month for empty trucks

Figure 8 and 9 show that the average speed of the loaded truck per month is 31 km/h and 57 km/h for empty trucks.

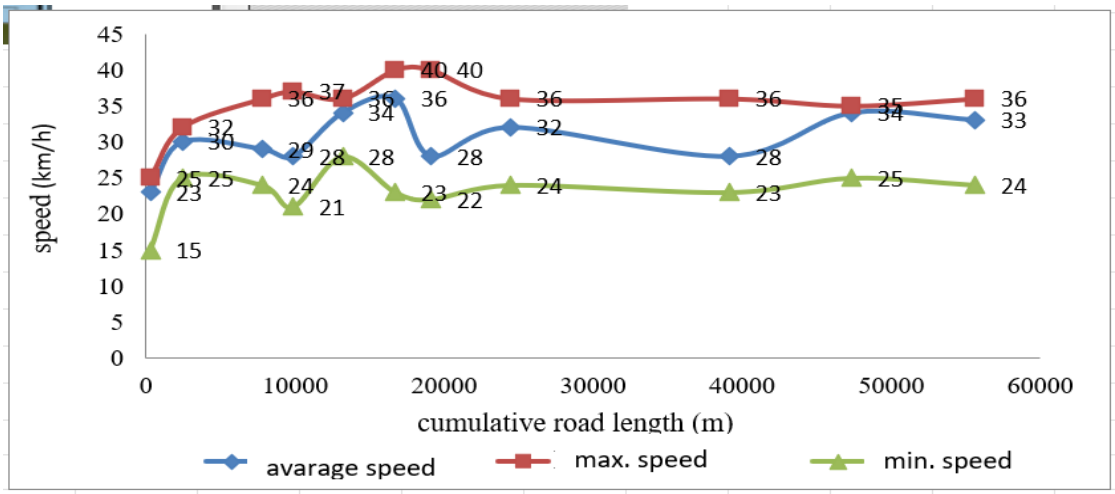

Figure 10. The average speed data over a month for loaded trucks

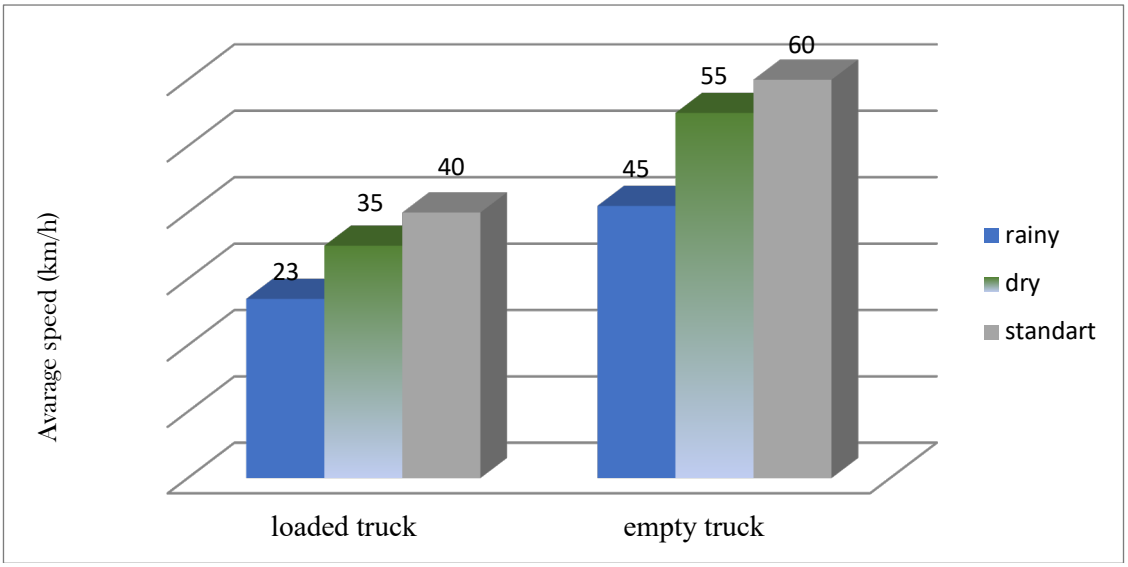

Figure 11. The average speed and maximum speed of trucks with load and without load as well as in different weather conditions

The average speed and maximum speed of trucks with load and without load as well as in different weather conditions (rain and dry) over one month of observation. Trucks carrying coal will travel differently between rainy and dry weather, with an average speed of 23 km/h and 35 km/h, while trucks without coal will also travel differently between rainy and dry weather, with an average speed of 45 km/h and 55 km/h. The speeds of 40 km/h and 60 km/h are the standard speeds on mining roads.

