



## Basic Awareness on Semi-Trailers as Heavy-Duty Freight Road Vehicles and their Uses in Nigerian Economy: A Review

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### ABSTRACT

Road haulage is a top lucrative transportation business in Nigeria and about 80% of the business is done by roads. Nigeria's economy is more than 90% petroleum-dependent. Road haulage of petroleum products constitutes about 30% of the total goods that are transported throughout the country on daily basis. Semi-trailers form the bulk of vehicles used in haulage of petroleum products and other goods in the country. The safety of these vehicles during the hauling process has been a critical concern to all and sundry in the road transport sector owing to the magnitudes of calamities and losses that often result from their failures or accidents. It is therefore needful for all but especially new investors in the haulage business to know the basics about the vehicles and not invest in the wrong transporter so that these selected vehicles are reliable, well used, and maintained in service for long time by reputable standards to enable the vehicles efficiently safely haul as much goods as they can. In this paper; essential literature information and perspectives on features, importance, and usage problems of semi-trailers as heavy-duty freight road vehicles as regards Nigerian economy have been explored and articulated. The motive of the paper is to provide basic awareness that can be strategic for acquiring and using the vehicles several years in safety for optimal transportation business profile in Nigeria.

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### INTRODUCTION

Efficient transportation is an essential aspect of the production and distribution process or supply chain logistics. In the field of logistics, the main task of transportation is to deliver freight to the place of destination safely (Tseng *et al*, 2005). Transportation business has contributed immensely to economic development of many nations (Redding and Turner, 2014). Road transportation is the type of transport that involves using roads. Transport on roads can be grouped into

freight transportation, and transportation of people. Road transportation is a huge industry with many and varied opportunities for anybody that is interested to invest in it. Road freight transport is currently one of the most important means of transportation in the worldwide logistics sector (US Department of Transportation, 2001; ILO, 2020). Road transportation has a number of advantages compared to the rail, water, and air modes within the transport sector in terms of; economy and quickness for short distances, and ease of change or



adjustment by routes and timings to suit service requirements. Other advantages of road transportation include less risk of damage or breakage of even fragile goods in transit, ability to provide door to door or warehouse to warehouse service, reduced cartage as well as loading and unloading expenses, less capital investment, and suitability for most rural areas which are not served by the other modes of transportation. Although road transport has such advantages and is currently the mode of transportation with the largest number of workers, it is on record that; it is the branch of transport with the highest number and frequency of accident casualties worldwide (Carnarius, 2018; ILO, 2020). Road transportation accidents result in the deaths of 1.2 million people worldwide each year and injury to about four times this number with rising morbidity and mortality burden in developing countries in contrasts with technologically advanced countries where the indices are reducing. For developing measures aimed at reducing the rate of road transportation accidents and the consequent injuries and fatalities, there is a need for regular evaluation of the road transport accidents in terms of the trend, major causes, vehicles involved and types among other factors (Ohakwe *et al*, 2011). In Nigeria, the overall road traffic injury rate is about 41 per 1000 population and mortality from road traffic injuries is about 1.6 per 1000 population. This is significant, considering the fact that majority of such injuries and deaths can be prevented (Eze, 2012).

Heavy-duty road vehicles have some distinct features and play integral role in bulk transportation in many nations. Examples of heavy-duty vehicles include semi-trailers, B-double freight trucks, road trains, passenger vehicles, vehicle carriers,

livestock and other agricultural vehicles, trailer/truck combination vehicles, and mobile cranes and other special purpose vehicles (NHVR, 2019).

Semi-trailers are capable of transporting containers. They play significant role in transports to and from the sea ports in many countries. Nigeria's economy is more than 90% petroleum-dependent. Petroleum hauling is a top lucrative transportation business in Nigeria and about 80% of petroleum haulage in the country is done on roads (Ikporukpo, 1977; Obasanjo, 2014; Carnarius, 2018; Guma *et al*, 2019). Semi-trailers form the bulk of road vehicles in hauling petroleum products and other goods from depots to various locations of the country. Semi-trailer tankers and trucks are more commonly sighted heavy-duty freight vehicles on Nigerian roads be it in the rural and urban areas than other types of heavy-duty commercial vehicles. There is an estimate of over 5,000 semi-trailer tankers involved in wet cargo haulage that includes about 150 million liters of fuel daily to various fuel stations across the country and 2,500 semi-trailer trucks in dry cargoes plying Nigeria roads daily. The economic impact of these vehicles in hauling loads in Nigeria has been significant in the annals of the country's nationhood (Ikporukpo, 1977; Obasanjo, 2014; Guma *et al*, 2019). It is desirable that these vehicles operate without any problems whilst delivering optimal services. There have however been interminable daily cases of failures or hazardous accidents in Nigeria involving semi-trailers during the process of hauling petroleum products and other goods resulting in freight destruction or spillage, fire hazards and other treats to environment, road blockages, and multiple accidents with loss of lives and properties. The majority of casualties that are often associated with the accidents are people outside the vehicles (Guma *et al*, 2019). The victims of such



