(RESEARCH ARTICLE)

The contribution of GIS applications in the management of service stations in the city of N'djamena republic of Chad

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Abstract

In the management of service stations in the city of N'Djamena and in the concern to resolve their storage management, and their taming from the Djarmaya refinery.

We used GIS and metrology measurements in this perspective in order to verify the quantities of petroleum products supplied to the population of N'Djamena.

Thanks to this approach, we were able to check more than 146 gas stations in the city of N'Djamena.

It was observed that the association of service stations and their GPS coordinates allowed us to determine which are the most efficient stations for the delivery of petroleum products to N'Djamena.

The implementation of this methodology played a crucial role in the efficient management of travel and fuel operations.

By employing the 2819 gauge, which has exceptional accuracy and reliability, it has played a vital role in establishing high quality standards in different industrial fields where metrology is crucial to ensure the accuracy and reliability of final products.

By pairing the 2819 gauge with GPS, nearby fuel stations can be easily located, simplifying planning routes and refueling stops, which can help make informed decisions when driving. Involves choosing a station to refuel. By incorporating GPS into the management of gas stations in the city of N'Djamena, it is possible to optimize the efficiency of operations, customer satisfaction and the overall management of the fuel distribution network.

Keywords: GIS; Station; GPS; Gauge2819; N'Djamena

1. Introduction

The downstream oil sector in Chad has evolved significantly since the 2000s. Indeed, in 2003, the first crude oil export took place with the start-up of the Doba oil field in the south of the country [1].

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This was made possible by the construction of a pipeline linking Chad to the port of Kribi in Cameroon. Subsequently, other oil fields were opened in the region, and investments were made to develop the infrastructure needed to export oil.

However, Chad's oil production has fluctuated significantly due to a number of factors, such as oil prices on the international market, political tensions in the region and disputes with oil companies [2].

Despite these challenges, the downstream oil sector remains an important pillar of the Chadian economy, contributing to the country's growth and development.

The population of N'Djamena, the capital of Chad, is currently estimated at 1,655,618 inhabitants in 2024. Over the past year, N'Djamena has grown by 63,294 inhabitants, representing an annual growth rate of 3.97%, according to data from [3].

The geographical position of the city of N'Djamena is between latitude 12°06′24″ North and longitude: 15°02′39″ East, and its altitude in relation to sea level: 299 m [4].

It is the capital of the Republic of Chad, in the southern part of the country, close to the border with Cameroon. It lies on the eastern bank of the Chari River, which marks the natural border between Chad and Cameroon.