3.2 Duration Of Travel Time

The cycle time refers to the turnaround time required for the truck to complete its work rotation. The duration of the coal truck with four conditions is shown in Figure 12.

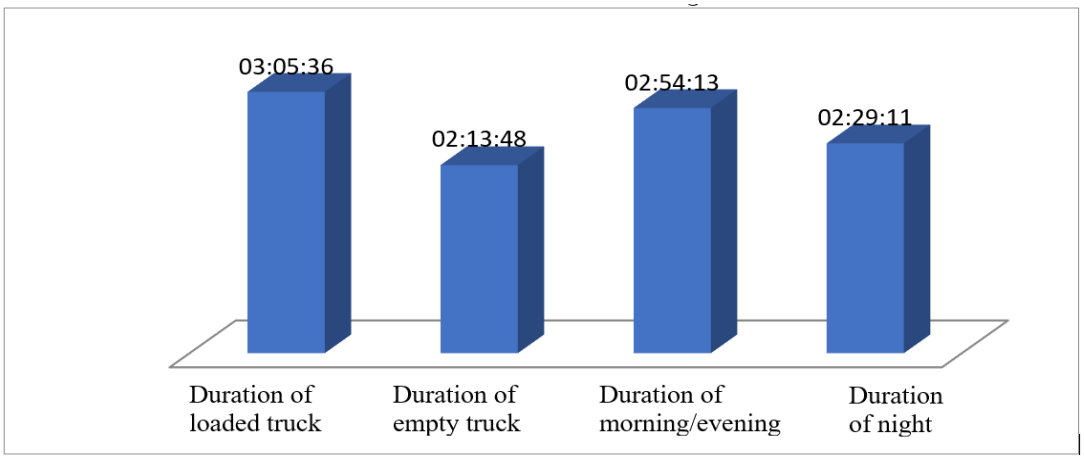

Figure 12. The duration of the coal truck with four conditions

From the analysis of the smart GPS system, the average duration of a truck's one-cycle journey is 3:05:36 and the average travel time without load is 02:13:48. The duration for transporting coal from the storage place to the port is 93.89 km. In the morning and afternoon, the travel time for loaded trucks is 2:50:49, while at night it is 3:31:28. The travel time for empty trucks in the morning-afternoon is 02:54:13 and in the evening is 02:29:11. The average travel time for coal transportation in the morning-afternoon is faster compared to the evening. Visually in the field, it is indicated that the mining road conditions have minimal lighting, the road conditions require maintenance, there are limited traffic signs, and the drivers are already tired.

Considering the importance of the reliability of coal transportation travel times for power supply and other needs, various quantitative approaches have been proposed and carried out to measure travel time reliability based on various data sources. Recommendations that can be made include optimizing travel speed according to safety standards, which are trucks loaded at 40 km/h and unloaded trucks at 60 km/h, optimizing distribution in the morning and afternoon due to minimal street lighting at night, limited traffic signs on mining roads, and the limitations of driver fatigue.

4. CONCLUSION

The research results indicate that the use of the GPS tracking system and the smart GPS tracker version 3.3 during a month of observation on coal trucks traveling from the stockpile to the port performed well and provided accurate information regarding truck speed performance, allowing for evaluation and improvement. The average speed of coal trucks per month is 31 km/h for loaded trucks and 57 km/h for empty trucks. The average travel time for loaded trucks is 3:05:36, while for empty trucks, it is 2:13:48, covering a coal route distance of 93.89 km. In the morning and afternoon, the travel time for loaded trucks is 2:50:49, while at night it is 3:31:28. The travel time for empty trucks in the morning/afternoon is 2:54:13 and at night it is 2:29:11.

In this research process, there are several limitations such as the long time needed to obtain research permits, the limited number of trucks being studied, the need to install GPS trackers on the truck bodies, and the difficulties in accessing mining locations for researchers. Future research could develop the role of smart GPS v.3.3 in evaluating the relationship between driver performance and coal truck performance in a larger mining area. The professionalism and reliability of drivers will affect travel duration and the smoothness of distribution. A questionnaire tool will be designed and linked to travel behavior. The installation of GPS trackers on trucks marks the beginning of a change towards more efficient timing.

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