accidents are in most cases occupants of other vehicles such as passenger cars and light trucks and vans as well as non-occupants such as pedestrians and bicyclist and motorcyclists. These accidents are often terrifying by sight and highly detestable to all and sundry but particularly to the vehicle owners owing to the much loss they can incur including litigations they can face and compensations they can be obliged to make to affected innocent victims (Guma *et al*, 2019). The critical issues of concern for semi-trailers as transporters are therefore their longevity and safety in service. These issues are seen to revolve around the acquirement and levels of maintenance of the vehicles, experience and integrity of the vehicle drivers, and general awareness by stakeholders of basic issues that pattern use of the vehicles (US Department of Transportation, 2001; ILLO, 2020). Because of the lucrative business of petroleum-hauling in Nigeria, it is seen that some old semi-trailers are sometimes acquired by some entrepreneurs for the business without much understanding of risk implications and other issues involved in using the vehicles on Nigerian roads many of which are in deplorable conditions. Also proper maintenance of the vehicles ought to be done in accordance to their manufacturers' specifications in conjunction with regulations of reputable relevant authorities but it is difficult to be sure these are always done by all or many stakeholders. Procurement of rather old semi-trailers and lack of compliance to requisite maintenance standards for the vehicles is seen to be the major origins of their deterioration which frequently lead to various levels of unpredictable failures or accidents involving the vehicles (Guma *et al*, 2019). There is great need for all drivers of these vehicles to have good health, psychological stability, proper training and retraining, and experience with good

understanding of the way the vehicles work and their maintenance but it also difficult to be sure that all or a good number of the vehicle owners employ only certified competent drivers and take care of proper welfare and retraining of the drivers (EU-OSHA, 2010).

From the forgoing perspectives, it is seen that positive research inputs for preventing or minimizing failures and accidents of these vehicles are necessary for optimal freight transportation business profile and road safety in Nigeria and other nations where semi-trailers are important in trucking business. The aim of this article is to explore and articulate essential literature information and perspectives on the features, importance, and problems in trucking use of semi-trailers as regards Nigerian economy; with the objective of providing a compendium of basic awareness that can be strategic for acquiring and using the vehicles several years in safety for optimal profile of the business.

#### FEATURES OF SEMI-TRAILERS

The semi-trailer is a type of heavy-duty road vehicle that is designed and fabricated to specification for use in bulk transportation of goods for business. There are different types of semi-trailers but all semi-trailers have common basic distinctiveness from other trailers and vehicles which need to be understood for acquiring and using them (INTERNET, 2019b&c). There is no much difference between a full trailer and a semi-trailer (Automotive and Transportation, 2019; Guma *et al*, 2019). Basically, a full-trailer is like the semi-trailer with the difference that the full-trailer has steerable axles at the front end and rear end and can be parked on its own without the need of prime mover or landing legs to support it. A drawbar is provided to couple it with the prime mover. A full-trailer supports its own



weight, and has wheels at both front and back. The tractor pulls the trailer load, but doesn't carry the load. Full trailers are basically used for transportation of materials from one place to another place (Tengdelius, 2012; INTERNET, 2019a). On the other hand, a semi-trailer is a dump trailer without a front axle with its weight supported by a road tractor or by detachable front axle. It is a trailer having wheels at the back but supported at the front by a towing vehicle. A semi-trailer is pulled by a truck tractor or a prime mover. In other words a semi-trailer is hauled by the semi-truck. Since the semi-trailer has wheels but no front axle and no engine, it can't move on its own. The semi-trailer contains the cargo which is being hauled. The semi-truck also supports a lot of the weight of semi-trailer when the two are attached. The semi-trailer has a kingpin near the front end to couple with the prime mover and axles and wheels at rear only. Most semi-trailers have one, two or three axles but can also have more than three axles (Tengdelius, 2012; Guma *et al*, 2019). Semi-trailers also have brakes, suspension, and lights like most vehicles. A pair of landing legs is fixable near the front end of the semi-trailer to support it after it is decoupled from the prime mover. Depending on their designs or types, the empty weights of most semi-trailers range from about 9 to 15 metric tons with maximum gross weight of about 36.3 metric tons for any such type (Turner, 2009; Tengdelius, 2012).

Full trailers are mainly used for short-distance transportation in factories, ports, terminals, warehouses, etc., while semi-trailers are mainly used for long-distance transportation of goods. The overwhelming majority of intercontinental long-haul transplantation of goods is usually carried out on road by semi-trailer trucks (Woxenius and Bergqvist, 2011). Semi-trailers predominate in road haulage over

full trailers because of their flexibility and general ability to haul greater load than full trailers. There are reasons why semi-trailers have flexibility as their major advantage. Semi-trailers can be coupled and detached easily and fast to provide for shunting during loading and for trailers to be trunked between loading depots. If the tractor breaks down, another tractor can be got and coupled and transportation of the load continues on to destination without lengthy delay. A semi-trailer can be attached to another semi-trailer using a dolly. This is common in some countries where several trailers are allowed to be attached to form a road train or combination vehicles. A semi-trailer also has a smaller turning circle compared to a full trailer. Semi-trailers provide better load ratio between tare and laden weight than full trailers. Semi-trailer tends to have more weight on the drive axles of the tractor unit which gives it better traction and road handling characteristics in adverse weather conditions such as in snow compared to full trailers. Semi-trailers can haul longer objects such as logs, pipe, beams, and railway track than full trailers. This depends on legislation of their designs and use in different countries (Jim McCormack, 2017; INTERNET, 2019b and 2019c). In some European countries, a full trailer can be as long as a semi-trailer. Compared with a full trailer, a semi-trailer attached to a tractor unit is easier to reverse, since it has only one turning point at the coupling, whereas a full trailer has two turning points each at the coupling and the drawbar attachment (INTERNET, 2019b&c).

