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Original Paper

Application of New Technology for Road Safety Optimization in Cameroon. The Case of Geographic Information System (GIS) On Buses and Trucks

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Abstract

Some countries around the world have set their objective to attain zero accidents on their roads in some few years to come. Cameroon certainly also works towards this objective. However, in Cameroon there exists a temporal or better still inadequate application of new technologies in the optimization of road safety measures. This study focused on using the GESPROS SA approach in monitoring their buses and trucks in Cameroon. The GIS system use SeeWorld GPS devices. This device is used to detect locations, speeds, driver behaviors, and status of buses and trucks. The study further shows how tracking location, track monitoring, overview information, report information, captured information, detail information, and playback information can be extracted by the control unit which if adopted can enhance efficiency, accuracy, and effective monitoring system, which then can further fast tract decisions making processes in Cameroon.

Keywords: Road safety, Accident prevention, GIS, Road network, and Cameroon

1. Introduction

Geographic Information System (GIS) is one of the most innovative advancement in the study of transport system [1]. Since its development in the 1970s, it has had a major impact on transport system analysis, security practice in governance and in the private sector [2]. Most transportation agencies now use GIS and Geospatial Information Systems for Transportation (GIS-T) [3], which is one of the largest users of GIS technology [4].

Real-time vehicle monitoring has become temporally use by some transportation agencies [5]. Monitoring System Technology is made possible by the integration of three incorporated new technologies: navigational technologies, database technologies, and communication technology [6]. The proposed platform design 'tracking system' is used to pinpoint trucks and buses location, speeding, driving behavior, and their status [7].

GIS now provides a wide range of tools for data management and analysis [8]. GIS added specific tools for linear data management of transportation data that has proven to be extremely successful among transportation organizations [9]. The deployment of GIS has attracted the interest of transportation vendors who provide scheduling, vehicle tracking, and trip itinerary monitoring programs [10]. This proposed platform visualize the real position of vehicles on maps and to take decisions according to real-time information.

As we all know, road accidents are a canker worm in Cameroon. It has plunged many families in agony, destroyed many vehicles and rendered many persons hopeless, handicapped and poor. The government of Cameroon has implanted several strategies to curb the problem but which seems futile [11]. Amongst

the strategies is the putting in place of radar system, which is not actually seeming to solve the problem [12].

The main objective of this research is to propose a system, which could bridge a gap of efficiency, accuracy, and effective monitoring system of buses and trucks, which then can further help to fast-track decision-making processes in Cameroon.

The set out objectives to achieve for this study are as follows;

- To develop the possibility of detecting wrong parking of trucks and buses using GPS devices along the highways in Cameroon which can reduce accidents tremendously.
- To propose the installation of GIS devices in trucks and buses that can detect their over speeding on the Cameroon major roads
- Identify poor behavior of truck and bus drivers on transit using GIS devices so as to inflict heavy sanctions on them.
- To ensure that the installed GIS devices in trucks and buses can inspect the vehicles on transit in order to pre-empt action before any serious breakdown that can lead to accident.

2. Methods

This is actually divided into three parts; the tool used for the study, Data collection and Data treatment.

2.1 The tool used for the study

Geographic Information System (GIS) as a tool,

- Geographic; relating to space (major road axes in Cameroon).
- Information; Global Positioning System (GPS) detect information about buses and trucks in space
- System; information about a defined space is stored in a certain network, which is interactive (i.e. in a computer with aid of software)

2.2 Data collection

The type of data collected here were quantitative real-time data collection. These type of data are location data, speeding data, driver's behavior data and vehicle's status data. The procedure was as follows;

2.2.1 Tracking location data collection

These were data collected while the vehicles were on motion. In the monitory platform, open the platform, login, Click on monitor, and click on Track. At this level, the platform is opened. The type data collected here are; location name, location coordinates location time, location distance, location speed, and location duration.

2.2.2 Parking location data collection

These data are collected when the vehicle is static. The process is as follows; Open the platform, login, Click on monitor, and Parking details. The type of data collected here are; Start time, End time. Stop duration, and address.

2.2.3 Speeding data collection

The process of speeding data collection were; Open the platform, login, and Click on monitor then click on Speeding trip report data. The type of data collected here were; speed start time, speed end time, speed time, speed distance (km), maximum speed (km/h), and Maximum speed duration.