N'Djamena is also close to Lake Chad, one of Africa's largest freshwater lakes. Its strategic geographical position makes it an important economic, political and cultural center of Chad, as well as a hub for trade with neighboring countries.
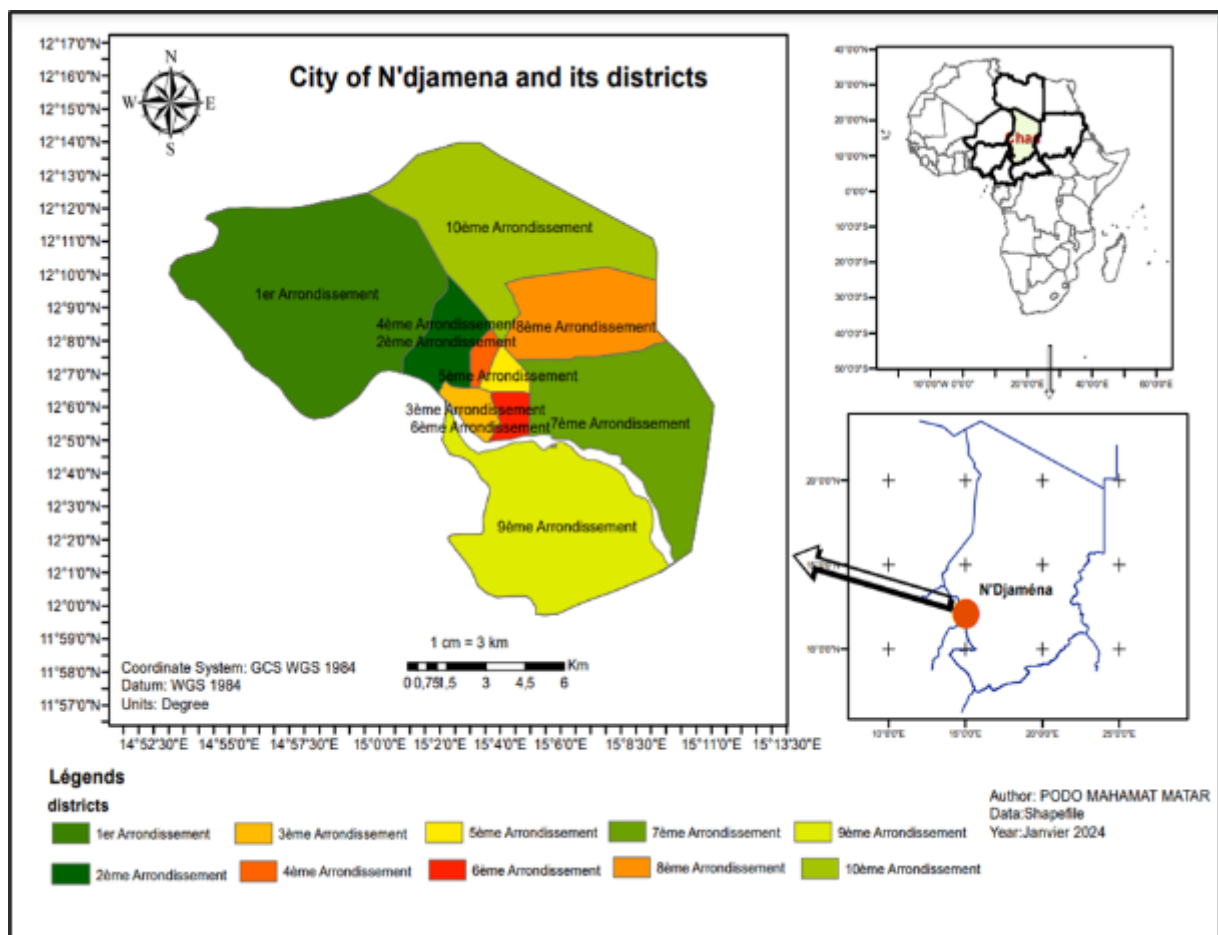

Figure 1 Location of the city of N'Djamena

The population of the city of N'Djamena will be around 1.2 million in 2021 and is growing [5]. In the same vein, the number of cars on the road is also growing at an exponential rate, given the galloping demography.

1.1. Hydrocarbon consumption in the city of N'Djamena

N'Djamena, the capital of Chad, is a fast-growing urban center with a population of over one million. Like many other cities around the world, N'Djamena relies heavily on hydrocarbon consumption to fuel its development. Hydrocarbon consumption has significant impacts on the city's environment, health, and economy [6]. This descriptive analysis will provide an overview of hydrocarbon consumption in N'Djamena, examine its impacts, and propose strategies to reduce it.

1.2. Overview of hydrocarbon consumption in N'Djamena.

In the city of N'Djamena, consumption of various types of hydrocarbons varies, notably gasoline, diesel and liquefied petroleum gas (LPG).

According to the International Energy Agency (IEA), Chad's total oil consumption in 2019 was 6,000 barrels per day, with N'Djamena accounting for a significant share [7].

The city's hydrocarbon consumption has increased over the years due to several factors, including population growth, urbanization and industrialization.

1.3. The Djarmaya refinery in Chad

The Djarmaya refinery in Chad is an important oil refining facility in the country, located in southern Chad. The refinery plays an essential role in the country's economy. The refinery is located in Djarmaya, some 30 km east of the capital Ndjamena.

It covers an area of 240 hectares and has a production capacity of 20,000 barrels per day. The refinery was established in 2011 and is owned by the Chadian government, in partnership with China National Petroleum Corporation (CNPC) [8].