The first semi-truck was invented in 1898 by Alexander Winton in Cleveland Ohio, USA (INTERNET, 2019b). This semi-truck underwent technological evolution into the features and different types of semi-trailers we have today. In the last 40 years, semi-trailers have undergone major changes in response to changes in



regulations in some countries, such as the shift from the industry standard 13.72m-long semi-trailers to current use of 16.15m-long semi-trailers. The historic trend has been incremental growth in the length of semi-trailers, with each new length taking about 10 to 12 years to become the new standard. For example, the 13.72-m semi-trailers introduced in 1970 were the industry standard for van trailers until the 1980s, when the 14.63-m semi-trailer became the standard. Currently, semi-trailers longer than 16.15m are permitted to operate in some countries such as United States (INTERNET, 2019b). The new market share for the 13.72-m semi-trailer in 1994 was 30 percent. The 14.63-m semi-trailer offers an 18% in cubic capacity over the 13.72-m semi-trailer. The distribution of 16.15-m semi-trailers by the trailer body type is; 30 to 40% of all types of van trailers, 15 to 20% of the flatbed fleet, and less than 10% of specialized truck body types. The current maximum width of any semi-trailer is 2.6m and height is 4.5m (US Department of Transportation, 2003; Automotive and Transportation, 2019; INTERNET, 2019b).

The foregoing rundown on basic features of semi-trailers has shown that, the vehicles are well specially engineered type. It has also been shown that the vehicles are more common among the most massive vehicle types that are seen on roads and they have features and performance characteristics which other road vehicles do not have. The rundown also shows the vehicles are crucial wherever bulk road transportation of goods is required. These distinctive features of the vehicles implies that they need not be acquired, used, and maintained at the same level with what is practicable with conventional road vehicles like cars and buses. For example, attempts to drive such vehicles at some high speeds which can be safe for cars or buses can be disastrous for the vehicles. Also some makeshift

maintenance of the vehicles using conventional automobile mechanics can be dangerous for the road safety of the vehicles. It is therefore important that all people that deal or want to be dealing with these vehicles must be knowledgeable of the distinct feature of the vehicles for their acquirement, optimal maintenance, and use in service.

### **MARKET SEGMENTATION OF SEMI-TRAILERS**

Analysis of the semi-trailer market shows that that they are segmented by types as refrigerated trailer, flatbed trailer, dump trailer, dry trailer, curtain trailer/stake trailer, tankers, and others. Semi-trailers are segmented by tonnage types as 22.68, between 22.68 and 45.36, from 45.36 to 90.72, and above 90.72 metric tons. They are also segmented by axle types as less than 3 axles, 3 to 4 axles, more than 4 axles. They are also segmented by end user types as Heavy Industry, Construction Industry, Medical Industry, Food and Beverage Industry, Oil and Gas Industry, Textile Industry. On the basis of regional analysis, the semi-trailer market is segmented into five major regions including North America, Europe, Asia Pacific, Latin America and Middle East & Africa region. The North America market is estimated to hold prominent share in the global market owing to the noticeable truck industry with good road infrastructure and connectivity among all the states in the United States. Growing construction activities and flexible inland transportation services are some of the major factors that are estimated to significantly drive the growth of the market in Asia Pacific region (US Department of Transportation, 2003; Automotive and Transportation, 2019; INTERNET, 2019b).

### **IMPORTANCE OF SEMI-TRAILERS**

Semi-trailers are very important to industrial and economic developments in



many countries. There are a number of industries or companies that cannot run without an efficient means of transporting goods in bulk. Most companies in the world depend on semi-trailers to transport raw materials and final products. If the semi-trailers were to close down, many industries would also close down. Some of the industries that depend on semi-trailers include waste removal, health-care, and retail. Others include food, transportation, and manufacturing. Some semi-trailers are designed to transport gas and other petroleum products like gasoline, diesel, etc. Gas tanker carriers have different structures depending on the type of gas they transport (INTERNET, 2019b and 2019c). Road tractors and semi-trailers accounted for 77.6% of the total ton-kilometers transported in 2015 in Europe. It is estimated that semi-trailers transport goods worth \$700.4 billion annually in the United States. The weight of these goods is estimated at over 9 billion metric ton. In addition to transporting raw materials and finished goods, semi-trailers are a source of employment. For example, more than 800,000 drivers in the United States transport goods with semi-trailers annually. Semi-trailer drivers in the United States earn about \$30 billion dollars every year, and spend their earnings in the country's economy which helps in expanding the economy. Most of the drivers however quit after a few months because of the busy work schedule. Given the indispensable roles of drivers of semi-trailers for failure-free or safety of the vehicles in hauling goods in most countries, it has been important for playing roles in creating good working conditions for the drivers and those of other heavy-duty freight vehicle. The drivers deserve better pay and flexible working schedules that give them enough time to rest (INTERNET, 2019b and 2019c).

#### USES OF SEMI-TRAILERS IN NIGERIA

In Nigeria, semi-trailers of various facilitation and capabilities are used to haul different types of goods. The various types of semi-trailers that the Nigerian logistics services providers use in hauling the bulk of goods in the country include; oil tankers, livestock carriers, car carriers, dry bulk or powder tankers, refrigerator tanks. Other types are the box or van, double-decker, bus-bodied, curtain-side, low-bed, drop-deck or step-frame, dump/tipper, side lifter, side bay, flatbed, hopper bottom, and glass in-loader semi-trailer trucks (Michael Adewale, 2020). Haulage of petroleum products is the most common and predominant use of the vehicles (Ikporukpo, 1977; Obasanjo, 2014; Guma *et al*, 2019).

Most oil-hauling semi-trailer tankers in Nigeria are under the managements or ownership of oil marketing companies involved in the sale of regulated gasoline and kerosene, diesel, aviation fuel and low pour fuel in the country. The vehicles are used for road transportation distribution of these products from the Nigerian National Petroleum Company (NNPC) depots to various locations of Nigeria that can be up to 1200km away (Ikporukpo, 1977; Obasanjo, 2014; Guma *et al*, 2019). The capacities of most tanks of petroleum-product-hauling semi-trailers that are used can accommodate from 14,000litres to 100,000litres of the products (Guma *et al*, 2019). A number of other companies or enterprises and individuals also possess semi-trailers that are used to transport other goods such as livestock, cement, agricultural products, manufactured goods, etc. The current number of semi-trailer tankers and trucks in Nigeria is estimated to be over 8,000. Many Nigerians find gainful employments as drivers of semi-trailers. Drivers of the vehicles frequently travel at night, on holidays, and weekends to avoid traffic delays and to deliver cargo on time.



