A STUDY OF THE LOCAL DESIGN MODIFICATIONS ON IMPORTED HEAVY VEHICLES IN GHANA

BY

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DECLARATION

I hereby declare that this thesis is my own original work undertaken at the Department of Mechanical Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, under the supervision of Dr. J. Antonio and Dr. E.S.D. Afrifa.

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ABSTRACT

In Ghana, it is common practice to modify imported heavy vehicles to suit the owners intended purpose and sometimes the environmental conditions, nature and design of the roads. Some of these modifications include conversion from cargo to tipper truck, lengthening and shortening of trailer bed, reassembling or repair of cracked or broken leaf springs, increasing the bucket capacity of trucks, and modifying vehicle structure to work with available spare parts. This thesis presents findings of a study of the various design modifications on imported heavy vehicles at Suame Magazine in Kumasi, a large informal site where major vehicle modifications and repairs are carried out.

The motive for the modifications is mainly economic.

These modifications are carried out by artisans with little or no background in automobile sciences. Due to the very informal nature of the operations of the artisans and their general suspicion of researchers trying to study their activities, data had to be collected by observation supplemented by interviews in the few cases where the artisans agreed to be interviewed.

Some of the materials used were badly corroded and some had visible cracks. Welded joints were of poor quality due to the presence of cavities, cracks and solid inclusions that resulted from poor surface preparation before welding. The research also observed illegal act of welding leaf springs, mismatch of leafs during re-assembly and lack of compatibility checks among associated leaf spring assembly as common practice among the artisans and these practices could be causes of failure during vehicle operation. Modifications, involving lengthening of vehicle chassis, which are also illegal, were also observed. Where modifications were made to increase the gross vehicle weight the engine capacity was not increased nor the brakes redesigned to match the new weight.

Absence of proper documentation of the modifications done and the unavailability of the manufacturer's vehicle documents make it difficult for the Driver and Vehicle Licensing Authority (the DVLA) to check the legality of most of the modifications. Comparison of the modifications done at Suame with international guidelines for heavy vehicle modifications showed serious implications for safety. There is little communication between the Ghana Standards Board, the Driver and Vehicle Authority and the artisans who carry out the modifications

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I also acknowledge the effort of Emmanuel Dadzie, my project colleague for his moral and technical support.

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March, 2009. **Adewale Adedamola**

DEDICATION

This work is dedicated to the Adewale and Agbeno family.

CHAPTER ONE

INTRODUCTION

1.1 General Background

Highway transportation has provided considerable opportunities for people, particularly the freedom to move goods and services from one place to another at one's will and convenience. Roads can be considered as much a cause and as a consequence of civilization; they both precede and follow it. As civilization advances and prosperity increases, there is an inevitable demand for better and faster transportation facilities, especially for roads. Indeed, it can truly be said that the prosperity of a nation is bound up with the state of its roads, and that the roads act as a palimpsest of a nation's history (O'Flaherty, 1998).

The desire to travel and transport more goods and services safely has been the aspiration of mankind at all times especially with the boom in population growth. This desire has led to the increase in the demand of heavy vehicles. The aspirations of mankind regarding safety are sometimes hindered, according to Enyonam (2002), by the conflicts arising among the various components of the road system, the road users plying the road network, and the vehicles themselves. Overcoming these hindrances on the part of the vehicles has led to the continual improvement by manufacturers in the safety of heavy vehicles. These improvements could sometimes mean modifying parts of the vehicle or the whole vehicle, while still meeting demand.

According to Hillier et al (2004), improvement in vehicle safety and performance have always been the aim of heavy vehicle manufacturers over the years. Unlike light vehicles, more power is needed from these vehicles to meet demand in the areas of loading, distance travelled, and road type (most especially off roads). To

continually achieve better vehicle performance, vehicle manufacturers take into consideration the differences in the environmental conditions and the nature and design of the roads in various regions of the world so as to produce vehicles that will suit all regions.

While vehicle manufacturers strife to improve heavy vehicle performance to satisfy environmental conditions and road designs, vehicle owners also often make modifications to suit the purpose the vehicle owner intends it to serve. In Ghana, modification of heavy vehicles is a common practice and the resources used are selected based on cost only with no check for compatibility. Acquiring parts specified by particular manufacturers or a brand new vehicle meant for the Ghanaian road for whatever purpose could be extremely expensive. The solution adopted by the Ghanaian vehicle technicians and operators, to cut down costs, is to modify the vehicles such that the available fairly used parts for the vehicle or parts from other manufacturers could be used (e.g. using a Nissan part on a Toyota vehicle or a certain Toyota part on another Toyota part but of a different model or design). Or if one has a cargo truck for transporting goods and decides to enter another area of business for example, transporting construction materials like sand and gravel, instead of buying a tipper truck, the cargo truck is then reconstructed to a tipper truck so as to meet the intended purpose. Another strategy employed to cut down cost is to buy a less expensive fairly used vehicle, which is referred to as „home use", and then modify it to suit the owners intended purpose as well as the environmental and road conditions. Because heavy vehicle modification in Ghana is based on cost consideration alone, on October 2, 2006, a letter was issued by Toyota Ghana Company Limited (TGCL) through the „Daily Graphic" to the general public to educate the public on the dangers and additional expenses that could be incurred when going for unauthorized parts (parts not meant for their geographical location) in carrying out these modifications.

In Ghana, local vehicle technicians and artisans engage in many modifications on both light and heavy vehicles for several reasons, some of which have already been stated above. These modifications have in many ways improved and increased the number of vehicles on our highways and at the same time, boosted employment in the repairs, fabrication and transportation sector of the economy. The confidence the "local vehicle manufacturers" (the mechanics technicians and artisans involved in the modifications) have put in the people has made it possible for many people to become vehicle owners due to the relatively cheap cost of carrying out the modifications. These modifications include:

- Wheelbase alteration
- Radiator change and thermostat removal
- Conversion of cargo vehicle to commercial passenger vehicle
- Conversion of petrol engine vehicles to gas (LPG) engine vehicles
- Increase in vehicle capacity so as to carry more passengers or goods
- Complete conversion of one vehicle type to another (e.g. cargo truck to tipper truck),
- Various structural cosmetic changes such as coloured head lamps and tinted glass

1.2 Problem Statement

Although it is known that local design modifications are common in Ghana, there has been no detailed study concerning the modifications and the kind of resources such as material, level of skilled labour, as well as the processes that go into their accomplishment to meet safety requirements. Without adequate knowledge of the operations of the artisans and craftsmen who carry out these modifications, it is difficult for universities and research institutions to provide them with the necessary technical support. This research seeks to study the resources and processes involved in the modifications carried out at Suame Magazine (the

major modification site in Ghana) in Kumasi and their possible implications on vehicle safety as well as their legal basis.

1.3 Objective

The overall objective of this work is to conduct a case study on the local design modifications on imported heavy vehicles at Suame Magazine where these modifications are done.

The specific objectives of this work are to identify:

- The various modifications that are carried out on heavy vehicles,
- Who carries them out,
- Why and how they are carried out,
- If they are based on sound design principles,
- The legal implications, and
- Their implications on safety and performance.

This work is intended to provide the baseline information which will form the basis for assisting the artisans and craftsmen with sound designs, technical training, manufacturing equipment, e.t.c.

1.4 Scope of Research

The scope of this work was limited to the study of the processes (design sketches, materials selection, joining, and finishing) involved in accomplishing the various modifications carried out on heavy vehicles (such as trailer trucks (flat bed and cargo) and tipper trucks), the possible implications in terms of safety as well as the legal requirements of the modifications. The operational analysis of the vehicles after the modification does not form part of the present study.

1.5 Methodology

The strategy adopted in this research work was based on:

(1) Obtaining published information from books, journals, and the Internet to get relevant background information on repairs, maintenance, and construction of heavy vehicles.

(2) Observation of the design modification process as carried out at Suame Magazine for eight weeks so as to have a comprehensive understanding of the operations carried in the modifications.

(3) Interviews with personnel from the Traffic Unit of the Ghana Police Service (MTTU), the Driver Vehicle and Licensing Authority (DVLA), Ghana Standards Board (GSB), National Road Safety Commission (NRSC), and the Ministry of Transportation to identify the legal implications of these modifications.

1.6 Structure of the Thesis

The report of this thesis is presented in five chapters. Chapter one is devoted to the introduction of the research project with special reference to the objectives and the approach to realising the objectives. Chapter two provides a brief review of the literature on heavy vehicle modification, types of modifications that are allowed, types that are not allowed, and types that need approval from the DVLA. It also presents the international regulations governing vehicle construction and use for local vehicle manufacturers, technicians, and operators. In addition, Ghana‟s vehicle standards, its heavy vehicle construction and use regulations and guidelines, and the agencies responsible for enforcing these regulations are stated. It further deals with road safety situations in Ghana and how these modifications affect road safety, vehicle safety and performance. Chapter three describes the design and method developed for carrying out the research, and gives a brief description of Suame (the modification site), the background of the

artisans, their mode of operations, the interviews carried out and the various modifications carried out there, the processes involved in accomplishing the modifications, and also the cost analysis for the modifications. Chapter four discuses the result of the research, it identifies the problems associated and created while accomplishing the modifications and finally, their possible implications for road safety. Chapter five presents the conclusion and recommendation for further work.

CHAPTER TWO

LITERATURE REVIEW

Heavy commercial vehicles or trucks are generally referred to as **heavy vehicles** or **heavy goods vehicles** (HGVs). These vehicles are used for long distance transportation of goods and they come in various sizes. Heavy vehicles have a load carrying capacity in excess of about 3 tonnes. The chassis frame of heavy goods vehicle consists of two straight and deep-sided members (I beams or channels) joined by several cross members. The frame supports the main components of the vehicle as well as the platform that forms the basis of the body (Hillier et al, 2004)

2.1 Definitions and Classification of Heavy Vehicles

Heavy vehicles are vehicles constructed to carry goods and passengers exceeding 50 in number with an unladen weight from 2,540 kg to 32,520 kg, not more than 19 meters in length, 2.6 meters in width, and about 4 meters and above in height when loaded. These vehicles are of various types depending on their purpose and they include:

- **Goods vehicle:** a vehicle or a trailer adapted or constructed to carry a load.
- **Heavy motor:** a vehicle constructed to carry goods or passengers with an unladen weight exceeding 2,540kg.
- **Heavy locomotive:** a vehicle which is not constructed to carry a load and which has an unladen weight exceeding 11,690kg.
- **Articulated vehicle:** as defined in the Construction and Use (C&U of EU) regulations, is a motor car or heavy car with a trailer so attached that when the trailer is uniformly loaded at least 20% of the weight of the load is imposed on the drawing vehicle.

- **Composite trailer:** is a combination of a converter dolly and a semi-trailer, and is treated as one trailer only when considering the number of trailers which may be drawn. (Lowe, 2002)

2.2 Definitions and Classification of Modification

The word „modification", which means „a slight change in order to make something more suitable for a particular purpose" will also be used for conversion (complete change) for the purpose of this research.