It was built to reduce Chad's dependence on imported refined petroleum products.

Before the refinery was built, Chad had to import all its refined petroleum products, which represented a major drain on the country's economy.

The refinery's products include gasoil, premium gasoline, jet A1, heavy fuel oil, polypropylene and LPG gas.

1.4. Refinery capacity

The Djarmaya refinery is the only oil refinery in Chad. It plays an important role in the production of refined petroleum products to meet the country's energy needs.

1.5. Service stations

Service stations in and around the city of N'Djamena play an essential role in the distribution of fuels and petroleum products to local residents. We have gathered some general information on service stations in and around N'Djamena [10]:

- Location: Service stations are generally spread across the city of N'Djamena and the surrounding area, along main roads, in residential and commercial districts, and near industrial zones.
- Fuel types: Service stations generally offer a range of fuels such as unleaded petrol and diesel, depending on the needs of drivers and users.
- Services: In addition to fuel distribution, many service stations offer additional services such as the sale of lubricating oils, car care products, convenience products, and sometimes light repair services.
- Opening hours: Service stations generally have extended opening hours to meet drivers' needs, and some may operate 24 hours a day to provide continuous service.

Fuel supply: Fuel supplies can sometimes be subject to fluctuations due to factors such as the availability of refined products, logistical constraints, and fluctuations in oil prices on the international market.

It is important for drivers and vehicle users in and around N'Djamena to keep informed of available service stations, their opening hours, and their services to ensure a reliable and efficient fuel supply. They are also advised to follow safety instructions when handling and storing fuel to avoid incidents.

Throughout the city of Ndjamena, we counted around 121 functional service stations, using their geographical coordinates for spatial distribution.

These stations are distributed disparately throughout the city but are generally located on the city's strategic axes and main streets.

Figure 2 Service stations in the city of N'Djamena

2. Materials and methods

Our methodology consists of collecting data, in particular locating service stations using a GPS that provides us with latitudes and longitudes. Once the coordinates have been obtained, we gauge the metered volumes using our 2018 gauge to see in what proportion the metered volumes are calibrated. The differences are noted to make a conclusion on the reliability of the meter volume for all the city's service stations. We would need to run three consecutive tests to see what results the 2018 gauge gives. This gauge allows us to determine three values that are more or less located within metrology standards by more than +/- 3%.

2.1. Materials

In the course of this study, we used various equipment and tools such as a GPS, the 2819 gauge integrated with ARCMAP 10.8 mapping software, and Excel software at all the stations in the city of N'Djamena.
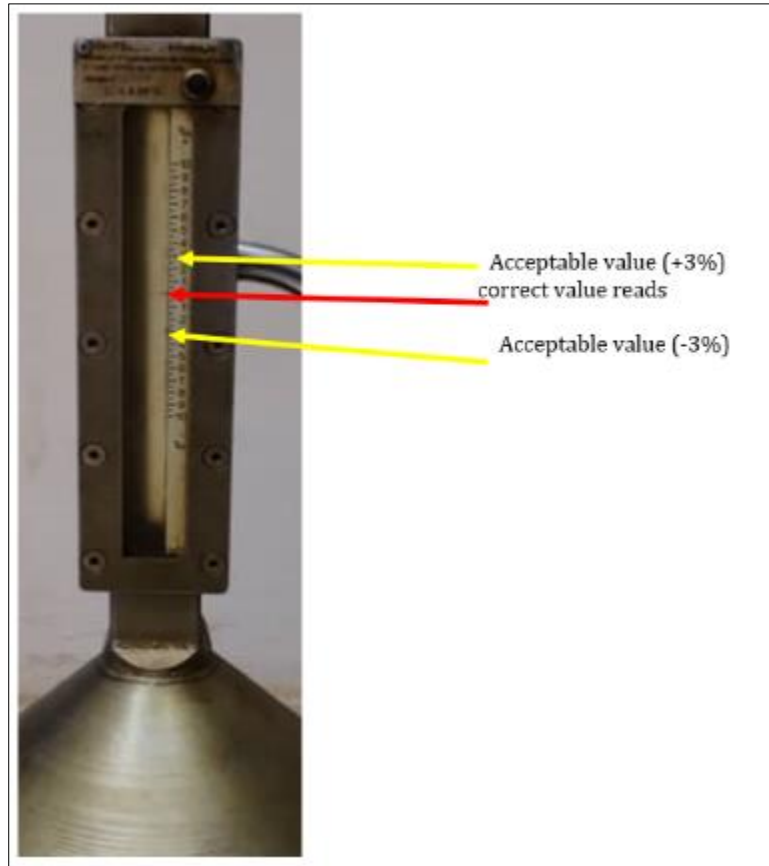
Figure 3 Values read from gauge 2819