The drivers have to cope with a variety of working conditions including variable weather and traffic conditions, boredom, deplorable road conditions, and fatigue. Many of the drivers enjoy the independence and lack of supervision found in long-distance driving. They collect about 10% of the money they make in every trip which can translate into personal earnings of as much as One Hundred Thousand Naira (N100, 000) in a month or even more (INTERNET, 2019d).

From foregoing, it can be appreciated that the importance of semi-trailer trucking business to the Nigerian economy is enormous and encompassing. This is in quite agreement with Olanrewaju (2013) that any appreciable reduction or stoppage in semi-trailer trucking services in Nigeria can directly or indirectly negatively affect almost the whole of the country's economy by causing among other things in the country;

- i. Drastic reduction or non-delivery of fuel to fuel stations.
- ii. Cessation or reduction in delivery of timber and agricultural products to urban areas.
- iii. Manufacturers to experience shortages or no supply of local and imported raw materials.
- iv. Construction industries to have shortage or no supply of cements and stone and sands.
- v. The country's mail and other package delivery to reduce or cease.
- vi. Food shortage in many urban areas.
- vii. Drastic reduction in availability and delivery of automobile fuel and gas which will lead to sky-rocketing prices and long lines at supply stations and cause most vehicles to run out of fuel.
- viii. Low or no production due to low or no deliveries of manufacturing

raw materials which can also cause many industries or production units to shut down and put thousands of their employees out of work.

- ix. Increase or prohibitive prices of many consumer goods.
- x. Garbage to start piling up in urban and suburban areas.
- xi. Container ships to be sitting idle in ports and rail transport to eventually be disrupted and come to standstill.
- xii. Many other vehicles such as automobiles and buses to reduce or stop operating.
- xiii. Transportation of people to reduce or cease due to low or lack of fuel supply.
- xiv. Many people not to be able to get to various locations to do work or business or get services they need because most automobiles and buses will not be fueled.
- xv. Electricity power generating stations that use gas or coal to have fuel supply problems that will lead to short fall or non-availability of electric power supply.
- xvi. Supplies of essentials such as bottled water and powdered milk at major retailers to reduce drastically or disappear.
- xvii. Hospitals to begin to exhaust oxygen and some other supplies.
- xviii. Lack or inadequate supply of potable water with attendant effect of increase in gastro-intestinal illness that will strain any already weakened health care system.

#### INDICES OF ROAD SAFETY LEVEL OF SEMI-TRAILERS AS TRANSPORTERS IN NIGERIA

Transport safety implies the prevention of accidents and the minimization of accident losses (Afolabi and



Gbadamosi, 2017). Records of accident cases involving semi-trailers in Nigeria with much casualties and loss of properties are well documented in the literature. For example;

The Federal Road Safety Corps (FRSC)-A Nigerian national authority that is responsible for ensuring safety on Nigerian roads, reported that at least 1,048 people were killed in 770 road crashes involving 4,365 tankers and trailers from January to November 2016 alone, and the country lost over 39 Billion Naira (108.33 Million Dollars) to tanker and trailer-related road crashes in 2018 alone (Premium Times, 2016; Oluwaseun, 2019).

FRSC Report, 2011 revealed that; between 2007 and June 2010, a total of 4,017 road traffic crashes (RTC) involving articulated trucks and tankers were recorded by the FRSC on Nigerian roads with a yearly average of 1,148 cases and monthly average of 96 crashes. The report added that 607 of the crashes were recorded in 2007. This figure increased by 102.47% to 1,229 in 2008. In 2009, the crash figure reduced from 1,229 by 1.3% to 1,213. As at June 2010, 968 crashes had so far been recorded for the year. These showed that the rate of crashes involving

the vehicles was on the increase. The report also supported the increasing trend of the crashes with analyzed monthly average crashes of 51 in 2007, 102 in 2008, and 101 in 2009, and 161 as at June in 2010. The increasing trend in the number of crashes was also supported by the report's daily average crashes of 1.66 in 2007, 3.37 in 2008, 3.32 in 2009, and 5.31 in 2010, which occurred on Nigerian roads. Furthermore, the report revealed that in all these crashes, 2,974 persons were either injured or killed in 2007. The 2,974 figure increased by 71.89% to 5112 in 2008. The 2008 casualty figure decreased by 6.12% to 4,779 in 2009; and in 2010 as at June, there were 4,185 casualties from crashes involving the articulated vehicles. Additional casualty information from the report showed monthly average casualty figure of 347.83 in 2007. In 2008, this figure rose to 417 and decreased to 399.92 in 2009 and geometrically rose to 697.5 casualties per month in June. 2010.

Boboyemi Opeyemi, 2018 presented FRSC Road Traffic Crash Data from 2007 to 2017 with specified numbers of articulated trailers/tankers as shown in Table 1.