2.2.4 Driving behavior data collection

The procedure for driving behavior data collection were; Open the platform. Login, Click on monitor, then click on driving behavior. Number of Fatigue Driving, Harsh driving acceleration, Harsh driving

braking, Sharp Turn, and Sharp Change Lane were detected.

2.2.5 Engine data status

To get to this; Open the platform, login, Click on monitor, and then Engine idle data collection. The type of data collected were; Start time data, End time data, Stop time data, Stop duration data, and Address data.

2.2.6 Fuel consumption data collection

The procedure goes those; Open the platform, login, Click on monitor, the type of data collected were; Device name Trip times, Mileage (KM) Run time Fuel, consumption(L), Average fuel consumption(L/100km).

2.3 Data treatment

2.3.1 Protract interface: permit the operator to login using the account name and password. This is the first displayed page in the monitoring platform. The aimed of this page is to is to verify if the the opperator is uplarge to have access to this platform. It can then further to Module configuration page.

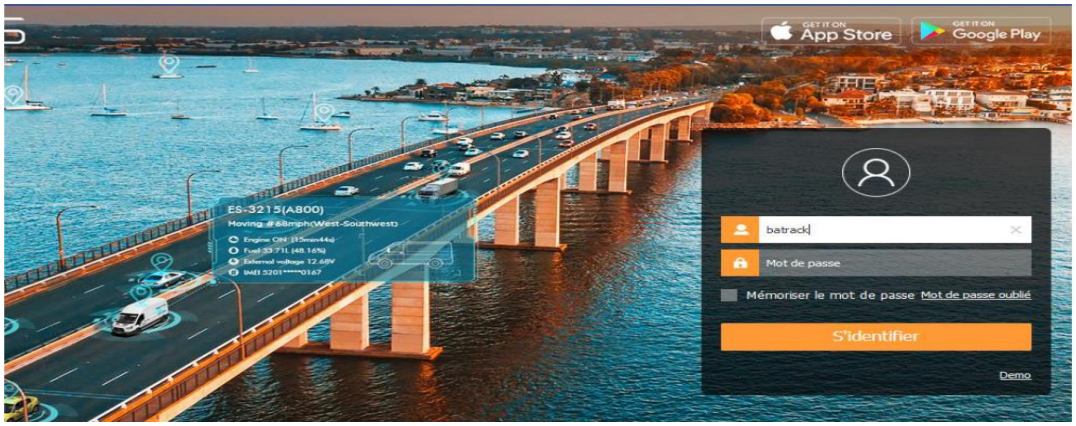

Figure 1. Interface to connect to protract platform

Source: GESPROS SA control unit, 2023

2.3.2 Module configuration

A page where instructions on tracking is inputs. Each module is equipped with a local network Sim card. Using the Sim card number, it enables one to communicate with the GPS and give it instructions. The various instructions to be given to the beacon GPS are as follows:

- IP and PORT configuration: to enable the tag to be visible in the tracking platform used.
- APN configuration: enabling the GPS to recognize the Sim card network.
- Time Zone Setup: connects to the local time zone.

Once the beacon has been connected and the configurations made (Figure 2), the vehicle in question becomes visible in the tracking platform.

Figure 2. Module configuration

Source: GESPROS SA control unit, 2023

2.3.3 Module wiring diagram

The wiring diagram provides a visual representation on how the various pins or terminals on the GPS module should be connected to other electronic components in a circuit or system.