- Slight change: this is when a part of the vehicle is modified in order to achieve desired performance. For example, lengthening trailer size to carry more loads or shortening it for easy maneuvering in certain narrow areas.
- Complete change: this is when the whole vehicle is converted from its present form to an entirely new form. Typical example of complete change is the conversion of a cargo truck to a tipper truck and a flat bed trailer to a cargo trailer.

A modification is usually carried out if for example a tipper truck is needed and a cargo truck is cheaper, the cargo truck is purchased and modified to meet the purpose of a tipper truck. In some cases, only the trailer head is bought and whatever is desired is built and connected to the head. These modifications are by themselves legitimate. However, the manner in which they are carried out may not conform to laid down regulations by the various international and national transport authorities in charge of vehicle registration and licensing and the manufacturers of the vehicles.

According to Donkor (1990), some of these modifications have been linked to fatalities on our roads due to the fact that they are built on poor design principles.

This can clearly be seen on Ghanaian roads where varying designs with disproportional bodies are seen sitting on particular chassis.

2.3 Heavy Vehicle Modifications

Most heavy vehicles are modified during their service lives to make the vehicle more suitable for a particular transport purpose. This practice is acceptable by the Land Transport Authority (LTA) of New Zealand, Transport Canada (TC), the Construction and Use (C&U) regulatory body of the European Union (EU), and the Drivers and Vehicles Licensing Authority of Ghana, provided that the guidelines laid down by the manufacturers and vehicle registration authorities are met both after the modification and during its service life.

Approval certificates are required for any modification to any part of a vehicle if it is suspected that it would have an effect on safety and performance. According to the Land Transport Authority (LTA) of New Zealand, these modifications are grouped into three classes to aid operators and technicians as to when approval is needed or not and also to guide local technicians and artisans in their operations.
(www.ltsa.govt.nz)

2.3.1 Modifications That Do Not Need Approval

Many minor vehicle modifications can be carried out without specific approval as long as they do not:

- reduce vehicle strength structurally
- affect vehicle control
- hinder vehicle safety, or
- cause a nuisance to other road users

However, these modifications are still subject to compliance with the Road Traffic and Vehicle Safety standard rules.

These minor modifications include:

- Door modification (changing of door handles, glass winding mechanism, etc)
- Tyre size and aspect ratio
- Air conditioners
- Alarm systems
- Additional lighting
- Roof racks
- Wind screens and lamp shields
- Seat belts
- Radio and stereo systems
- Blinds and other internal screening systems are also allowed subject to clear view

2.3.2 Modifications That Need Approval

Modifications that need approval are those that affect vehicle safety and performance. An example is the replacement of engines which differ in capacity and/or configuration from the original or replacing the radiator or thermostat which is also different in configuration from the original so as to achieve faster or slower cooling.

Other modifications that need approval are those that affect the:

- Steering system
- Brakes
- Suspensions

It should be noted that the finished modified vehicle must continue to comply with relevant road traffic and vehicle safety standards. The following modifications also need approval:

- Additional axle or axles
- Chassis extension
- Wheelbase alterations
- Increase in gross vehicle mass or gross vehicle weight rating
- Brake modifications, including trailer brake connections
- Change of vehicle type
- Engine changes

2.3.3 Modifications That Are Not Allowed

The following modifications are regarded to create vehicles, which pose danger to both the driver and other road users:

- Leaf springs repairs or alterations
- Drive shaft repairs or alterations

2.4 United Nations (UN) Regulations Governing Heavy Vehicle Modifications

In the construction of heavy vehicles, in the automobile industry, manufacturers, bodybuilders, and operators must observe the requirements regarding the specification and standards of construction of parts as laid down by licensing authorities.

The vehicles construction and use regulations of the UN require that all vehicles and trailers, their parts and accessories, weight distribution, parking and adjustment of their loads, should be such that no danger is caused or likely to be caused in or on the vehicle or trailer while in use. In addition, no vehicle or trailer must be used for any purpose other than that for which it was designed. Lengthening of trailers beyond the manufacturer"s recommendation is not permitted by the regulation. According to Lowe (2002), this lengthening, alongside with the position, nature, and size of the load greatly affects the handling of the vehicle when loaded. If the limit (as specified by the manufacturer) is exceeded, the vehicle may overturn while negotiating a bend or going uphill as mostly seen on our roads.

2.4.1 European Union Construction and Use (C&U) Requirements for Heavy Vehicles

As required by the C&U regulations of the EU regarding heavy vehicles, the following areas should be critically considered when carrying out modifications or a total reconstruction:

 Vehicle Length: For rigid vehicles, the maximum length should be 12 meters, while for articulated vehicles, the maximum permitted length is 16.5 meters, provided the combination can turn within minimum and maximum swept inner and outer concentric circles of 5.3 meters and 12.5 meters respectively as shown in Figures 2.1 and 2.2; otherwise the maximum permitted length is 15.5 meters. (Vehicle length is the distance between the extreme forward and rearward projecting points of the vehicle/trailer inclusive of all parts, but excluding load securing sheets and flexible coverings, receptacles for customs seals and tailboards (provided they are not supporting the load in which case they are included in the length)). These dimensions do not apply when the vehicles are being towed.

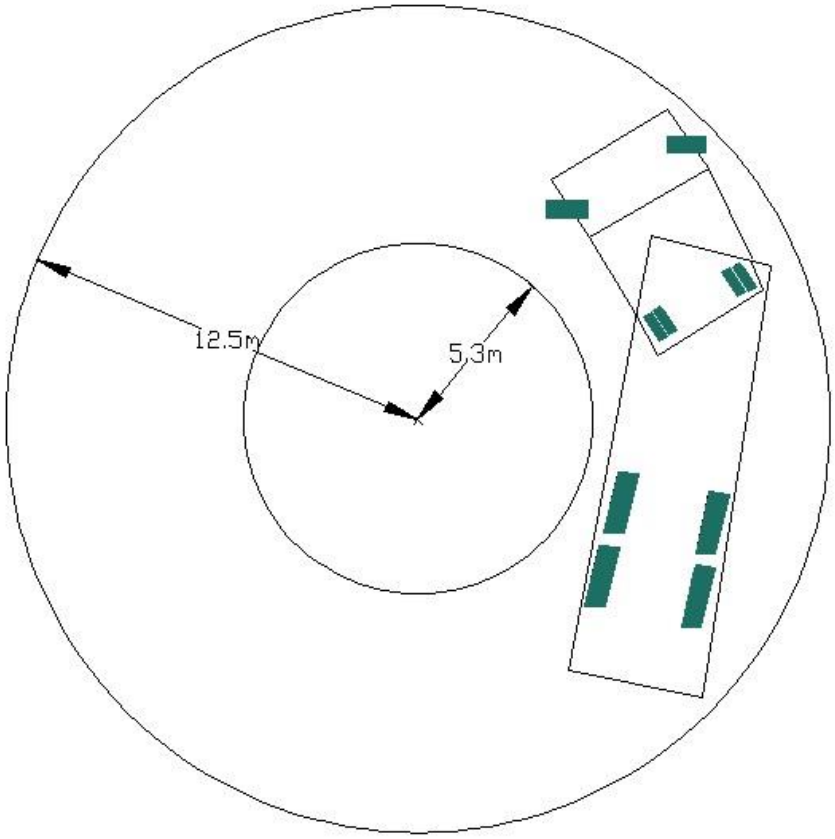

Figure 2.1 The maximum and minimum outer and inner swept circles within which a 16.5 meter long articulated vehicle must be able to turn.
(Source: Lowe, 2002)

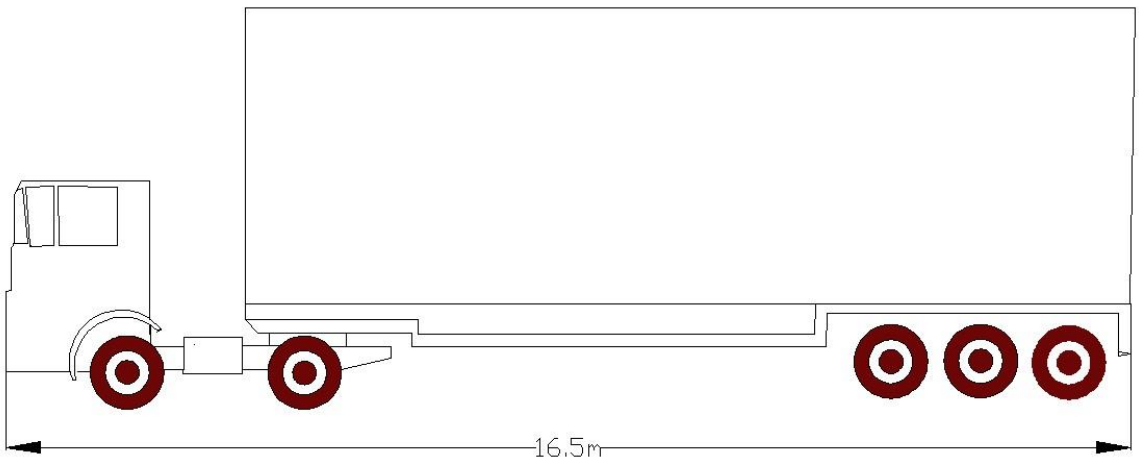

Figure 2.2 The maximum permitted length for articulated vehicles and semi-trailers (Source: Lowe, 2002)

Vehicles with drawbar combinations, Figure 2.3, should have a maximum overall length of 18.75 meters. This length incorporates:

- A maximum load space of 15.65 meters to be shared between the two bodies. o A minimum-coupling dimension of 0.75 meters.
- A minimum cab length of 2.35 meters.