**Table 1:** FRSC Road Traffic Crash Data 2007 to 2017 (Boboye Opeyemi, 2018)

Year	No. of trailers involved	No. of tankers Involved	Total RTC	Total No. of persons killed	Total No. of persons injured	Total No. of Casualty
2007	703	273	607	805	269	1074
2008	1192	463	1229	1221	3891	5112
2009	1272	495	1213	1085	3714	4799
2010	1186	461	968	965	3220	4185
2011	464	180	1188	1090	4117	5207
2012	462	179	1194	1097	3935	5032
2013	1180	315	1222	1178	4006	5184
2014	727	271	934	1079	3206	4285
2015	761	331	876	979	3048	4027
2016	657	359	872	910	3516	442
2017	624	308	779	737	2622	3359

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From Table 1 and the other discussions in this section, it is vividly demonstrative that despite the much importance of semi-trailers as transporters to Nigerian economy; a critical obstacle to optimal trucking business profile with the vehicles in the country is the accident level with the vehicles. The indices depict a very bad and worrisome scenario considering the alarming number of accident casualties that have been witnessed and recorded with the vehicles in the country over the years. It is seen that, while the issues involved in road safety of such vehicles are the same everywhere the vehicles are used in the world, the levels attained on the issues can vary from country to country due to variations in standards of the vehicles used and their maintenance levels, compliance to road safety standards in driving the vehicles, availability and quality of roads on which the vehicles are driven, availability of installed road safety facilities for the vehicles, standard of road safety regulations, and quality and commitment of road safety workers in different countries. The levels of variation in such factors can thus cause more safety problems with the vehicles in some countries. In Nigeria, several stakeholders' engagements are seen to be held where preventive measures of the vehicles' accidents are carried out. The next thing that needs to be done is implementation of the preventative measures with due consideration of the level of peculiar problems to road safety of the vehicles in the country. The list and percentage contributions of peculiar causes of articulated vehicle accidents in Nigeria from 2007 to 2017 had been provided by FRC Report, 2011. The causes included; road obstructions (7.79%), speed violation (23.08%), dangerous driving (26.4%), tire violation (8.56%), brake failure (9.14%), mechanically deficient vehicle (1.3%), overloading violation (2.34%), dangerous overtaking (2.95%), loss of control (2.26%),

route violation (0.87%), driving under the influence of alcohol and drug (0.13%), speed limit violation (0.28%), and wrong overtaking (0.98%). It can therefore be recognized that the critical approaches to tackling these peculiar problems is through provision of good roads, use of standard vehicles, and improvement in the quality of manpower such as drivers and mechanics for the vehicles. This is quite in line with Ohakwe *et al* (2011) who observed that road accidents occur as a result of one, or various combinations of two or more of; human, vehicle, road and environmental factors.

#### **Buying semi-trailer in Nigeria**

The returns that one can make in haulage depends mainly on what their vehicle can be doing, so acquiring correct vehicle is the first important to do for profitable business. World over, the cost of acquiring a brand new semi-trailer can range from as low as 3,500 to as high as 190,000 US Dollars depending on the type. In Nigeria, a brand new semi-trailer costs from about 20 to 30 Million Naira at Leventis and United African Company of Nigeria (UAC) while the second hand type popularly known as 'Tokunbo' can be got around seven to eight Million Naira. Almost 90% of the semi-trailers on Nigerian roads are Tokunbos (Tunji Afuwape, 2019). Some of the Tokunbos are imported from Belgium, Germany and United Kingdom. Some Nigerians also buy trailer heads and refurbish the engine to standard at total costs of about 3 to 3.5 Million Naira. A Trailer Tanker costs around 3 to 3.6 Million Naira. If one doesn't want to spend a lot of money they can decide to rent the back which goes for about Thirty Thousand Naira (N30, 000) in a month, and need to pay for 4 months which is One Hundred and Twenty Thousand Naira (N120, 000). Purchasing a Tokunbo semi-trailer can save a lot of upfront costs if the right



decision is made. It is also cost-effective way to building fleet quickly when in a dramatic business growth mode. However, if care is not taken, a Tokunbo semi-trailer can easily become an impediment to growth, as well as a business loss rather than profitability. Just like purchasing a new semi-trailer, matching needs with the trailer's functionality is the most important purchase criteria when considering a Tokunbo semi-trailer (Tunji Afuwape, 2019).

From the foregoing, it is seen that although some semi-trailers of good qualities can be purchased at fair prices in Nigeria for trucking business in the country, it is advisable to always buy only from reputable dealers and request for their warranties. It is also necessary to always buy vehicles of the correct intended capacity and types and select the best insurance option for the vehicles from the insurance providers. Moreover, it is necessary to be sure that spare parts of the vehicles are easily obtainable in Nigeria. Experts may be consulted where there is need on all these and other pertaining issues before purchasing any of the vehicle types. When purchasing a Tokunbo semi-trailer much greater caution is needed. It is necessary to first thoroughly assess the chosen vehicle to be sure that it is reliable, effective, and durable before any other things. In line with Transport Services (2020), such assessment can include:

- i. Performance of compatibility, and market check. It is needful to make sure the trailer is compatible with the truck for it. It is also advisable to check from relevant dealers and people and on the INTERNET to see what is available and what the average prices are in one's market for the type of trailer they are considering.
- ii. Ensuring that the trailer has current inspection by reputable authorities such as Federal Road Safety Corps (FRSC) of Nigeria or Federal Highway

Administration (FHWA) of United States. It is important to know whether the trailer seller is independent owner or brokers, and why the trailer is being sold or why it was traded in. Service records of the trailer should be seen and it must be ensured that the replacement parts of the vehicle are readily available.