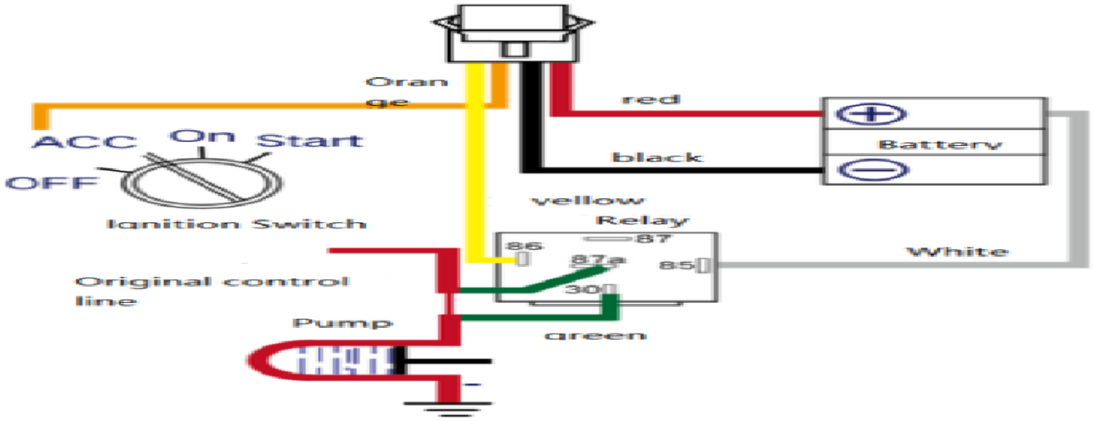

Figure 3. GPS S102A wiring diagram

Source: GESPROS SA control unit, 2023

2.3.4 Protract platform functions (PPF)

The main function of a tracking platform is to enable one to monitor vehicle fleets in real time, or to track the delivery of a product to its destination. However, there are also secondary functions that help to optimize fleet management. Real-time tracking: allows one to locate the position of a vehicle or cargo in real time and limit driving hours.

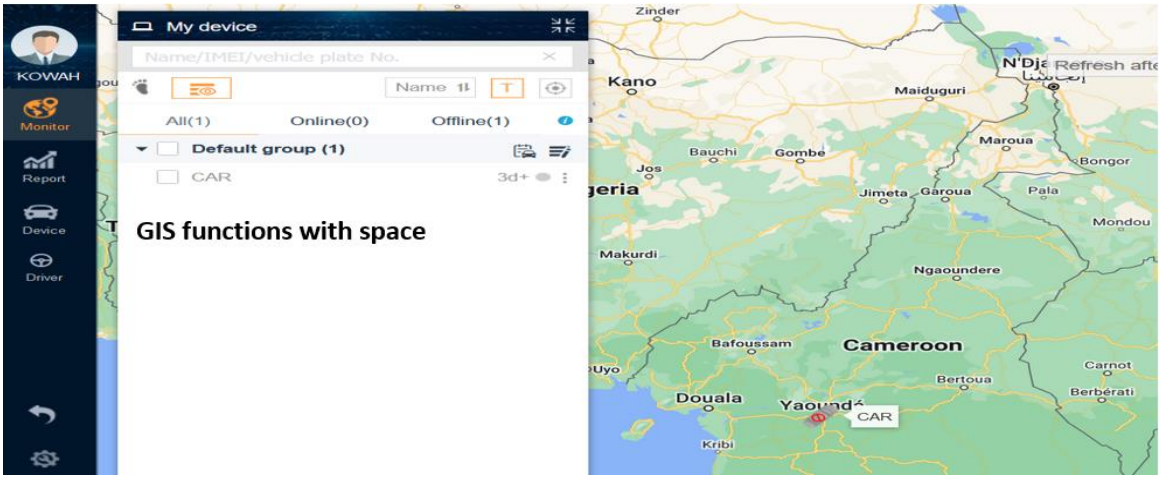

Figure 4. Displayed page of tracking vehicles completely opened

Source: GESPROS SA control unit, 2023

3. Results and Discussion

After going through methodology processes, other accesses such as; Tracking location, Track Monitoring, Playback Monitoring, Parking location data result, Speed detection data result, Overview speeding graph result, Poor driving detection result, and Vehicle status monitoring result could be further developed.

3.1 Tracking location, monitoring system where fleet could be seen directly, along Cameroon national road number 3 (N3), Douala Yaoundé and Maroua segment. There, track monitoring were visualized through central monitoring unit.

Figure 5. Trucks wrong parking locations

Source: GESPROS SA control unit, 2023

In figure 5, good number fleets were seen simultaneously on the platform as well. GESPROS SA, wanted to view; the safety of their buses and trucks, their current locations, possibly detects their service routes and predicts an acceptable accuracy and efficiency of their buses and trucks.

3.2 Track Monitoring

In figure 6 below, emphases are laid on a particular vehicle (LITTR737 SX Diderot (102A). here the operator view through figure 5 above and sorted out this particular truck as the current position of the truck was supicius. He now had to track on that that truck to overview it current situation.