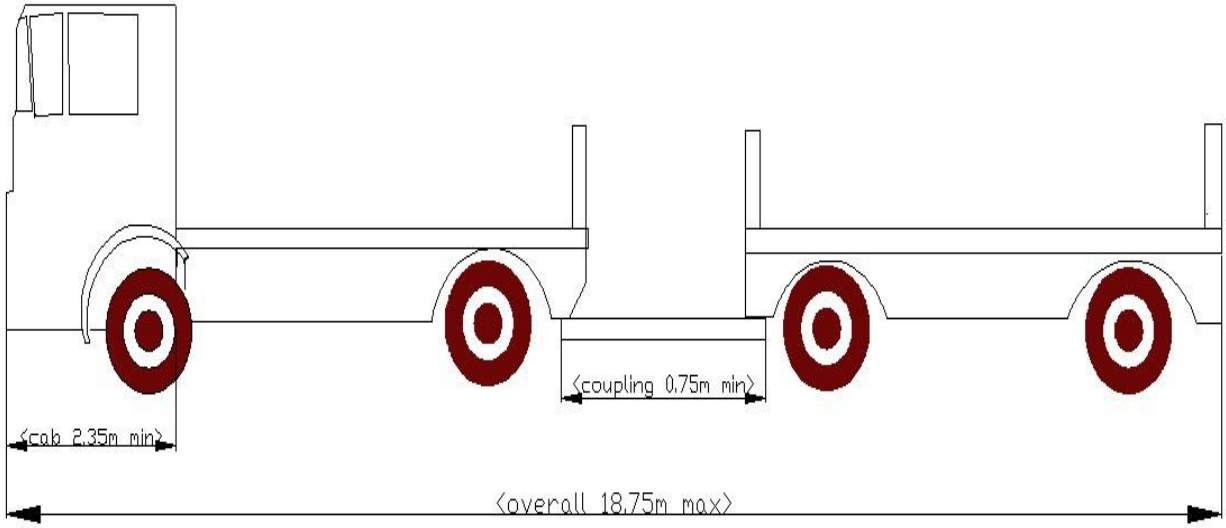

Figure 2.3 The maximum length for drawbar vehicle combination. (Source: Lowe, 2002)

The overhang, (x), Figures 2.4 (a), which is also considered, is the distance, (x), by which the body and other parts of a vehicle extend beyond the rear axle. The maximum overhang, (x), permitted for rigid goods vehicles is 60% of the distance, (y), between the center of the front axle and the point from which the overhang is to be measured. The point from which overhang is measured is, in the case of two axled vehicles, the center line through the rear axle, and in the

case of vehicles with three or more axles two of which are rear axles, 110 mm to the rear of the center line between the two rear axles, Figure 2.4 (b) (Lowe, 2002).

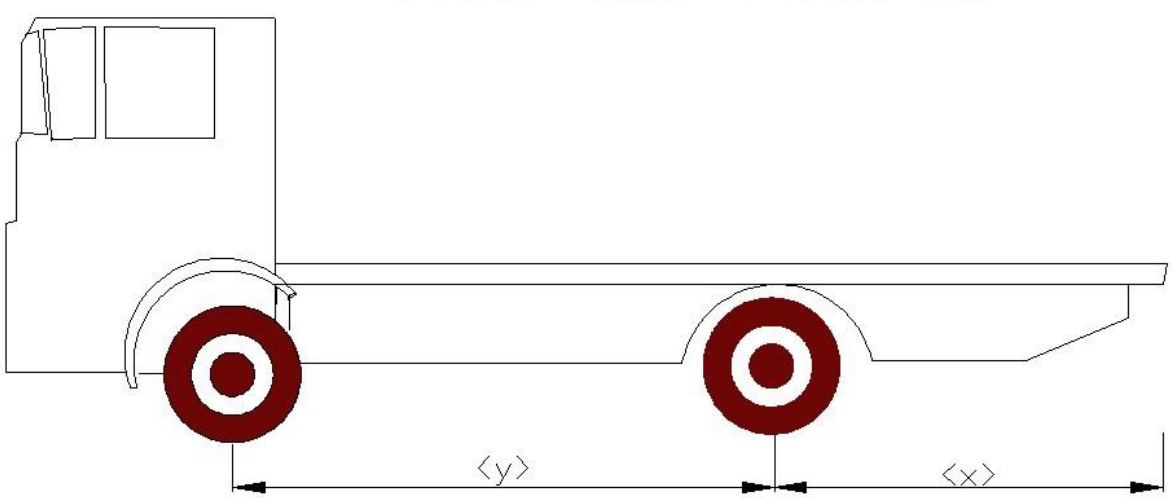

Figure 2.4 (a) Two-axled vehicles: Overhang „x" must not exceed 60% of length „y" (Source: Lowe, 2002)

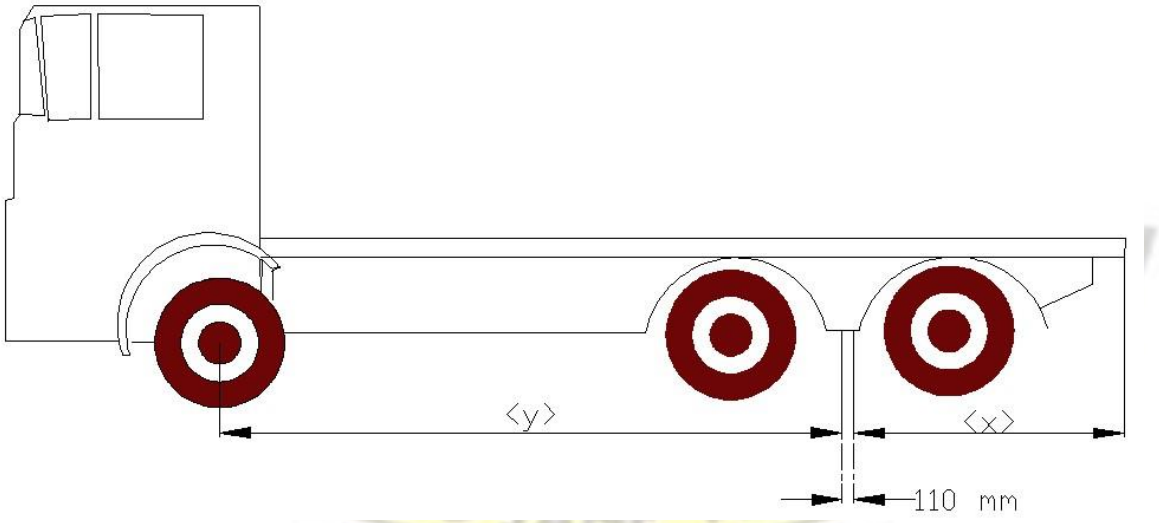

Figure 2.4 (b) Vehicles with three or more axles: Overhang „x" measured from 110 mm behind the center line of the two rear axles must not exceed 60% of the

length „y“ which is the distance between the center-line of the front wheel to the center-line of the two rear axles. (Source: Lowe, 2002)

- Vehicle Width: The maximum width for trailers should not exceed 2.55 meters provided the drawing vehicles have a maximum permissible weight exceeding 3500 kg. If the drawing vehicles are below this weight, the width of the trailer must not exceed 2.3 meters.
- Vehicle Height: There are currently no legal maximum height limits for goods vehicles or for loads. They are governed by the height of bridges and overhead barriers on the routes the vehicles are operated. The minimum height of bridges varies with different countries. Heavy vehicle operators are responsible for deciding loading heights by studying the routes to be used except in countries where specific limits have been stated.
- Vehicle Weight: Maximum permissible weights (the total weight of the vehicle and load, including the weight of fuel, and the driver and passenger if carried) for goods vehicles and trailers depend on their wheelbase, the number of axles, the outer axle spread (the distance between the center of the wheels on the front and rearmost axles) and the relevant axle spacing in the case of articulated vehicles.

The maximum permissible laden weights for different types of vehicles are shown in Table 2.1. Lorry and trailer combination weights must not exceed 24,390 kg gross weight unless the trailer is fitted with power- assisted brakes which remain operative even when

the drawing vehicles engine is not running, and a brake warning device in the driver“s cab in which case the permitted maximum train weight for the combination is 32,520 kg or more depending on specification. In the case of trailers, the maximum laden weight permitted for unbraked trailers is not more than half the unladen weight of the drawing vehicle. Trailers with overrun brakes are limited to a maximum laden weight of 3500 kg.

Table 2.1 Permissible weights for rigid vehicles and trailers

	Vehicle Type	**Permissible weight (kg)**
1	Trailer with two closely spaced axles and with a distance between the foremost axle of the trailer and the rearmost axle of the drawing vehicle of at least 4.2 meters	18,000
2	Trailer with three closely spaced axles and with a distance between the foremost axle of the trailer and the rearmost axle of the drawing vehicle of at least 4.2 meters	24,000
3	Two-axled vehicle with a distance between the foremost and rearmost axles of at least 3.0 meters	17,000
4	Two-axled trailer with a distance between the foremost and rearmost axles of at least 3.0 meters	18,000

(Lowe, 2002)

Ground Clearance: this is the distance between the ground and the underside of the vehicle chassis as shown in Figure 2.5 (in determining the minimum ground clearance, no account should be taken of any part of the suspension, steering or braking system attached to any of the axle, any wheel and any air-skirt). Minimum ground clearances are specified for goods-carrying trailers. Such trailers must have a minimum ground clearance of 160 mm if they have an axle interspace of more than 6 meters and not more than 11.5 meters as shown in Figure 2.5 (a). If the interspace is more than 11.5 meters as shown in Figure 2.5 (b), the minimum ground clearance is 190 mm.

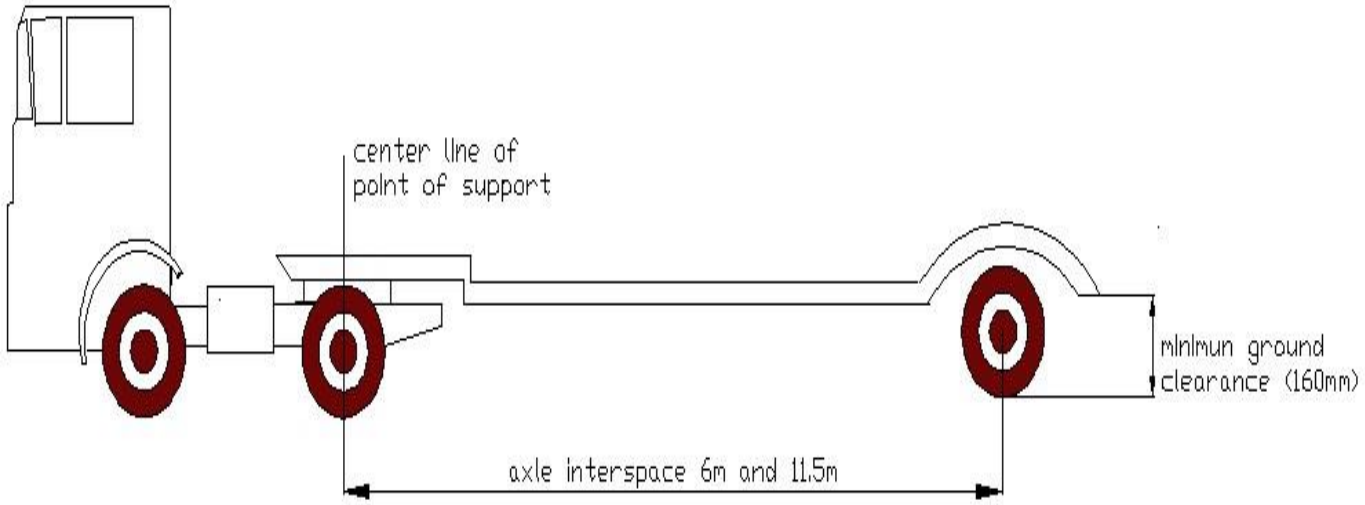

Figure 2.5 (a) Ground clearance for trailers with axle interspace between 6 meters and
11.5 meters
(Source: Lowe, 2002)