- iii. Checking the structural components of the trailer. An examination of the undercarriage of the trailer can be conducted with torchlight to assess the level of corrosion or damage to the vehicle. This is because structural corrosion could mean a shorter service life for the trailer or major maintenance further down the road. There should be checking for cracks, irregular formations, and welds that could need major repair. It should be checked to make sure that all lights, including brake lights and signals are all operational. All electrical connections and wires should be checked for fraying or other wear and tear. Brakes should be checked, and the drums and linings be inspected for unusual wear and tear. The working of the anti-lock braking system (ABS) must be ensured and it should be seen that its wires are not frayed or cut. Tires should be inspected because they can tell a lot about the condition of the trailer. The tires should be checked for ample tread, embedded objects as well as bulges or other irregularities on the sidewalls that could lead to catastrophic failure while on the road. There should be check for uneven tire wear because it can indicate a big problem with the axle, wheels, rims, brake drums, hubs, shocks or the tires themselves. The tire pressure should be checked first since shoulder wear, center wear and cupping and scalloping are common symptoms of poor tire



- inflation. Other common mechanical problems associated with uneven tire wear include misalignment of an axle, poorly maintained or broken suspension components, or bad shocks.
- iv. Need to consult sales professionals from transport services who understand the industry to help meet trucking needs within budget. These professionals have reputation for offering used trailers in all configurations, so can help to walk through the entire purchase process.

#### MAINTENANCE OF SEMI-TRAILERS

A well maintained vehicle is cheaper to run, helps to reduce expenses caused by failures or breakdowns, maximizes life and safety of the vehicle, helps in delivering reliable service to customers, enhances reputation for reliability, and increases business base. Ipso facto, effective preventative maintenance system for semi-trailer increases customer satisfaction due to consistent on-time deliveries, reduces its overall maintenance and operating costs due to fewer breakdowns, improves its fuel consumption, increases its residual value and protects its life, lowers its insurance costs, and reduces its risk of downtime at roadside check points, etc (CCDT, 2016). All parts of heavy-duty vehicle like semi-trailer such as the transmission fluid, fuel system, cooling system, engine and oil filter, exterior and interior lights, body, glass and mirrors, windshield wiper system, horn, seatbelts, seat structures, fluid leaks, auxiliary systems, engine and transmission mounts, exhaust system, undercarriage and frame, drive shaft or constant velocity (CV) joints, belts, hoses, tune-ups, electrical system components, braking system, steering and suspension system, tires, wheels, rims, etc are all important for road safety of the vehicles and require regular maintenance attention. However some of

parts such as, brakes, tires, shafts, and engines require more regular attention because their failures in service can spell instant disaster (CCDT, 2016).

Inspection is critical appraisal involving examination, measurement, testing, gauging, and comparison of various component parts of the vehicle and their working levels with the set or acceptable standards for the vehicle to reduce problems and failures. Inspection is an essential aspect for maintaining semi-trailer (CCDT, 2016). When regularly and properly done, inspection reduces maintenance costs and prevents the operation of semi-trailers with problems that are likely to cause or contribute to the severity of accident with the vehicles. Hence, it is important to inspect all parts of semi-trailers from time to time. There are some things that require regular attention or care to keep a critical vehicle like semi-trailer running without failure such as, wear and tear, load weight to ensure that it does not exceed the recommended capacity for the trailer, wheel alignment, axle alignment for proper steering, and the body and supporting beams to avoid excessive rust. If the axles are not properly aligned, the outer wheels may not touch the ground. If tires are worn out they should be replaced immediately (CCDT, 2016). All misalignment should be corrected immediately. Loose fasteners like bolts can cause semi-trailer to roll over when carrying heavy loads. It is also pertinent to confirm that all fasteners are tightened especially before loading heavy cargo. No any loose bolt or fastener should be ignored even if the others appear tight (Denise Rondini, 2015). Loose bolts cause excess wear and tear on the rubber. The trailer brakes should be inspected often by checking the drum conditions when adjusting the brakes. The brakes need to be inspected for any wear and tear on it and speed of releasing air when the trailers are in motion for corrective or maintenance



actions. Trailer maintenance must include a close inspection of tie-down straps, chains, ratchets and winches. Power train, suspension and hydraulic brake systems, brakes, steering, instruments and auxiliary equipment, lamps, electrical system, body, tires and wheels, couplers and hitches components should be thoroughly inspected to ensure that they comply with the National Safety Standard and applicable legislations. Periodic inspections are also required for the trailers and converter dollies. These inspections can help reduce collisions caused by mechanical defects and improve highway safety. There are three safety inspections: annual, semi-annual, and safety standard certificates. The annual and semi-annual inspection requirements are the minimum requirement under the law (Denise Rondini, 2015).

Corrosion and wear and fatigue are common causes of unpredictable calamitous failures of vehicles. Unexpected failure of semi-trailer can occur due to various forms of corrosion such as stress corrosion cracking, corrosion fatigue, and pitting perforations that emanate in conjunction with improper distribution of carried weight in synergism with structural vibrations when the vehicle is in motion. Breakages and unacceptable levels of corrosion, wear, tear, crack, scratch marks, dirt or stain are critical for failure of semi-trailer; so require prompt attention (Carrera-Alegre *et al*, 2016; Guma *et al*, 2017 & 2019; Pedigree, 2019). All painted parts of the semi-trailer should be repainted if excessive rust is observed. Sometimes corrosion causes the lighting and electrical system of the vehicle to stop working. It is therefore crucial to inspect the vehicle for any corrosion and correct it before it affects critical parts like the electric and engine systems. Electric wires and all parts of the engine system need to be checked for wear and tear or functionality for corrective actions before

embarking on journeys with the vehicles. All the exterior and interior parts of the vehicle such as the walls, suspensions, and floor should often be inspected visually for corrosion, wear, tears or heat cracks. It must always be ensured that nothing touches the suspension or interferes with its movement. Spillage on the vehicle floor may lead to bad corrosion. The easiest way to prevent or minimize corrosion inside the vehicle is to keep the vehicle clean by properly cleaning it after transporting every type of cargo (Denise Rondini, 2015; CCDT, 2016; Guma *et al*, 2017 & 2019). The trailers also require daily inspection looking for holes, tears and cuts, snags, loose stitching or embedded particles in the entire body structures or components. The purpose of the daily inspection is to ensure that problems and defects are always identified before the vehicle is operated on the highway (Pedigree, 2019).