2.2. Field data collection

In the course of this study, we used a GPS for data collection, which enabled us to carry out an inventory of 121 service stations throughout the city of N'Djamena.

We then used Excel to carry out the rest of our analyses.

Table 1 List of some of the service stations inventoried for the city of Ndjamena

N°		Coordinates	
	Unit	**Latitude**	**Longitude**
1	SOPETRANS GOUDJI	N : $12^009.051'$	E : $15^002.872'$
2	AL NIZAM	N : $12^008.742'$	E : $15^003.171'$
3	OILBYA	N : $12^006.520'$	E : $15^002.506'$
4	SOSADEP	N : $12^007.741'$	E : $14^059.313'$
5	SEDIGUI	N : $12^012.256'$	E : $15^002.899'$
6	ABOUNA	N : $12^013.170'$	E : $15^003.113'$
7	AVENIR	N : $12^012.509'$	E : $15^002.997'$
8	SPS	N : $12^012.249'$	E : $15^002.859'$

Table 2 Values read on gauge 2819 at some service stations

NAME STATION SERVICES	PRODUCT	First Trial	2^e Trial	3^e Trial	Average
SOPETRANS GOUDJI	DIESIEL	3,5	3,5	5,5	4,167
AL NIZAM	DIESIEL	-3,5	-3,5	-3,5	-3,500
SEDIGUI SADJERE	DIESIEL	-6	-10	-10	-8,667
SEDIGUI NGABO 1	DIESIEL	-7,5	-5	-5	-5,833
LA LUNE	DIESIEL	-7,5	-5	-5	-5,833
WADI HAMRA	DIESIEL	-2,5	-9,5	-10	-7,333
ABD LONI	DIESIEL	-7,5	-4,4	-5,5	-5,800
ALRIZEGATE	GAZOLINE	-9	-8	-3,5	-6,833
GABINE GAOUI	DIESIEL	2,5	4	4	3,500
SIPECT	DIESIEL	2,5	4	4	3,500
OILIBYA (AZIZ)	DIESIEL	6	6,5	6,5	6,333
DJAMAL RUE 60	DIESIEL	-4	-3	-3,5	-3,500
MODERNE	GAZOLINE	-4	-3	-3,5	-3,500
AMANA DEMBE	DIESIEL	8	8	8	8,000
SALSABIL	ESSENCE	-3,5	-3,5	-3,5	-3,500
TOTAL GASSI	DIESIEL	-6	-6	-8	-6,667
INDJAZ	DIESIEL	-8,5	-9	-9,5	-9,000
KAGEBER	DIESIEL	-8,5	-6,5	-6,5	-7,167
KEIRA OIL	GAZOLINE	-5,5	-7	-7	-6,500
STD	DIESIEL	-9,5	-8,5	-6	-8,000
TRADEX NGUELI	DIESIEL	-9	-7	-4,5	-6,833
TOTAL WALIA	DIESIEL	-6	-5,5	-5,5	-5,667
B13 TOUKRA	GAZOLINE	-7	-6	-6	-6,333
OILIBYA TOUKRA	DIESIEL	-7,5	-9	-5,5	-7,333
ZP TOUKRA	DIESIEL	-3,5	-3,5	-3,5	-3,500
SABARNA	DIESIEL	-6	-4	-4,5	-4,833
OILIBYA RYAD	DIESIEL	-8	-8,5	-10	-8,833
OIL TCHAD	DIESIEL	-7	-5	-3	-5,000
DJAMAL RUE 40	GAZOLINE	-4	-5	-2,5	-3,833