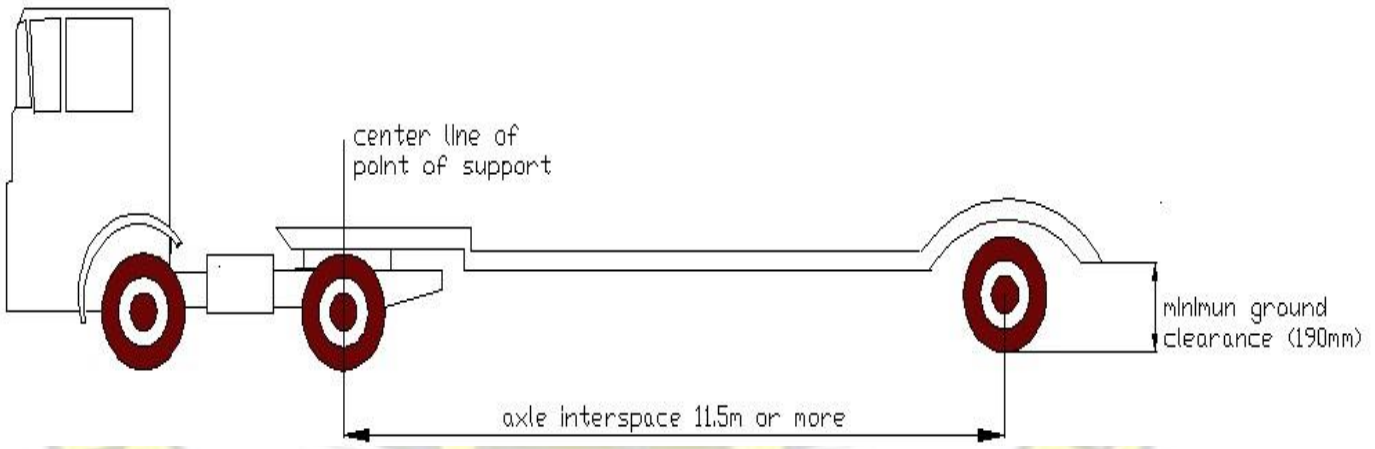

Figure 2.5 (b) Ground clearance for trailers with axle interspace of 11.5 meters or more (Source: Lowe, 2002)

Measurement of the axle interspace is taken from the point of support on the tractive unit in the case of semi-trailers or the center line of the front axle in other cases to the center line of the rear axle or the center point between rear axles if there is more than one as shown in Figures 2.6 (a), (b), and (c).

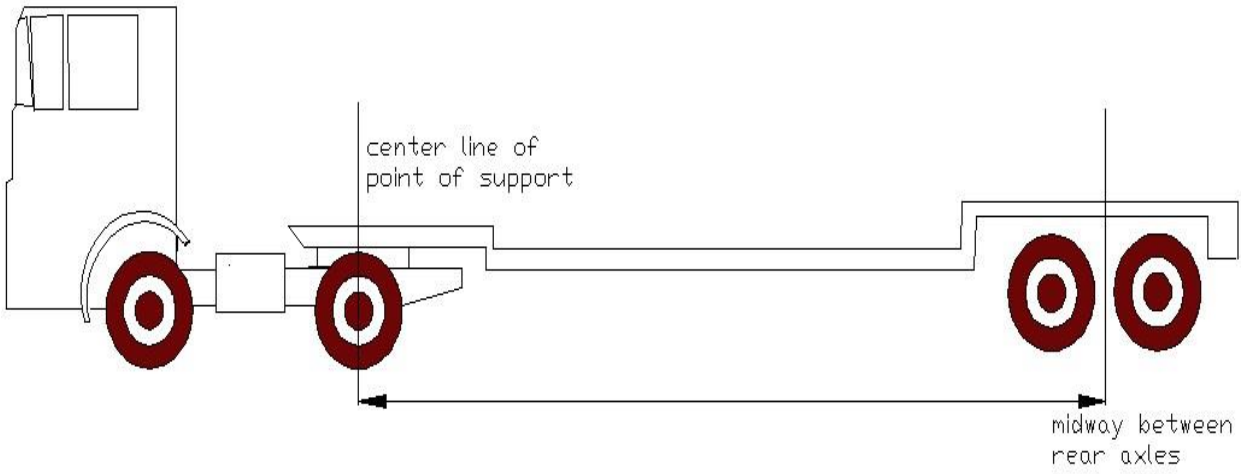

Figure 2.6 (a) Measurement of axle interspace on a double-axle trailer. (Source: Lowe, 2002)

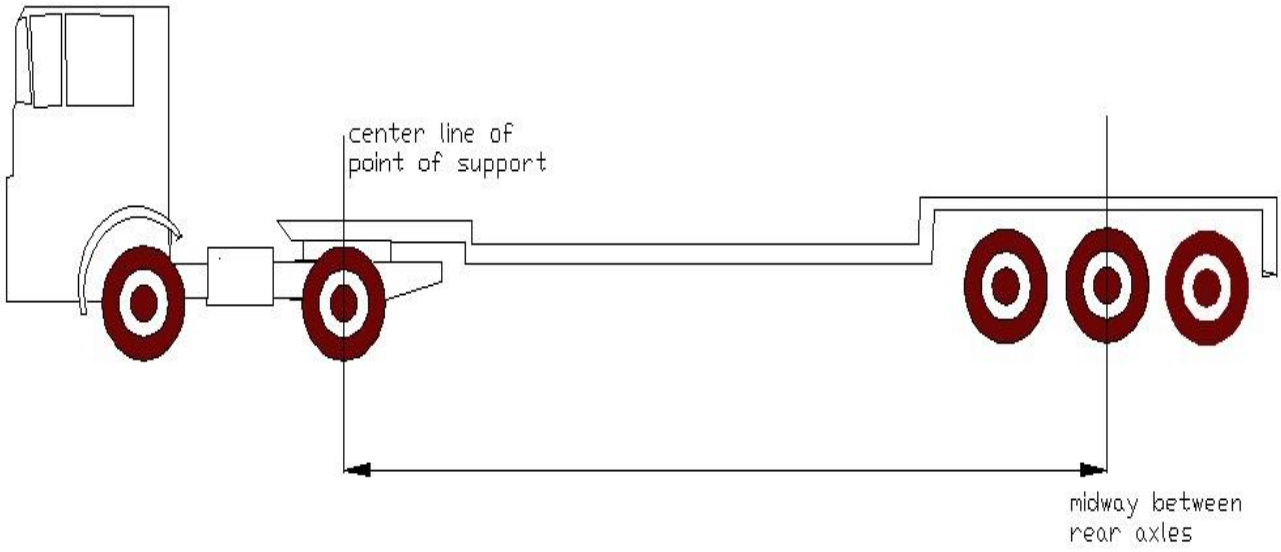

Figure 2.6 (b) Measurement of axle interspace on a triple-axle trailer (Source: Lowe, 2002)

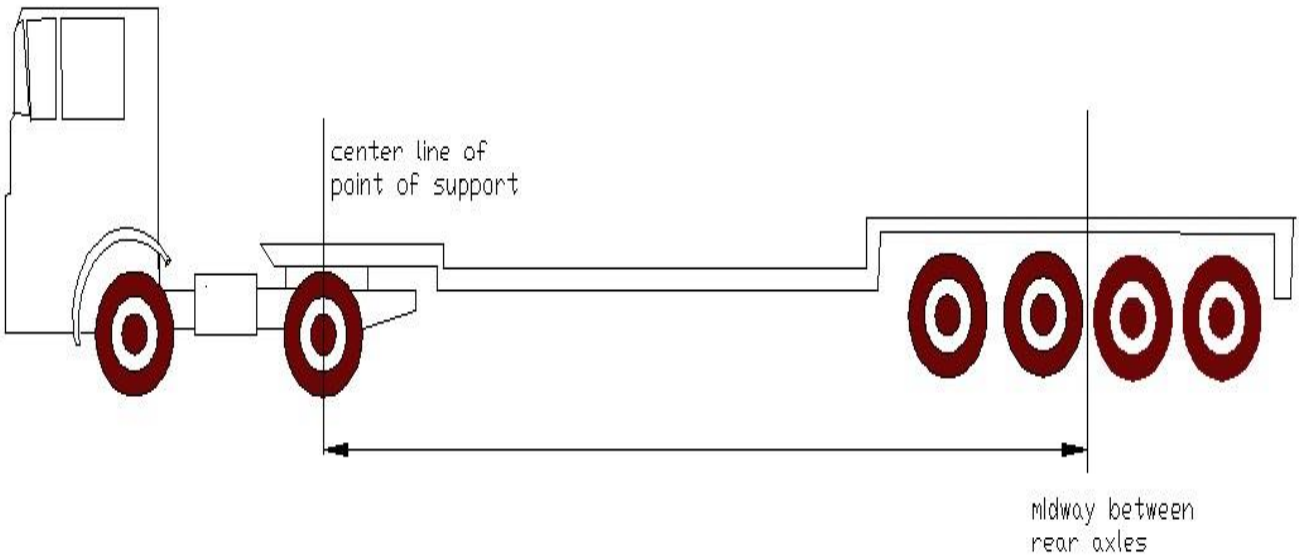

Figure 2.6 (c) Measurement of axle interspace on a quadruple-axle trailer (Source: Lowe, 2002)

2.5 Ghana Vehicle Standards

In Ghana, the Ghana Standards Board (GSB), established in 1973, is the national statutory body with the overall responsibility to establish and promulgate standards for quality infrastructure and assurance. But according to the GSB, standards are only set for new products. The GSB does not develop standards for fairly used products, which is the case for most vehicles that are imported. This is because the extent of usage cannot be verified. So to create fair play, standards are set for new products (vehicles inclusive) rather than for used products. There are also no standards governing which type of vehicle is allowed on a particular road. Ghana does not manufacture vehicles and therefore relies on standards from countries where these vehicles are manufactured.

2.6 Ghana Vehicle Constructions and Use Regulation

The Drivers and Vehicle Licensing Authority (DVLA) was established in 1999 by Act 569 of the

Parliament of the Republic of Ghana, to replace the Vehicle, Examination and Licensing Division (VELD) of the Ministry of Road and Transport. The DVLA is mandated as the only authorized body with the objective of promoting good driving standards and road worthy vehicles. Its responsibilities also include ensuring safety of vehicles on roads, and to provide for related matters. (Parliament of the Republic of Ghana Act 569, 1999)

The DVLA is also responsible for setting guidelines for vehicle construction and use for the public. To achieve its objectives, the DVLA has the following functions:

(a) Establishing standards and methods for the training and testing of driving instructors and drivers of motor vehicles and riders of motor cycles. (b) Establishing standards and methods for the training and testing of vehicle examiners.

(c) Providing syllabi for driver training and the training of instructors.

(d) Issuing driving licenses.

(e) Registering and licensing driving schools.

(f) Licensing driving instructors.

(g) Inspecting, testing and registering motor vehicles.

(h) Issuing vehicle registration certificates.

(i) Issuing vehicle examination certificates.

(j) Licensing and regulating private garages to undertake vehicle testing.