The discussion presented in this section vividly indicates that, there are unavoidable unpredictable natural and human-caused factors that structurally and mechanically deteriorate all road vehicles and reduce their lives and safety levels. These factors are seen to be of critical concern for massive transporters such as semi where failure of even a small component part of the vehicle such as valve by such inimical factors can result into serious accident. It is therefore seen that it is not just acquiring the transporters for business but awareness of these factors with the potential and dedication in maintaining the vehicles in service use that really matters thereafter. It is noted that, as heavy vehicles with distinct features; maintenance of the transporters is far more demanding, requires special facilities, and needs to be done according to standards by specialized mechanics compared to maintenance of buses and other smaller vehicles. Without proper scheduled maintenance of the transporters accidents



with them is seen to be inevitable. The vehicles will therefore not last long for business and the business profitability with them will be curtailed. It is thinkable that a good number of trucking entrepreneurs in Nigeria do not always maintain their vehicles to satisfactory standard. This is quite in agreement with the regret by The Commonwealth of Pennsylvania, 2017 that many of the trailers used for hauling loads on even deplorable roads in many developing countries are very old but frequently employed in carrying heavy loads without adequate maintenance schedule services such as corrosion monitoring, corrosion inspections and repairs. . Lapses in protecting and maintaining these vehicles from such inimical processes coupled with overloading the vehicles is seen to be the cause of various types and levels of failures or accidents with the vehicles. It is therefore seen that maintenance of semi-trailer to prevent or mitigate their deteriorations by processes like corrosion and wear is the most important technological way of preventing accidents with the vehicles.

#### **SIZE, DYNAMIC ISSUES, AND HUMAN FACTOR IN USE OF SEMI-TRAILERS AS TRANSPORTERS**

Semi-trailers take up more physical space in a queue; are slower to accelerate, so slower in accelerating from a stop at a signal; require larger gaps when turning such as entering roundabout; have wider turn radii which cause them to typically conduct turning maneuvers more slowly and carefully; and have physical constraint on long and/or steep grades, causing them to reduce their speed relative to cars, even at low traffic volumes (Moridpour, *et al*, 2015).

These vehicles have greater effects on their surrounding traffic than passenger cars. The vehicles impose physical and psychological effects on surrounding traffic.

There is potential for these vehicles to have a substantial impact on macroscopic and microscopic traffic flow characteristics because of the interference effect they have on surrounding vehicles. These effects are the results of physical characteristics of all heavy vehicles such as length and size and operational characteristics such as acceleration/deceleration and maneuverability. The effect of these operational characteristics becomes prominent under heavy traffic conditions (Moridpour, *et al*, 2015).

Heavy vehicles such as semi-trailers and heavier combination vehicles cause several times higher deterioration of pavement structure than cars or light commercial vehicles. The total weight of heavy trailers, trucks and heavier combination vehicles has highest impact on bridges, viaducts and other over land infrastructure utilities. Vehicles such as semi-trailers and heavier types tend to rollover when negotiating curves or steep grades. The risk of static rollover is also great for these vehicles and heavier combination vehicles. The possibility of rollover is related to the height of vehicle center of gravity. Rearward amplification occurs when a semi-trailer or longer combination vehicle is travelling at high speed above 80 km/h and the driver sharply maneuvers left then right or right and then left. In situations whereby the driver tries to avoid collision with an unexpected obstacle and makes a sharp maneuver, the end of such vehicle or heavier combination vehicle tends to skid sideways into other traffic lanes or to rollover. Greater weight of semi-trailers as heavy-duty vehicles means greater kinetic energy and thus higher destructive force in case of accidents compared to cars and other light vehicles. Secondly, the longer length of the vehicles sometimes lead to their overtaking other vehicles and stability problems (Luskin and Walton, 2001; Hanley and Forkenbrock,



2005; Findley *et al*, 2015; Salek and Slabik, 2019).

Semi-trailers generally have centers of gravity which tend to be higher than those of full trailers which make them prone to tipping over compared to rigid trailer construction. Semi-trailers are also prone to jackknifing because they are articulated, that is they do not have a fixed but movable attachment between tractor and trailer. The different designs, massiveness, heights, lengths, widths, number of axles etc of semi-trailers have impacts on dynamics and driving of the vehicles (Sharaf, 2013).

Heavy vehicles like semi-trailers typically take at least twice the distance to stop from highway speeds on dry roads as passenger vehicles. On wet roads, the disparity is even greater. Practical considerations such as tire life, vehicle control, load transfer, suspension design, and physical configuration of these vehicles preclude making stopping performance equal to that of passenger cars; however, marked improvements can be made. Reduced stopping distances from highway speeds can be improved by brake manufacturers for these vehicles by greater braking torque, particularly at the front (steering) axle. Most high-performance heavy vehicle braking systems utilize air disc brakes or high-performance drum brakes. The ability of the driver to continuously assess the combination of speed, load, and cornering and road conditions is paramount for safe operation of these types of vehicles since the dangers these combined factors pose can be obvious (Hanley and Forkenbrock, 2005; Prinka *et al*, 2014; Salek and Slabik, 2019).