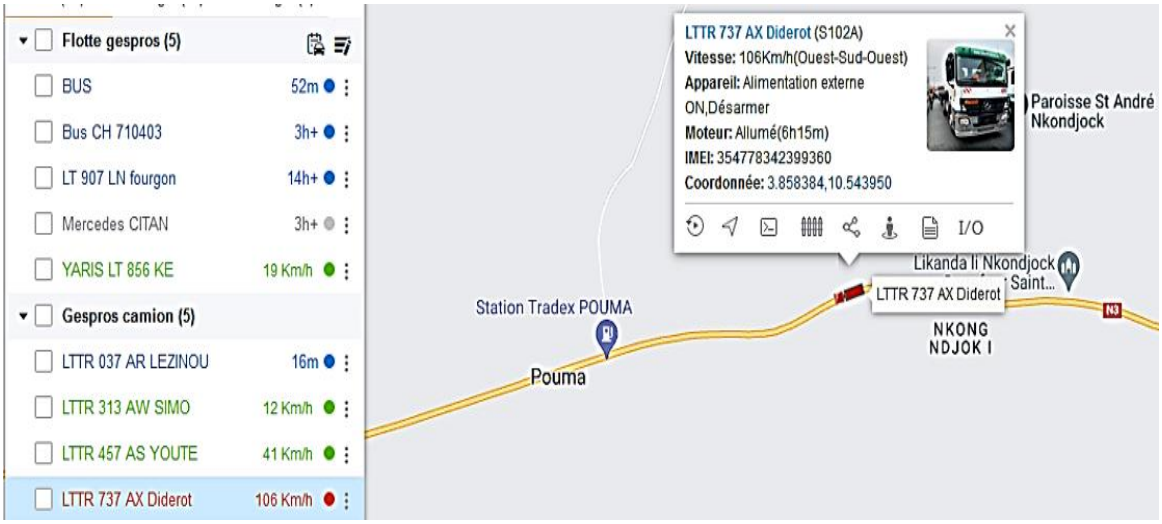

Figure 6. Accessed information on a wrong-parked vehicle

Source: GESPROS SA control unit 2023 as displayed in their system

From figure 6 above, location name, location coordinates, location time, location distance, location speed, and location duration, vehicle number plate, GPS Mark, device name, and road number are viewed. This enable the operator see the problem before he could deep in the machine to trace out alert information about that particular truck.

3.3 Playback Monitoring

Replayed execution of a particular truck (LITTR737 SX Diderot (s102A). this was just to enable the operator to request the platform to view the truck movement that took place in his absence. This was replayed because the travel was executed at night and same data for location were re-monitored.

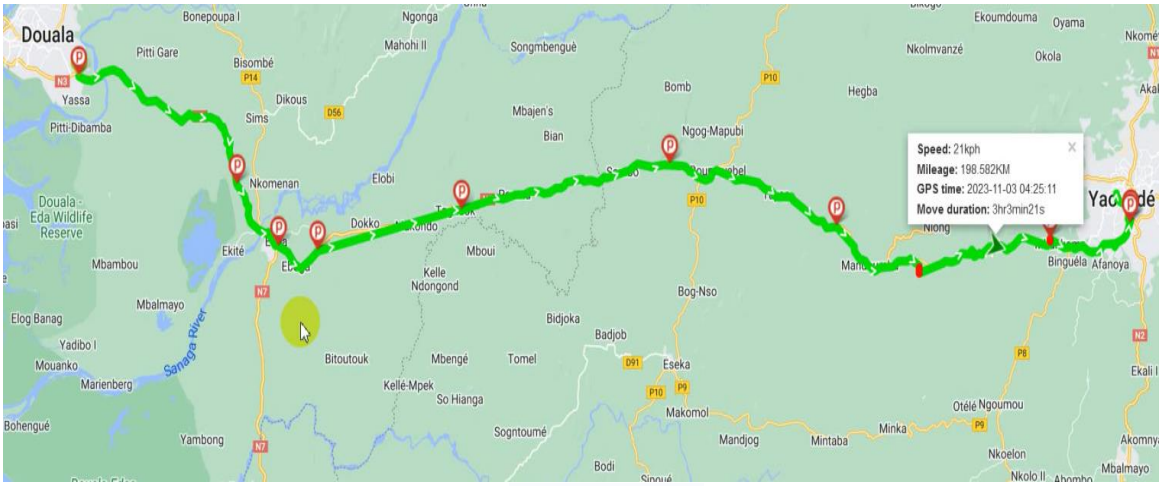

Figure 7. Track monitoring

Source: Gespros sa control unit, 2023

The result of this playback displayed in figure seven shows that the truck was at a low speed: 21kph, mileage: 198.582km, time: 2023-11-03 (04 25 11), and duration 3hrs3min21s.