(k) Maintaining registers containing particulars of licensed motor vehicles, driving instructors, driving schools and drivers of motor vehicles.

(l) Advising the Minister on policy formulation and development strategy for the achievement of the objectives of the Authority.

(m) Ensuring strict compliance with this Act and regulations made under it. (n) Carrying out such other function as are incidental to the attainment of the object of the authority

(Parliament of the Republic of Ghana Act 569, 1999)

According to DVLA Kumasi, vehicle modifications are legal so long as they are within the stated guidelines below (section 2.6.1) and do not contravene the Road Traffic Regulations of the Motor Traffic and Transport Unit of the Ghana Police Service. In setting the guidelines for heavy vehicle modifications, the DVLA takes into consideration vehicle standards set by the vehicle manufacturers. These guidelines are communicated to the general public through the media and bulletins (pasted on their notice boards).

2.6.1 Ghana Heavy Vehicle Construction and Use Guidelines

In constructing or carrying out any modification on heavy vehicles, the DVLA has set guidelines for vehicle operators and artisans involved in the modification to follow so as to provide road worthy vehicles for the country‟s road. These guidelines take into consideration the length, width, height and weight of heavy vehicles. It also considers the engineering components of heavy vehicles such as the engine, brakes, wheels and axle, steering, suspension, and the trailer size.

Width and Length

According to the guidelines set by the DVLA, no heavy vehicle or trailer is to exceed eight feet three inches in overall width, and no bolster on a prime mover or trailer shall project beyond the outside edge of the outside tyres.

When a motor vehicle or trailer is loaded, the load is not to:

(a) Project beyond the near side of such vehicle or trailer to a greater extent than 6 inches, or to any extent on the off side.

(b) In the case of a timber-carrying vehicle or trailer loaded with a log or logs, project to a greater extent than three inches on the near side and three inches on the off side.

(c) Project more than 3 feet beyond the front elevation of such vehicle or trailer.

Where the load on a heavy vehicle or trailer projects more than 6 feet behind the rear elevation, a red flag must be fixed to the end of the load during the day and a red lamp at night is to be in a similar position. The flag or lamp should be clearly visible from the rear. The overhang of a heavy vehicle or trailer must not exceed one-half of the wheelbase. In the case of a vehicle or trailer constructed and fitted in Ghana, the overhang must not exceed two-fifths of the wheelbase. Also, no heavy vehicle or trai1er may exceed thirty-six feet in length or, in the case of an articulated vehicle, forty-two feet eight inches in length.

No heavy vehicle may have a chassis, which has been altered so as to be longer than the chassis length given in the specifications issued for that type of vehicle by the manufacturer of the vehicle.

Height

The height from ground level of a heavy vehicle or trailer with freight or load placed on it must not at any point exceed eleven feet.

Weight

The maximum net weight permitted for heavy vehicles and trailer must not exceed 16 tons, and (a) in the case of non-articulated vehicles

(i) the maximum gross weight on two axles shall not exceed 16 tons

(ii) the maximum gross weight on three axles shall not exceed 22 tons

(iii) the maximum gross weight on more than three axles shall not exceed 28 tons (b) in the case of articulated vehicles

(i) the maximum gross weight on three axles shall not exceed 24 tons;

(ii) the maximum gross weight on four or more axles shall not exceed 32 tons

Engine

All engines must be efficiently silenced; no cutouts or open exhausts shall be used.

Brakes

Every heavy vehicle must have two entirely independent and efficient braking systems, or one efficient braking system having two independent means of operation. In each case, the system should be designed, constructed and maintained such that the failure of any single portion of any of the braking system shall not, even under the most adverse conditions, prevent the brakes on two wheels. In the case of a single system, the two means of operation shall not be deemed to be otherwise than independent solely by reason of the fact that they are connected either directly or indirectly with the same cross shaft. Also for a single braking system, the means of operation should be connected either directly or indirectly with the same cross shaft. The brakes applied by one of such means shall act on all the wheels of the motor vehicle directly and not through the transmission gear. In all cases, the brakes operated by one of the means of operation shall be applied by direct mechanical action without the intervention of any hydraulic, electric or pneumatic device. It should also act directly upon the wheels and not through the transmission gear.

Wheels and Axle

Every heavy vehicle or trailer when moving on any road shall have its wheels properly aligned to the chassis so that the true rolling motion of the wheels or trailer shall be conveyed to the road. No heavy vehicle or trailer with a defective wheel, wheel hub, or axle-tree, shall be used on any road.

Steering

All heavy vehicles must be provided with a strong and reliable steering gear, which shall be kept in such a state of repair and adjustment as to allow the vehicle to be turned readily and with certainty. The steering apparatus and driving gear of heavy vehicles must be so arranged that the driver can manipulate the controls with certainty and at the same time have a clear view of the road.

Suspension

Every heavy vehicle and trailer must be equipped with suitable, free acting and efficient suspension springs and shock absorbers, or any other efficient suspension system approved by a licensing authority. These suspension springs and shock absorbers must be kept at all times in proper alignment and must be properly secured to the axle and to the frame of the vehicle so that no undue lateral movement is allowed.

Trailer

Trailers are not to be used on any road unless the following conditions are observed:

(a) The couplings provided for attaching the trailer to a motor vehicle must be efficient for the purpose.

(b) Any trailer exceeding one ton gross weight must have a brake in good working order which, when applied, shall cause two of the wheels of the trailer on the same axle to be so held that the wheels shall be effectively prevented from revolving or shall have the same effect in stopping the trailer as if those wheels were so held.

(c) The braking system of the trailer must be constructed such that when any of the brakes on the motor vehicle are used, the brakes on the trailer are brought into action simultaneously.

(d) If more than one trailer is drawn by a motor vehicle the coupling provided for attaching any trailer to another trailer in front of it shall be efficient for the purpose, and paragraphs (b) and (c) of this regulation shall apply to each of the trailers.

(e) The wheelbase of any trailer having an axle weight of four tons or over must not be less than 9 feet 6 inches between axle centres;

(j) No more than three trailers of a maximum chassis carrying capacity of 8 tons must be drawn at any one time.

(g) The prime mover of all articulated vehicle must not be used to pull a load heavier than the maximum load specified by the manufacturer of the prime mover.

(h) The drawbar connecting a trailer with a prime mover must be attached directly to the prime mover's tunable unit.

2.7 Heavy Vehicle Registration in Ghana

Registration of heavy vehicles is carried out after all modifications have been completed. This is to ensure that the modification conforms with the vehicle particulars (vehicle weight, axle weight, number of axles, gross vehicle weight, ream diameter, net weight e.t.c). A form type „B" (application to register a trailer) is filled by the vehicle owner and an official of the DVLA ascertains the conformity by crosschecking what is on the form against the vehicle particulars (as stated above) issued by the manufacturer. A copy of the form type "B" can be seen in Appendix C.

When cross-checking, the major information on the vehicle looked out for are the net vehicle weight, axle weight, and weight of load expected to be carried as stated in Part I of LI (Legislative instrument) 953, section 3 which states:

(I) Before a vehicle is registered, its net weight and, if the licensing authority so directs, the axle weight of each ax1e shall, if facilities for weighing the vehicle are available, be ascertained by a competent officer, who shall certify the weight so ascertained and make any necessary correction in the statement of weight declared by the owner.

(2) If facilities for weighing a vehicle are not available, the licensing authority may require the owner of the vehicle to produce a certificate of its weight issued by the manufacturer or other recognized authority.

According to the Road Traffic (Amendment) Regulation, 1998 (of Ghana), if the owner of a registered vehicle should change the use for which the vehicle was registered or carry out any physical conversion to alter the use for which the vehicle was registered, the vehicle owner is to inform the DVLA through the form type „B". A proof of full payment of the sum of one million and thirty thousand cedis (¢ 1,030,000), which is payment for physical conversion, should also be tendered so as to amend the vehicle records.

2.8 Ghana Law Enforcement Agencies

According to the Road Traffic Act 683 (2004), the Ghana Police Service is the only authorized agency responsible for enforcing the laws governing vehicle modifications. The department of the police service responsible for the enforcement is the Motor Transport and Traffic Unit (MTTU).

The Ghana Police Service also has the power to inspect any vehicle while in operation so as to ascertain the vehicle"s compliance with the road traffic regulation as stated in the Part VII of LI 953, section 85, which states:

(1) An examiner appointed by the Commissioner or any police officer may inspect any motor vehicle or trailer with a view to ascertaining whether the provisions of the ordinance or of any regulation made or permit issued there under are being complied with, and in the event of any non-compliance with any of the said provisions, any such examiner or police officer not below the rank of inspector may by order in writing prohibit the further use of such motor vehicle or trailer until the said provisions have been complied with to his satisfaction.

(2) A police officer in uniform may stop any motor vehicle with a view to ascertaining whether such motor vehicle or any trailer drawn thereby is being used in contravention of the ordinance or any regulation made or permit or license issued there under, and in the event of any motor vehicle or trailer being used in such manner a police officer may take the motor vehicle and trailer or cause them to be taken to any police station or place of safety and detained there until the motor vehicle or trailer and driver can be identified.

(3) The owner or driver of any motor vehicle shall, on demand by a police officer of or above the rank of inspector, produce such vehicle or any trailer drawn thereby at such time and place as the police officer may appoint and submit it for such inspection and test as may be required with a view to ascertaining whether the provisions of the ordinance or of any regulation are complied with.

The police consider any modification that does not conform to the Road Traffic Act or guidelines, which have been specified by the DVLA in the Legislative Instrument, a criminal act. Section 25 of the LI as stated below makes it clear that it is an offence to tamper with any mechanism of a vehicle, which can result in injury, death, or loss of property.

A person tampers with a motor vehicle with intent of causing the malfunctioning of the brakes or other part of the vehicle mechanism commits an offence and liable on a summary conviction to a fine not exceeding 100 penalty units or to a term of imprisonment not exceeding 6 months or both')
(100 penalty units = ¢ 2,000,000)

Sections 80-83 of the Road Traffic law cater for vehicle construction and use (Appendix A). These sections take into account regulation of construction, weight, equipment and use of vehicles. It also accounts for contraventions of requirement for brakes, steering gear or tyres as well as compliance with requirements for weight of commercial vehicles.

As part of executing its duties, the MTTU carries out seasonal operations for specific situations at Suame Magazine. For example, on June 2nd, 2006, an operation was carried out at Suame Magazine by the MTTU department to check vehicles with condemned rear brakes. The defaulters (the drivers, vehicle owners, and the artisans) were arrested and prosecuted.

2.9 Ghana Heavy Vehicle Inspection

In ensuring that heavy vehicles comply with the regulations of the Road Traffic Acts even after registration, the DVLA alongside the police have the power to inspect all vehicles according to Part VII of LI (Legislative Instrument) 953, section 85. Also, to ensure that heavy vehicle weights are not altered while in operation, the licensing authority or any police officer may at any time require the vehicle to be driven to any convenient place to have its net or gross weight or axle weight checked to ascertain its compliance (Section 47of LI 953, 1974).