2.3. Statistical analysis

After gauging all the service stations, we used Arc Gis software to produce a spatial distribution of service stations throughout the city of N'Djamena. Figure 7 shows this spatial distribution.
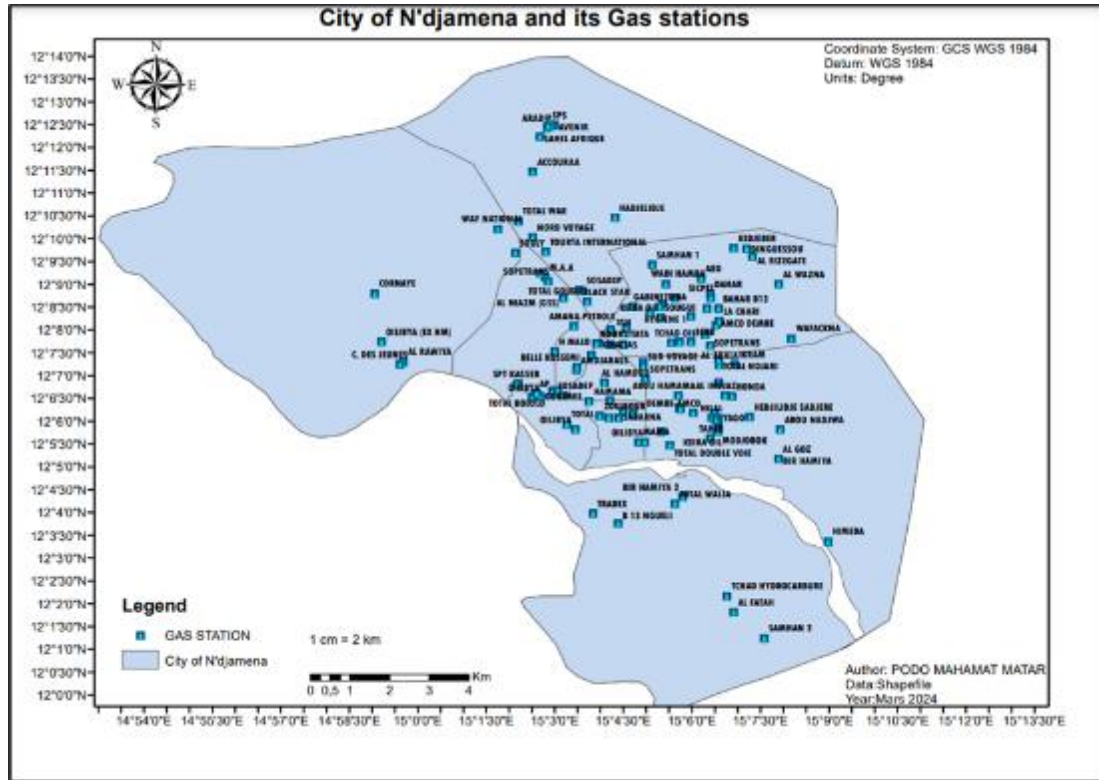
Figure 4 Distribution of service stations in the city of N'Djamena

3. Results

The test results are compiled in the following table according to the nature of the product either gasoline or diesel.