3.4 Parking location data result

These are results summery data of all stops of Toyota land cruiser along Douala-Yaoundé segment of national road number 3. These data were parking start time; end time, stop duration and location address.

Table 1. Displayed truck parking details

Parking details(Truck)				
From 2023-11-03 00:00:00 To 2023-11-03 15:15:59				
Parking marker:3Minute				
#	Start time	End time	Stop duration	Address
1	2023-11-03 02:12:14	2023-11-03 02:32:02	19min48s	3.784897N,10.203682E N3, Cameroon
2	2023-11-03 02:32:58	2023-11-03 02:37:38	4min40s	3.835159N,10.436125E N3, Ngwei, Sanaga-Maritime, Littoral, Cameroun
3	2023-11-03 03:54:21	2023-11-03 03:58:07	3min46s	3.815489N,11.041805E Nationale 3, Matomb, Nyong-et-Kéllé, Centre, Cameroun
4	2023-11-03 04:40:44	2023-11-03 04:45:05	4min21s	3.800170N,11.386129E Mbankomo, Méfou-et-Akono, Centre, Cameroun
5	2023-11-03 07:16:43	2023-11-03 15:15:59	7hr59min16s	3.855440N,11.492914E Ngola Ekele, VF4V+39R, Yaoundé, Cameroon
Sum:8hr31min51s				

Source: Gespros sa control unit, 2023

Table 1 displayed a small part of parking detail table. This is just to prove that testing the applicability of buses and buses parking in Cameroon can work very well. Here detail of all buses and trucks were extracted. As a result, detail information of trucks were considered. This data were; start time, end time, duration, and address were ta taken in to consideration.

3.5 Speed detection data result.

Here, GESPROS SA considers 80 km/h as speed limit to trucks and buses. Speeding data above 80 km/h is alerted and registered as over speeding. Table 2 shows speeding summary.

Table 2. Display of speed details

Speeding details					
From 2023-10-27 To 2023-10-29 13:25:59					
Device: Toyota Land cruiser (Speeding value: 80kph)					
#	GPS time	Speed (Kph)	Longitude	Latitude	Address
1	2023-10-27 13:48:59	81	9.700017	4.016700	Axe lourd Douala-Edea New Bell Douala Wouri Litoral. Cameroon

2	2023-10-27 13:48:59	82	9.700017	4.016700	Axe lourd Douala -Edea New Bell Douala. wouri litoral .Cameroon
3	2023-10-27 13:50:09	83	9.712234	4.013800	Douala-Edea. Ancien Aeroport Douala wouri litoral .Cameroon
4	2023-10-27 13:50:14	83	9.713084	4.014467	Douala-Edea. Ancien Aeroport Douala wouri litoral .Cameroon
5	2023-10-27 13:50:33	87	9.716634	4.017634	Douala-Edea. Ancien Aeroport Douala wouri litoral .Cameroon

Source: Gespros sa control unit, 2023

Table 2 displayed a small sample of the result of speeding detail which was automatically registered when the vehicle speeded more than 80kmph. Here, over speeding time, longitude, latitude, and address were registered. Furthermore, this result was to savaged Gespros SA decision makers to make decisions during weekly evaluation board meeting.

3.6 Overview speeding graph result.

This is a speed distance graph. Tis graph was detected on the platform by the operator. So as to enable the operator to take a look on the graph. As such the operator wanted to view the general behavior of a bus or truck trip.