A check of all heavy vehicles operating in Ghana is conducted by the DVLA every 6 months at their yard to see if there has been any contravention to any of the Road Traffic Regulation Acts.

2.10 United Nations Road Safety Regulations

The United Nations (UN) Road Safety Board has devoted themselves over the years to increasing safety on roads and also in vehicles by identifying the major hindrances to safety and implementing necessary solutions. The major hindrances have been:

- Poor road conditions.
- Careless road usage by both drivers and pedestrian and Poor law enforcement. (www.tc.gc.ca)

As part of tackling these hindrances, all vehicles with a maximum permissible weight exceeding 7500 kg and trailers with a maximum permissible weight exceeding 3500 kg are required to fit both side and rear reflective markers which make them more conspicuous at night and in poor visibility conditions (Lowe, 2002). These markers Figures 2.7 (a) and (b), are by law also displayed on loads depending on the size. This requirement has helped boost road safety.

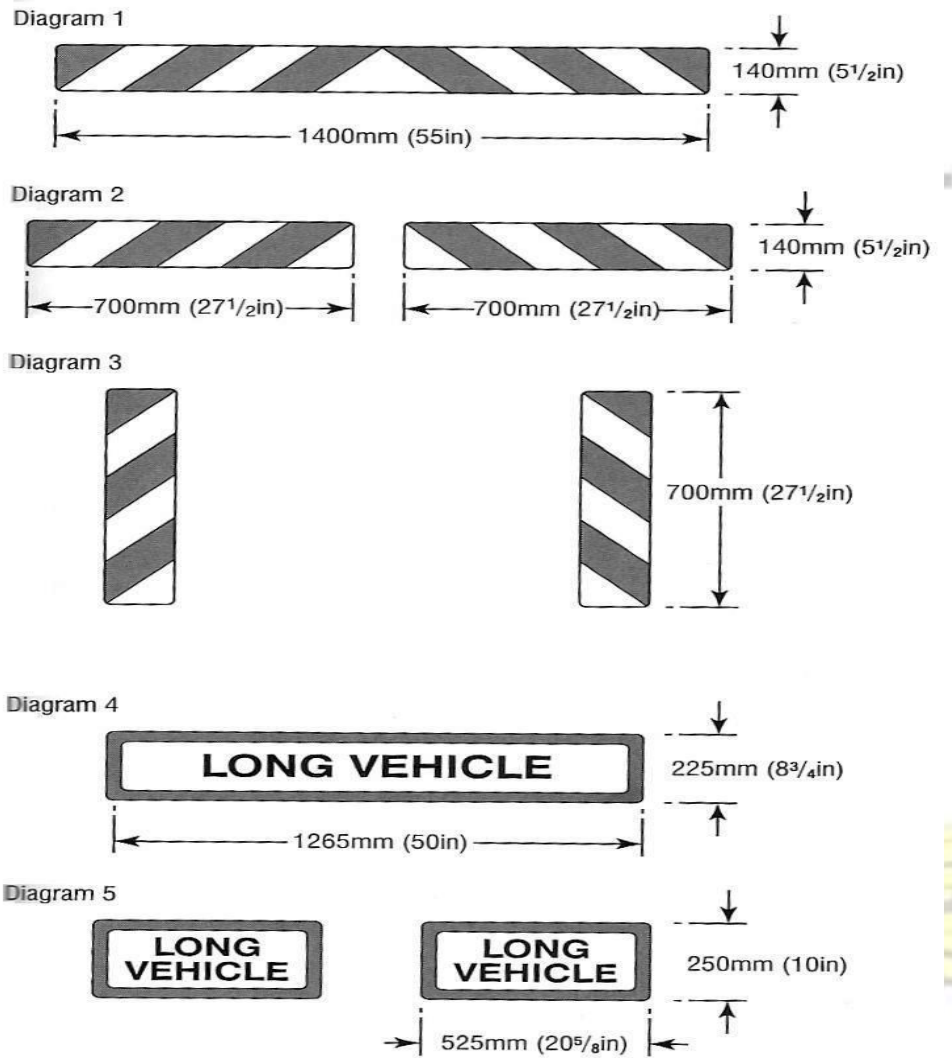

Figure 2.7 (a) The various types of reflective markings and their dimensions (Source: Lowe, 2002)

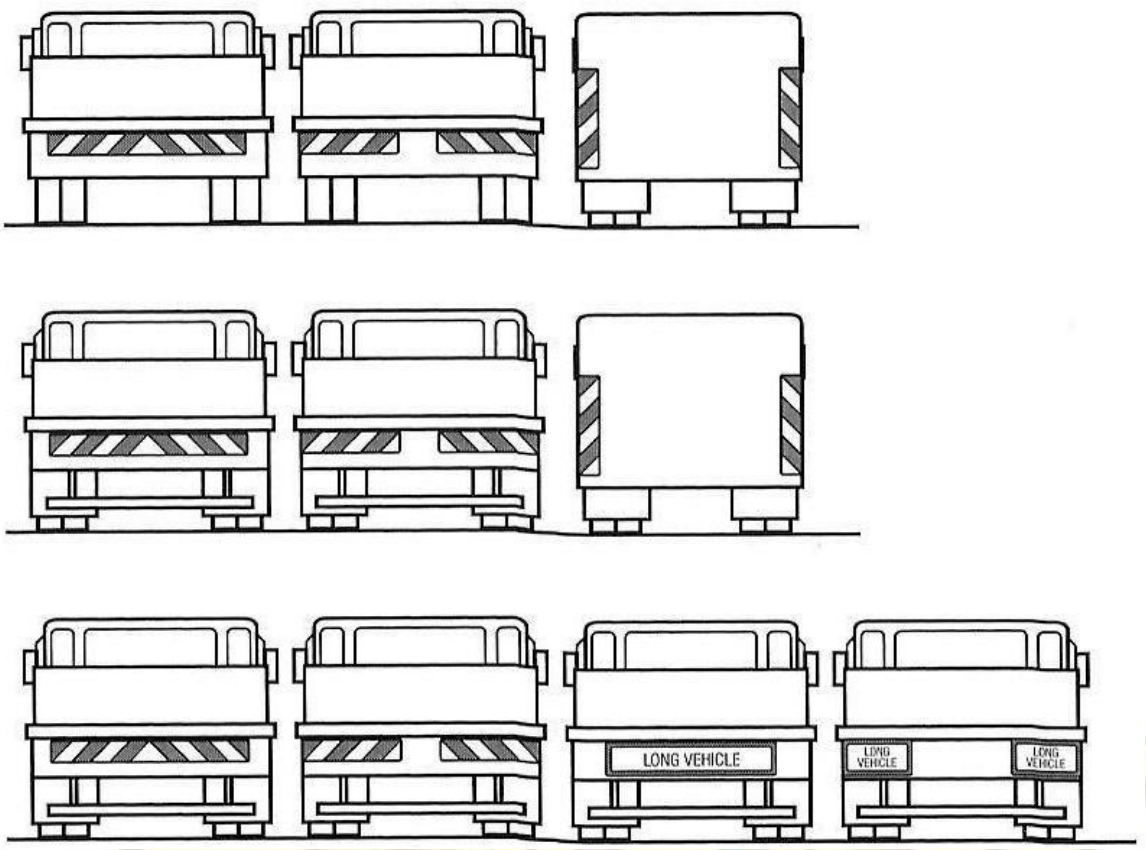

Figure 2.7 (b) How reflective markings are fitted to the vehicles (Source: Lowe, 2002)

However, certain measures were added in some countries to further curb the upward trend of road accidents. In Nigeria, for example, the Federal Road Safety Commission (FRSC) resolved to improve vehicle safety by pursuing and encouraging the following:

- Spearhead the enactment and implementation of a National Vehicle Inspection Programme.
- Pursue improvements in construction of the vehicle body of local commercial buses and trucks that protect occupants in the event of an accident.

- Package better vehicle information for consumers to help them choose safer tyres, etc, and know more about personal vehicle maintenance.
- Ensure that all buses, lorries, trailers and heavy-duty vehicles are affixed with retro-reflective strips at the side and rear.

(www.frscnigeria.org)

In Canada, the Transport Ministry (Transport Canada: www.tc.gc.ca) has identified that inappropriate construction and repairs, lack of vehicle maintenance and poor inspection practices on commercial trucks and buses may result in serious damage to the vehicle and injury or death to the operator and other road users. A typical example of inappropriate construction and repairs is the re-assembling of leaf springs from different and questionable sources. This led to the ministry of transportation warning operators and technicians of the importance of spring care, repairs and installation practices. The following are some important factors that should be addressed while performing maintenance and/or repair of leaf springs:

- Leaf spring suspensions are often overlooked and neglected. Inspection of these systems should be part of regular scheduled maintenance and service programs. During inspection, operators should look for items such as leaf spring displacement (out of position), cracking or actual breakage of springs and or spring components, wear or rubbing of spring clips/bands or any other abnormality within the suspension system. If problems are found, the vehicle should be serviced immediately.
- U-Bolts must be kept tight and must be properly torqued after a spring has been repaired or replaced. Most manufacturers recommend the use of new U-bolts and related hardware any time spring repairs are performed. When installing U-bolts it is important to properly torque the assembly. The suspension should be re-torqued after a short period of operation.
- Adding a leaf to increase the load-carrying capacity should be considered very carefully. All of the suspension parts are designed to carry part of

the load. Adding leaves may result in overloading of other suspension parts or the vehicle itself. If leaves are added, compatibility should be verified. Leaf springs should not be mixed or matched. Insure that the system is equipped with all the appropriate parts (i.e. spring clips/bands). Any modification to the original leaf spring design may seriously damage the associated parts of the suspension system or the spring itself.

- Spring clips/bands are installed to assist the leaf spring suspension when exposed to shock and rebound loads and prevents spreading or fanning out of the leaves. Make certain that broken clips or bands are replaced and are properly adjusted.
- Manufacturer‟s recommended Gross Vehicle Weight Rating (GVWR) and Gross Axle Weight Rating (GAWR) should not be exceeded.

(www.tc.gc.ca)

2.11 Road Safety Situation in Ghana

The need for road safety implies joint efforts by the various stakeholders made up of the vehicle operators and technicians, vehicle owners, law enforcement agencies, the vehicle licensing authorities, and other road users. The Ministry of Road Transport therefore established the National Road Safety Commission (NRSC) so as to develop, promote, and co-ordinate road safety in Ghana (Afukaar, 2003). The purpose of the strategy is to break the upward trend in road accidents within the next five years and create a basis for concrete, sustainable accident reduction towards 2010. The overall target is a 5% reduction in road fatalities from base year 1998-2005 and a further 15% before the end of 2010. (NRSC, 2001-2005)

The NRSC seeks to use the following measures to improve road safety;

- Education: Knowledge about road user behaviour and risks will be disseminated through targeted public campaigns, concrete training for

drivers, and development of a programme for nationwide education of school children.