Drivers of these types of vehicle are generally exposed to more stress driving for long distances or on bad roads most of the time than drivers of light commercial vehicles (EU-OSHA, 2010; TYA Solna Sweden, 2019). Drivers of semi-trailers and

other comparable heavy duty vehicles have a higher risk of some general and mental health problems compared to drivers of light commercial vehicles because of meticulous driving control requirement for the vehicles amid road conditions that can be bad coupled with environment monitoring to avoid accident (Turner, 2009; EU-OSHA, 2010; McKnight and Bahouth, 2008). Failure of a semi-trailer can not only lead to much loss of lives and cargo, but also the costly vehicle. The trailer can also end up depositing its cargo on the highway and causing multiple vehicle accidents and huge traffic disruption and treat to environment. In developing countries such as Nigeria where there are many bad roads and less adherence to traffic regulations and standards, failures of heavy duty vehicles such as semi-trailers that carry highly inflammable petroleum products are seen to be more critical issues that require proactive prevention all the times by the vehicles' owners, road safety workers, practicing engineers, government legislation, and the vehicle drivers (Ikporukpo, 1977; Guma *et al*, 2019).

From the above discussions; it can be appreciated that massiveness, dynamic tendencies, and human factors have great effects on the motion and safety of heavy-duty road vehicles like semi-trailers. The effects are attributed to limitation or difficulty of the present level of technological knowledge to better massiveness of the vehicles. The human factor is seen to be the most important factor of all factors which affects road safety of vehicles because the human factor determines greatly the extent to which all other factors that affect the safety of a vehicle can be controlled. From this, it can be understood that, drivers as a component of human factor that is directly involved in motion and control of semi-trailers on roads; are most important in road safety of the vehicles. It has however



not been found on record that many trucking entrepreneurs in Nigeria if not all of them employ only certified competent drivers of high moral integrity and take care of proper welfare of the drivers. It is thus recognizable that, for significant safety enhancement in trucking business with semi-trailers in Nigeria, the foremost issue that needs to be addressed is that; stakeholders should be ensuring that only certified and licensed competent drivers of high moral integrity who have basic level of education and knowledge of the vehicles are employed to be driving the vehicles. To achieve this, it is hereby suggested that, all trucking entrepreneurs in the country should be compelled by government legislation with monitoring to be employing only drivers of high standard and to be well-paying the drivers to make the drivers committed to their tasks. Each driver should also always be given enough time to rest after every long haulage trip before embarking on another trip to avoid tiredness and sleepiness while driving. These opinions are quite in agreement with Afolabi and Gbadamosi, 2017 who observed that the human factor constitute about 80% of the cause of road traffic accidents recorded in Nigeria; and the major components of the human factor are drivers, pedestrian, law enforcement agent and the engineer. The opinions are also in line with Victor *et al*, 2016 who after examining the literacy of Nigerian truck drivers being used in haulage operations with a view to assess whether driver's literacy enhances haulage operational performance, observed that the problem of haulage operations in Nigeria can be attributed to inadequacy of well trained and educated drivers who can carry out deliveries with little or no supervision. They also noted the need for the drivers to have certain level of education that will enable them understand; road signs, traffic signals, documentation procedures, negotiations

and readings of certain descriptions on equipment like fire-extinguisher, mechanics tools.

#### **WAYS OF PREVENTING OR MINIMIZING ROAD SAFETY PROBLEMS WITH SEMI-TRAILERS**

From the foregoing it can be appreciated that semi-trailers as heavy-duty vehicles require:

- i. High level of adherence to road traffic safety practices.
- ii. Very good road conditions for operation.
- iii. Parking at only authorized or safe locations along the road.
- iv. Installation of speed limiting devices.
- v. That their drivers to have good health and judgment, awareness on the vehicles, and practical training/certification and retraining to minimize driving errors and chances for accidents
- vi. Adequate training/certification and retraining of drivers to minimize driving errors.
- vii. Provision of parks for them.
- viii. Fleet renewal programs and avoidance of aging.
- ix. Adherence to safe laden and haulage practices and standards by stakeholders, in accordance with practice guidance.
- x. Non-headiness and cooperative attitude of drivers and other stakeholders.
- xi. Clear-cut policy on their transit and overcoming security challenges.
- xii. Adherence to standards by operators and tank constructors.
- xiii. No alteration of their original design values.

#### **CONCLUSION**

Transportation safety management is part of environmental management. Ensuring transport safety with optimal



business profile is the key area of transport companies' operations. Road transport is the dominant mode of movement of both freight and passenger traffic in Nigeria. Semi-trailers are the most important vehicles in road transportation of bulk goods in Nigeria and many other countries. These vehicles have peculiar features, dynamic problems and intimidating sizes on majority of road users. Hazardous failures or accidents from these types of vehicles have greater effects on the vehicles themselves and their occupants and the transported goods with majority of impact in the surrounding environment and other people that use the road than cars and small buses. The features and importance and problems of semi-trailers as transporters of goods with respect to Nigerian economy have been surveyed. The survey depicts a very bad and worrisome scenario of the safety level attained in using the vehicles for trucking business in the country over the years. The critical concern for these vehicles is therefore seen to be their safety, and longevity in use. It is seen that road safety, longevity, serviceability, and the overall trucking business profiles with these vehicles can be greatly improved through: basic awareness on features and problems in usage of the vehicles by all and sundry in the road transport sector especially owners and drivers of the vehicles, correct acquirement and maintenance of the vehicles in accordance with proper procedures or standards, assignments of the vehicles to only drivers of high moral integrity that are well-paid and have good knowledge of driving and repairing the vehicles, operating the vehicles in accordance with provided clear guidelines and good roads, and operating the vehicles with high level of adherence to road traffic safety such as safe laden haulage practices and other standards by drivers and owners of the vehicles.

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