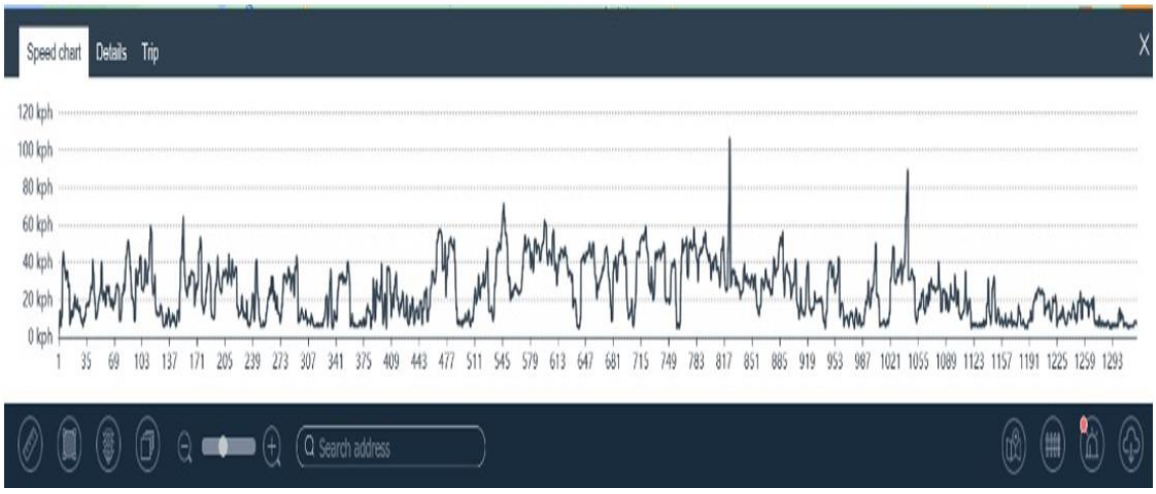

Figure 8. Display of playback review

Source: Gespros sa control unit, 2023

Figure 8 shows the undulating overview speeding distance graph of a trip that was conducted on Road National number three (N3) in the graph, you will notice that from distance 0km to 443km, the speed was averagely at 30km/from distance 443km to distance 851km the average speed raise at 55km/finally, from distance 851km to distance 1293km the average speed descended to 10km/h.

3.7 Poor driving detection result

In this regard, data for a single vehicle was tracked for seven days.

Here, number of fatigue driving, harsh driving acceleration, harsh driving braking, sharp turn and sharp change lane were considered.

Table 3. Display of driving behavior report

Toyota Proace-Driving behavior report						
From 2023-10-23 00:00:00 To 2023-10-29 23:59:59						
#	Date	Fatigue Driving	Harsh driving acceleration	Harsh driving braking	Sharp Turn	Sharp Change Lane
1	10/23/2023	0	0	0	0	0
2	10/24/2023	0	0	0	0	0
3	10/25/2023	0	0	0	0	0
4	10/26/2023	0	0	0	0	0
5	10/27/2023	0	0	0	0	0

Source: Gespros sa control unit, 2023

Table 3 shows that the driving behavior Toyota proace did not have no fatigue hash driving acceleration, hash-driving braking, sharp turn, and sharp change of lane.

3.8 Vehicle status monitoring result.

Here, the operator wanted to know buses and trucks functions. so as to know when the engine was on and off. The time coordinates, and address were considered or extracted. Emphasis too laid on fuel status and engine status. Furthermore, data on trip fuel consumption, Engine overview, Here, engine report data are collected.

Table 4. Trip fuel consumption overview

Engine report					
GESPROS S.A(GESPROS)					
From 2023-10-23 00:00:00 To 2023-10-29 23:59:59					
Device: Toyota Proace					
#	GPS time	ACC	Coordinate	Duration	Address
1	2023-10-23 00:00:00	Engine OFF	4.045338N,9.705211E	2d12h28m	4.045338N,9.705211E Avenue du Docteur Jamot 1.407), Vallée Bessengué, Douala Wouri, Littoral, Cameroun
2	2023-10-25 12:28:48	Engine ON	4.047735N,9.693291E	26m15s	4.047735N,9.693291E 2MXV+26M, Douala, Cameroon
3	2023-10-25 12:55:03	Engine OFF	4.047697N,9.693290E	2h58s	4.047697N,9.693290E 2MXV+26M, Douala, Cameroon
4	2023-10-25 14:56:01	Engine ON	4.047828N,9.693285E	29m23s	4.047828N,9.693285E 2MXV+26M, Douala, Cameroon
5	2023-10-25 15:25:24	Engine OFF	4.047760N,9.693335E	24m42s	4.047760N,9.693335E 2MXV+26M, Douala, Cameroon

Source: Gespros sa control unit, 2023

From table 4, the state of Toyota proace were considered as a sample to prove the state of the vehicle. Here the operator try to find out when the vehicle was on, off, the time delayed, coordinates, duration and address. As a result, the operator could detect when the truck was at rest and on motion. The time it took be on and off and where that happen.