- Enforcement: The public media educational campaign measures will be followed up by systematic and more visible police enforcement on major highways targeted at the most accident-prone road sections. Overloading and vehicle condition will also be addressed through the installment of permanent and mobile weighbridges on highways
- Engineering: The most accident-prone spots and sections on highways, urban roads, and feeder roads, will be identified and engineering measures carried out to reduce accidents. The measures seek to target urban roads with many accidents involving vulnerable road users (children and the old).

(Salifu, 2004)

2.11.1 Ghana Heavy Vehicle Safety Guidelines

In Ghana, all heavy vehicles are required by law to carry reflectors attached to the side and rear

of the vehicle. Reflectors or reflex Reflectors as defined under section 43 of the LI 953 "is a device used to indicate the presence of a vehicle by reflection of light emanating from a light source unconnected with that vehicle, the observer being placed near the source". Every motor vehicle and trailer (heavy vehicles) is to be fitted at the front with at least two white reflex reflectors and at least two red reflex reflectors or two red and white diagonally striped reflex reflectors at the rear. These reflectors are required to conform to paragraphs 3-5 of the LI 953 which states:

> *(3) The reflex reflectors required to be fitted to a vehicle under this regulation shall-*
>
> > *(a) In the case of commercial vehicles (other than taxis weighing 40 cwt. or less) and private vehicles weighing over 40*

cwt., consist of plain white rectangular reflectors measuring 9 inches by 4 inches which shall be fitted to the front of the vehicle at a height of not more than three feet from the ground and red and white diagonally striped rectangular reflectors measuring 9 inches by 4 inches which shall be fitted to the rear of the vehicle at a height of not more than five feet from the ground, and.

(b) In the case of any other motor vehicles, consist of at least two plain white rectangular reflectors measuring 12 inches by 1 inch, which shall be fitted to the front of the vehicle and at least two plain red rectangular reflectors measuring 12 inches by 1 inch which shall be fitted to the rear of the vehicle.

(4) The outer vertical edge of the illuminating surface of any reflector required to be fitted to a motor vehicle (other than a two-wheeled motor-cycle) shall not be more than 16 inches from the extreme vertical edge of the vehicle nearer to such outer edge.

(5) Every reflector required to be fitted under this regulation shall be of such a make that it is visible to the driver of any vehicle at night in clear weather at a distance of at least 500 feet when illuminated by the driving lights of that vehicle.

Also, every motor vehicle and trailer without a side-car is to carry two un-obscured and efficient red reflectors which shall be fixed to the vehicle on each side so as to indicate width of the vehicle, in a vertical position and facing squarely to the rear and not less than fifteen inches above the ground in measurement so that no part of the vehicle projects more than thirty inches to the rear of the reflector. In the case of a timber lorry, a third reflector is required to be carried at the rear end of the drawbar.

(Section 42 of LI 953, 1974)

2.12 Summary

It can be seen from the literature gathered above that the various modifications carried out on heavy vehicles are based on legitimate reasons and are an acceptable practice both in and outside Ghana.

It can also be seen that there are slight differences in the specifications stated in the guide lines of

Ghana and other international transport bodies. This is due to the nature of roads in Ghana. Table 2.2 shows the differences between the international dimensions and weights for heavy vehicle modifications with that of Ghana.

Table 2.2 Comparison of the International maximum dimensions and weights of heavy vehicles with that of Ghana

Dimension Type	**International (maximum dimension)**	**Ghana (maximum dimension)**
Vehicle length	19 meters	13 meters
Vehicle Width	2.6 meters	2.5 meters
Vehicle Height	About 4 meters and above	3.4 meters
Vehicle Weight	2,540 kg-32,520kg	16,000 kg-32,000kg
Ground Clearance	160-190 millimeters	

CHAPTER THREE

RESEARCH DESIGN, METHOD AND PRESENTATION OF RESULTS

This chapter presents the results of the interviews with the mechanics and artisans at Suame Magazine, the Drivers and Vehicle Licensing Authority (DVLA), the Motor Traffic and Transport Unit (MTTU) of the Ghana Police Service, and the Ghana Standards Board (GSB). It also presents the information obtained during the observation period of the research at Suame Magazine

3.1 Modification Site

The study was carried out at Suame Magazine. Suame Magazine has been known over the years as a major site in Ghana where local vehicle modifications are carried out. Located at the outskirts of Kumasi in the Ashanti region along the road leading to the north, the site is known not just for the modifications but also for its wide range of business activities ranging from spare part dealers, scrap dealers, black smiths, tools dealers, oil and lubricant dealers, electronic dealers, vehicles and vehicle accessories sales, vulcanizers, to machine tool shop operators, casting experts and food sellers. In Ghana, Suame Magazine stands out as the site where all vehicle problems can be attended to.

3.2 Background of the artisans at Suame Magazine

The various modifications done in Magazine are often carried out by mechanics with little or no background or foundation in engineering or science. The maximum level of their education is the senior secondary school.

About 90-95% of the artisans have been in their respective trade from their childhood. They were introduced into the trade by their parents who own the business and later passed it to them when the parents retired. The remaining started as apprentices also at very young ages before being on their own and are also introducing their children to the trade. The cycle is repeated over and over and this is the trend at Magazine.

3.3 Mode of Operation at Suame Magazine

The operations at Suame Magazine are informal. All operations are carried out according to what they have learnt from their predecessors. There are no detailed documentations on how jobs are accomplished or records of jobs that have been carried out for reference purposes. Due to this reason, it was very difficult to

obtain any statistical data of the operations of the artisans within Magazine. The fact that the artisans at Magazine are largely illiterates was also a major factor that affected data collection.

3.4 Research Method

A descriptive research technique was used to carry out a study of the local design modifications carried out on imported heavy vehicles in Ghana. Five interview guides were developed (Appendix B) to interview the mechanics and artisans involved in heavy vehicle modifications at Suame Magazine, the Ghana Standard Board (GBS), the Drivers and Vehicle Licensing Authority (DVLA), the traffic unit of the Ghana Police Service (MTTU), and the National Road Safety Commission (NRSC).
The researcher also carried out direct observation in order to obtain a firsthand knowledge of the modification process at Suame Magazine.

Interviews were conducted using the interview guides to obtain information from the artisans. Observation of the modifications was also done to compliment the information obtained from the artisans during the interviews. The use of questionnaires was not adopted due to the level of education of the artisans.

Interviews were also conducted using the interview guides to obtain information from the Ghana Standards Board (GBS), the Drivers and Vehicle Licensing Authority (DVLA), the traffic unit of the Ghana Police Service (MTTU), and the National Road Safety Commission (NRSC).

These interview guides were presented to the supervisors for approval. This was done to ensure that the guidelines covered all the areas they were supposed to cover and were able to elicit information that provided answers to the questions raised in the research objectives.

3.5 Interviews with the Mechanics and Artisans

The interview and survey at Suame Magazine showed a lot of modifications on heavy vehicles being carried out. The followings are the various local design modifications carried out on imported heavy vehicles:

- Vehicle conversion (cargo truck to a tipper truck or vice versa).
- Lengthening or shortening the trailer bed.
- Increasing the capacity of the truck bucket (cargo truck).
- Complete conversion of vehicles (conversion of cargo truck to tipper truck).
- Reassembling and repair of leaf springs, and
- Modifying the part of the vehicle to work with available spare parts

According to some of the mechanics in Magazine, the reason for carrying out these modifications is that "whatever vehicle is imported into the country is not suitable for the Ghanaian roads or environment and must, therefore, be modified to suit the country"s conditions".

It takes an apprentice at Magazine 3-5 years to become a mechanic and another 3 years to become independent (Master) in the trade. This makes a total of 6-8 years in all before a mechanic in the heavy vehicle modification trade can be established.

Based on the kind of modifications and jobs being carried out, these mechanics are divided into the following groups:

- Vehicle mechanics
- Hydraulic mechanics Body builders
- Chassis builders, and

- Spring repairers

Vehicle Mechanics: These mechanics are more general in their scope of work and are concerned with the smooth running of the vehicle. They carry out repairs and maintenance on the vehicle engine, the gearbox, the radiator, and the electrical system

Hydraulic Mechanics: These mechanics are more specific in their line of work. They deal with both the hydraulic and pneumatic systems in vehicles. An example of the hydraulic system is the tipping mechanisms in tipper trucks.

Body Builders: These are mainly welders. On heavy vehicles, they are responsible for the moulding and construction of tipper buckets, trailer buckets, and cargo backs.

Chassis Builders: These are called "blacksmiths" at Magazine. They are responsible for all modifications carried out on all vehicle chassis ranging from lengthening to shortening of the chassis.

Spring Repairers: They are responsible for repairing and reassembling of leaf springs

3.6 Field Observations – main study activities

A total of 87 shops were visited during the survey and it was observed that the methods adopted in accomplishing these modifications are the same with all the 87 shops. Table 3.1 shows a breakdown of the various modifications and the number of shops involved that were visited.

With this observation, the number of shops studied was narrowed to 10 as shown in Table 3.2.

Table 3.1 Breakdown of the number of shops visited

Type of Modification	**Number of shops visited**
Lengthening and shortening of trailer	27
Spring Modification	60
Body modification	27
Vehicle conversion	27

Table 3.2 Breakdown of the number of shops studied

Type of Modification	**Number of shops visited**
Lengthening and shortening of trailer	2
Spring Modification	4
Body modification	2
Vehicle conversion	2

3.6.1 Description of the Processes Involved in Each Modification

Lengthening and Shortening of Trailer: Lengthening of trailer is one of the commonest modifications carried out on heavy vehicles at Suame Magazine. It is carried out mainly on single axle vehicles. It involves disassembling of the initial trailer or bed, or just the rear axle in the case of a trailer head alone of the vehicle to be modified. After the disassembly, another frame of desired length is

attached to the existing frame by welding to give the overall desired length. The rear axle is then coupled back together with another axle to make it double axle. This is to enable it withstand the extra operating load to be placed on it. Additional drive shafts are also added to transmit power from the engine to the rear axle. The number of drive shafts used depends on the desired length of the vehicle. The ground clearance is also increased to about 2.53 feet due to the increased number of leaf springs to support the extra load. The new bed or bucket is then welded on the new frame. The lengthened trailer is then washed. Figure 3.1 shows two lengthening processes. Figure 3.1(a) shows a lengthened chassis while Figure 3.1(b) shows a modification involving lengthening (increasing the cargo truck capacity).

Shortening of trailers is mainly done for vehicle conversion. It also involves the disassembling of the initial trailer or bed, or bucket. The existing frame is then reduced to the desired length. The axles are replaced if a double axle vehicle is still required or only one if a single axle vehicle is required. In this case, the number of drive shafts is reduced. The ground clearance is also increased in this case and the reason given is the poor nature of our roads. The new bucket is then welded to the frame before the vehicle is washed. Shortening of trailers is rarely done at Suame Magazine.