Table 3 Test values for gasolines read on the 2018 gauge by service station

Name of station services	Product	1er Trial	2e Trial	3e Trial	Average in %
NORD VOYAGE	Gasoline	-4	-2,5	-1,5	-2,667
AL TANWIR 2	Gasoline	-2,5	-2	-2	-2,167
ALRIZEGATE	Gasoline	-9	-8	-3,5	-6,833
LONI (HAMAMA)	Gasoline	1,5	-0,5	0	0,333
HYGIENE 2	Gasoline	-4	-4	0	-2,667
SPTTC NDJARI	Gasoline	-3,5	-3	-2	-2,833
TATA	Gasoline	1	2	0	1,000
BATHA	Gasoline	-0,5	-0,5	-0,5	-0,500
MODERNE	Gasoline	-4	-3	-3,5	-3,500
SALSABIL	Gasoline	-3,5	-3,5	-3,5	-3,500
MOJOBOK	Gasoline	-1,5	-3	-2,5	-2,333
KEIRA OIL	Gasoline	-5,5	-7	-7	-6,500
B13 TOUKRA	Gasoline	-7	-6	-6	-6,333
HYGIENE 1	Gasoline	-1,5	-1,5	-1,5	-1,500
DJAMAL RUE 40	Gasoline	-4	-5	-2,5	-3,833

If we look, values greater than or equal to -3% are correct values. In this case, we can say that the quantities of petrol delivered comply with standards, despite some disparities.

Of the 15 service stations that served petrol, 9 provided correct quantities, representing a percentage of 60%, while only 6 provided quantities below the normal value, representing a percentage of 40%.

Table 4 Test values for diesel readings on the 2018 gauge

Name of station services	Product	1er Trial	2e Trial	3e Trial	Average in %
AL NIZAM	Diesel	-3,5	-3,5	-3,5	-3,500
OILIBYA	Diesel	2,5	-0,5	-0,5	0,500
SOSADEP SADJERE	Diesel	-3	-3	-3	-3,000
AVENIR	Diesel	-4	-3	-3	-3,333
SEDIGUI SADJERE	Diesel	-6	-10	-10	-8,667
SPS	Diesel	-0,5	-0,5	-0,5	-0,500
AMANA WAR	Diesel	3	1	-1,5	0,833
SEDIGUI NGABO 1	Diesel	-7,5	-5	-5	-5,833
SEDIGUI NGABO 2	Diesel	-2,5	-2	-2	-2,167
LA LUNE	Diesel	-7,5	-5	-5	-5,833
TOTAL CHARAFA	Diesel	-1	-3	-3	-2,333
ARADIP 1	Diesel	-1	0	-1	-0,667
SAMHAN	Diesel	-3,5	-2,5	-3	-3,000
ADOUDOU	Diesel	-3,5	-2,5	-3	-3,000
WADI HAMRA	Diesel	-2,5	-9,5	-10	-7,333
ALTANWIR 1	Diesel	-2,5	-2	-2	-2,167
ABD LONI	Diesel	-7,5	-4,4	-5,5	-5,800
IKRAM	Diesel	-1	-1	-2	-1,333
GABINE GAOUI	Diesel	-2,5	-4	-4	-3,500
DAHAR	Diesel	2	5,2	-3	-1,400
SIPECT	Diesel	-2,5	-4	-4	-3,500
PETROLINE	Diesel	-1,5	0	0	-0,500
TOTAL NDJARI	Diesel	-2,5	-2,5	-2,5	-2,500
ECRB	Diesel	-2,5	-3	-3	-2,833

For diesel, we had counted 106 service stations that supplied diesel, we have more than 70 service stations that supplied correct gauge results, representing 66.03%, while only 36 service stations supplied correct values, representing 33.96%.

Thus, we had mapped service stations into two categories: those serving good fuel quantities and those with poor fuel measurements. Figures 5 and 6 provide an illustration.

Figure 5 Location of the best service stations in terms of quality and price

We have also drawn up a map of stations with a poor reputation in terms of quality/price, as illustrated in figure 6.

Figure 6 Bad service stations in terms of quantity/price

4. Discussions

In researching and collecting data for gauging at service stations.

It turns out that many service stations do not have a gauge that allows them to control the volumes they supply to customers.

Other service stations also claim to measure with unconventional units, just random bottles.

There are also others who deliberately lower the quantity to make a profit by not respecting the quantity/price ratio.