4. Conclusion

Given the approach of GESPROS SA in enhancing efficiency, accuracy and effectiveness of transportation monitoring in Cameroon. This approach could have a greater impact in curbing road accidents if it is implemented in the private and public transport. Although significant efforts have been made by the Ministries of Transport and Defense in using radar instrument as a new technology in monitoring vehicle speed, there has not been any significant improvement in curbing road accidents in Cameroon. There are many limits with the mobile radar system, which include; it is only used by the forces of law and order who at times practice bias and corruption. They only function during the day especially on good weather conditions (no rain), only limited to specific road arteries and absent in many others, communications between drivers on radar positions along the road, and most importantly, data collected by this instrument on the victims are inconsistent and provide no bases for further planning by transport experts.

The fact that GESPROS SA has operated all this while, without registering any accident is a proof of the effective functioning of the monitoring system. They do weekly evaluation of driver's performances, which is a great boost to the consciousness of the drivers. The pro-active functioning of GESPROS SA Company is laudable. This is because during a delivery project, it is capable of sorting out information of vehicle location, vehicle speeding, vehicles driving behavior, and vehicles status. In doing that, it produces a summary of signals information. There are intervention mechanisms whereby devices called buzzers are installed in the vehicle, which creates an alarm to alert a driver in default.

This thesis sets the bases for the application of new technology in the context of GIS in monitoring vehicle movement in Cameroon. It provides the bases for which Ministry of Transport can adopt in optimizing road safety which then can FastTrack decisions making processes. Some of these include: Creation of GIS control units at regional, divisional, and sub divisional levels, Installation of the GIS devices in vehicles that ply the inter-urban roads in Cameroon, and Putting in place of GIS control unit at the Ministry of Transport. If this systems is tested and proven to be effective with GESPROS SA, why not extend it to buses with travelling agencies in Cameroon. With travelling agencies, a partnership agreement can simply be signed with GESPROS SA where by buses from their sources can be tracked before they get to the Douala port. In the course of their clearance, the GIS devices can be installed and the monitoring confided to GESPROS SA. Either daily or weekly reports can be produced depending on how sanctions will be implemented. These reports are forwarded to the authorities of the Ministry of Transport or to the forces of law and order for quick action.

References

1. Parker, H. D. The Role of the Private Sector in GIs. 1993; 1993 (April 1991).
2. McCall, M. K. Seeking good governance in participatory-GIS: A review of processes and governance dimensions in applying GIS to participatory spatial planning. *Habitat Int*. 2003; 27(4), 549-573. https://doi.org/10.1016/S0197-3975(03)00005-5
3. ch59.
4. Aloquili, O., Elbanna, A., Al-Azizi, A. Automatic vehicle location tracking system based on GIS environment. *IET Softw*. 2009; 3(4), 255-263. https://doi.org/10.1049/iet-sen.2008.0048
5. Alapj án- V. No Title. Published online 2016:1-23.
6. Giannopoulos, G. A. The application of information and communication technologies in transport. *Eur J Oper Res*. 2004; 152(2), 302-320. https://doi.org/10.1016/S0377-2217(03)00026-2
7. Dong, Y., Hu, Z., Uchimura, K., Murayama, N. Driver inattention monitoring system for intelligent vehicles: A review. *IEEE Trans Intell Transp Syst*. 2011; 12(2): 596-614. https://doi.org/10.1109/TITS.2010.2092770

8. Devillers, R., Bédard, Y., Jeansoulin, R. Multidimensional management of geospatial data quality information for its dynamic use within GIS. *Photogramm Eng Remote Sensing*. 2005; 71(2): 205-215. https://doi.org/10.14358/PERS.71.2.205

9. Baker, G. A Look at Illinois ' Department of Transportation Automated Over-Dimension and Oversize Permit System IDOT ' s Automated System (cont ' d). Published online 2014.

10. Olba, M. A. A. GIS Applications in Transportation Analysis and Planning. *CRP 514 Term Pap*. 2006; (January): 1-51.

11. Energie, L. De, Em, M. M. Prediction of the Mortality Caused by Road Traffic Injury in. 2022;7:46-57.

12. Jacobs, G., Astrop, A. Estimating global road fatalities. TRL Report 445. 2003;(December). http://www.esafetysupport.info/download/eSafety_Activities/Related_Studies_and_Reports/Estimating Global Road Fatalities report, TRL.pdf

13. Sur, G., Gps, L. E. S. CHAPITRE IV : OPERATIONS DE SUIVI DE CARGAISON Utilisations d ' u n traceur GPS. :1-13.

14. rapport STAGE PRO bk.