That's why we need to go out into the field as often as possible to check the volume meters at service stations, so that they comply with the law.
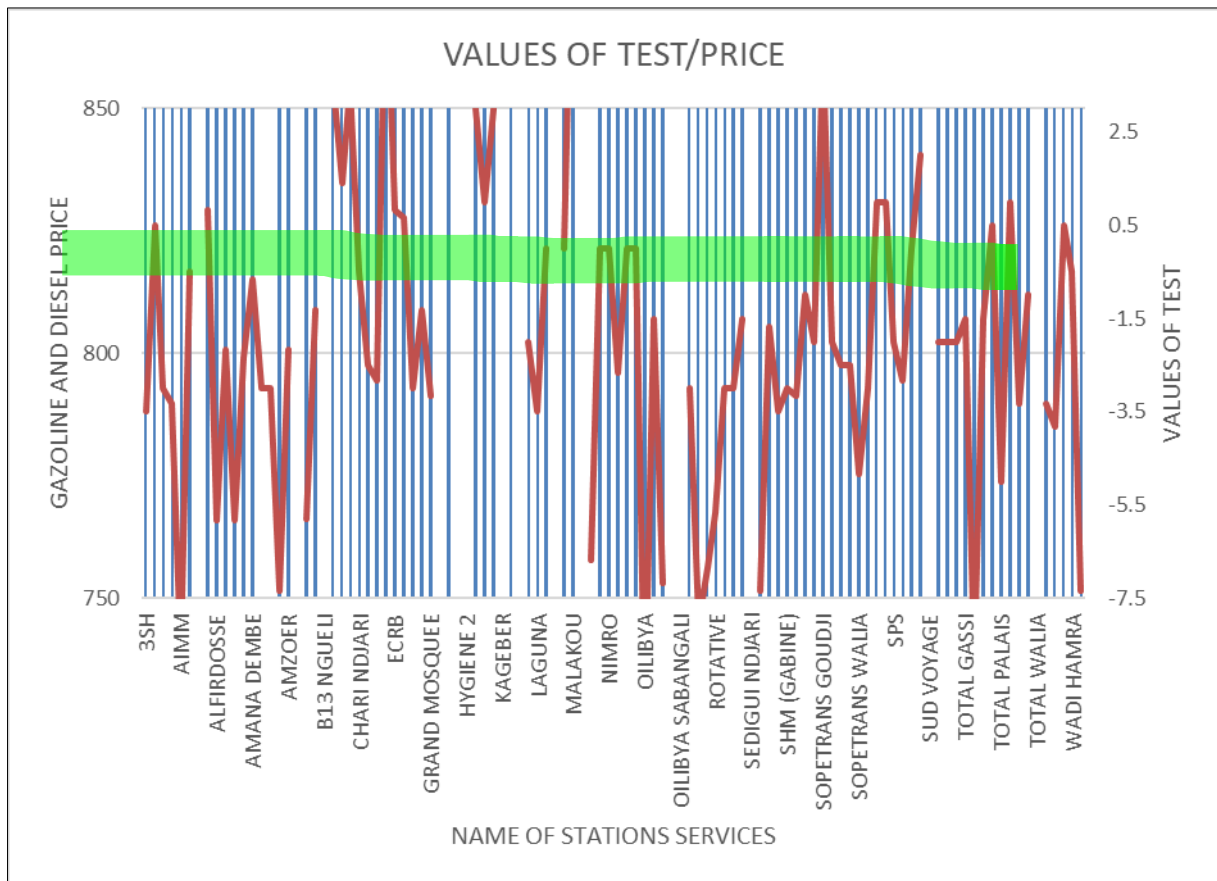

Figure 7 The green colour showing the right prices according to the quantity

5. Conclusion

All our work has enabled us to highlight the fact that some service stations do not deliver the quantities they display to their customers. This creates problems for customers, who do not know whether service stations are really serious about their work.

Through this study, we alerted Chad Downstream Oil Regulatory Authority (ARSAT) to apply the law in force, so that service stations can return to order. Unannounced volume-metering checks should be carried out from time to time to assess the quantity being priced at service stations.

Compliance with ethical standards

Disclosure of conflict of interest

We declare on our honour that all the authors who contributed to this article have no conflict of interest.

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