Vehicle Conversion: This modification involves the conversion of one vehicle type to another. For example, conversion of a cargo truck into a tipper truck or vice versa. In converting a cargo truck to a tipper truck, the bucket of the truck is removed. A seat for the hydraulic pistons is then constructed and attached to the existing frame by welding. Another frame is also constructed and attached to the underside of the bucket (if the same bucket is desired or otherwise). The cylinder of the hydraulic system is attached to the existing frame while the top of the piston is attached to the underside of the bucket (by pin or ball joint). The back of the bucket is made to open under the weight of the load during offloading. The

bucket is attached by a pin joint at the end of the vehicle to allow for the up and down motion of the bucket.

A pump is connected to the engine of the vehicle from where it is powered, and a tank for the hydraulic fluid is constructed and seated under the vehicle. The tank is connected to the pump by hydraulic lines (hoses) and the pump is connected to a valve placed in the cabin also by hydraulic lines. These lines also connect the valve to the cylinder. A lever attached to the valve is used for the opening and closing of the valve for the lifting and dropping of the bucket. The final step in the conversion is to wash and then coat the vehicle with paint.

In the case of tipper to cargo conversion, the bucket is removed alongside with all the hydraulic components. The frame underneath the bucket is removed (if the same bucket is to be used) or another bucket is moulded. In the case of the same bucket being used, the back is welded permanently since it is not needed for load to fall out. The bucket is then attached by welding it to the vehicle frame before it is washed and coated.

Figure 3.1 (a) A lengthened trailer frame

Figure 3.1 (b) Modification in progress (Increasing cargo truck capacity)

Spring Modification: Modification of leaf springs is very common at Suame Magazine. These springs, when purchased from scrap dealers, have a lot of defects ranging from corrosion to cracks. Corrosion greatly reduces the fatigue strength of the leaf, while cracks increase induced stress. In the case of cracks, the springs are filled with a filler metal by welding. After the welding, the welded spot on the leaf is grinded (as shown in figure 3.2). A mixture of red sand, water, and salt is applied to the grinded surface to give it a rust colour, which blends with the rest of the leaf. In some cases, the spring is painted black to conceal the welded spot. Some of the welded leaves are shown in figure 3.3.

Figure 3.2 Grinded springs after welding

Figure 3.3 Finished products (leaves painted black to conceal welded spot)

Some of the modifications described above, though simple, take weeks for completion. Table 3.3 shows the period of accomplishment for each modification.

Table 3.3 Period of accomplishment for each modification.

Type of Modification	**Period of accomplishment**
Lengthening and shortening of trailer	1-3 weeks
Spring repair and assembly	½ week
Body modification	2 weeks
Vehicle conversion	2-4 weeks

The number of modifications carried out in a month is greatly dependent on the number of workers in a particular shop. Some shops have as low as 6 workers while some have as many as 40 workers including apprentices.

3.6.2 Processes of Design Modification at Suame Magazine

The main processes observed to be involved in the modifications described above are the selection of the materials used, joining, and finally finishing. Sketches are sometimes made but due to years of working experience, a sketch may not be needed, as the people know what and how to achieve what the client desires. The sketches made are usually not detailed. They are very scanty. Figure 3.4 shows a typical sketch by one of the heads for a trailer lengthening modification.

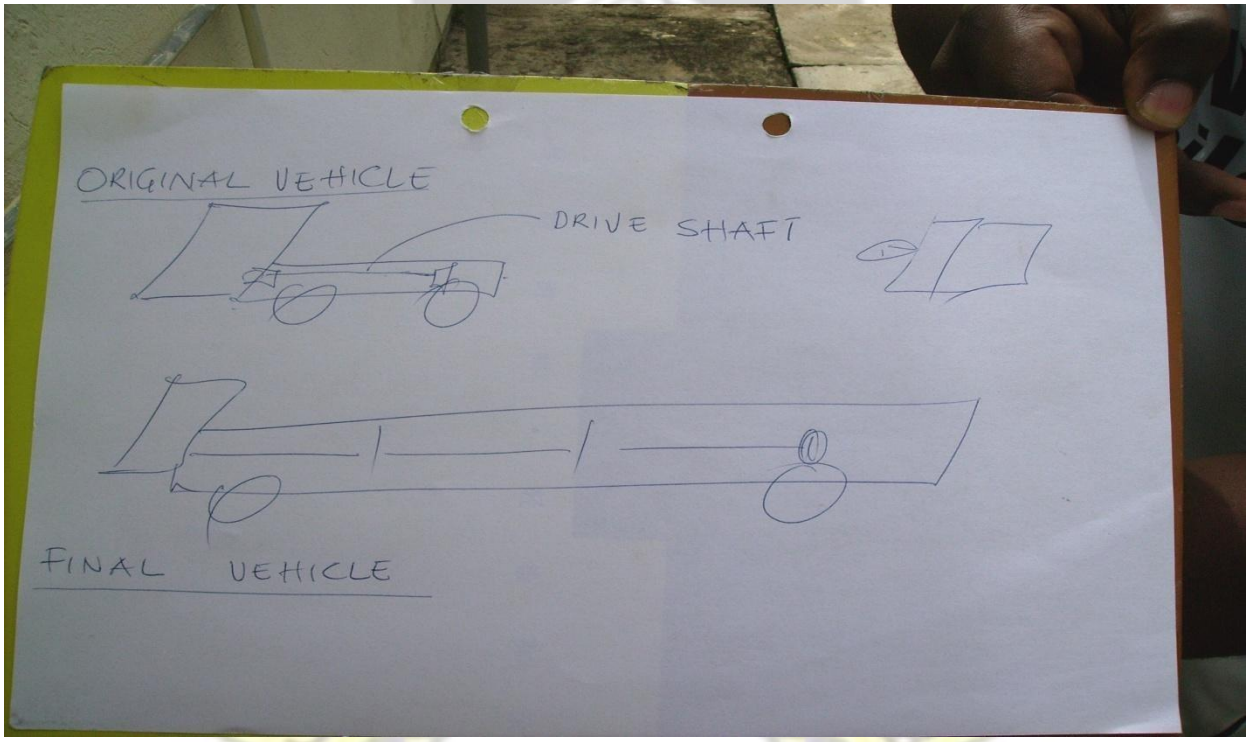

Figure 3.4 Sketch for a design modification to be carried out

Material Selection: Availability and cost are the two major requirements used for the material selection process at Suame. The materials are obtained from the scrap market. Good thermal conductivity, which is understood by the mechanics "as easy to weld", is the third factor considered. For this reason, mild steel is considered the best material since it is cheap, easy to weld, and is readily available in the scrap market. In Figure 3.5, galvanized iron and mild steel have been selected and joined together to construct a vehicle frame. The reason for this was insufficient availability of mild steel with the idea that galvanized iron is also strong enough to sustain whatever demand is placed on mild steel.

Materials often used in Magazine are usually in a poor state. Many of the materials are scraps and not suitable for use due to defects such as cracks, deformation, and corrosion.

Figure 3.5 Galvanized iron and steel (yellow colour) selected in a vehicle frame construction

The life of most engineering materials greatly depends on their fatigue strength. Corrosion substantially reduces the fatigue strength of materials and also leads to

a gradual loss of the material itself (Denny, 1996). Figure 3.6 shows a close view of a corroded metal sheet being displayed for sale at Suame Magazine. These materials are already weak due to the reduction in fatigue strength as a result of the corrosion.

Figure 3.6 Corroded metal sheet being offered for sale at Suame Magazine

Joining Methods: The Shielded metal arc welding process is the most widely used joining method in Suame Magazine. This is due to the inexpensive and simple set up of the equipment.

By visual inspection, the quality of the weld produced by this method was observed to be poor.

Defects such as **cracks**, **cavities** and **inclusions** could clearly be seen as shown in Figure 3.7. Poor surface and joint preparation, which leads to the presence of solid inclusions, were also noticed.

Figure 3.7 Cavity and inclusion defects in a weld produced at Suame Magazine

Finishing: This is the last process in the accomplishment of these modifications. It gives the modified vehicle an overall judgement of the modification aesthetically. It involves washing and coating the surface of the body of the vehicle with paint so as to give it a befitting appearance. At Suame Magazine, besides coating the vehicle with paint, other various artistic designs are carried out on the vehicle as desired by the client (Figure 3.9 (a and b)). Reflective markings are also fixed to the vehicle during the finishing process.

According to Robinson (1993), finishing involves more than coating the vehicle surface with paint. Before paint is applied to the surface, the surface should first be properly prepared. Preparing the surface involves washing to remove dirt and other solid particles. The removal of rust is essential before the paint is applied. After the preparation is complete, filler is used to fill cracks on the surface if any, and a first layer coating applied by spraying. This is followed by a second layer coating also applied by spraying. A film thickness gauge is then used to measure film thickness for uniformity around the vehicle body so as to obtain a proper overall finishing.

At Magazine, though there is no equipment for measuring uniformity of the applied coat, the artisans try to achieve a good overall coat. Because a paintbrush is used to apply the paint, the film thickness of the coat is not uniform and result into bulges on the vehicle body. Figure 3.8 shows a trailer bucket being painted with brush. These coats are sometimes used to conceal illegal acts such as point of welds on leaf springs. Figures 3.9 (a) and (b) shows a finished modified vehicle in Suame Magazine. Often, the finishing process at Magazine is restricted to the parts that are visible while the hidden parts are left bare and unattended to after the modification. The final dimensions of some of these modified heavy vehicles are shown in Table
3.4.

Figure 3.8 A trailer bucket being painted at Suame Magazine

Figure 3.9 (a) Finished vehicle (side view)

Figure 3.9 (b) Finished vehicle (back view)

Table 3.4 Final Dimension of some modified heavy vehicles at Suame

Lengthened Trailer				
Vehicle Manufacturer	**Length**	**Width**	**Height**	**Ground Clearance**
Daf	**12 meters**	**2.6 meters**	**2.7 meters**	**0.91 meters**
Daf	**14 meters**	**2.6 meters**	**2.9 meters**	**0.91 meters**
Daf	**14 meters**	**2.6 meters**	**2.9 meters**	**0.76 meters**
Daf	**12 meters**	**2.6 meters**	**2.9 meters**	**0.91 meters**
Daf	**13 meters**	**2.6 meters**	**2.7 meters**	**0.80 meters**
Man Diesel	**14 meters**	**2.5 meters**	**2.9 meters**	**0.76 meters**
Man Diesel	**14 meters**	**2.6 meters**	**2.9 meters**	**0.91 meters**
Increased Cargo Truck				
Vehicle Manufacturer	**Length**	**Width**	**Height**	**Ground Clearance**
Daf	**14 meters**	**2.6 meters**	**2.9 meters**	**0.80 meters**
Daf	**13 meters**	**2.6 meters**	**2.7 meters**	**0.76 meters**
Daf	**13 meters**	**2.55 meters**	**2.9 meters**	**0.80 meters**
Daf	**13 meters**	**2.6 meters**	**2.9 meters**	**0.80 meters**
Converted Cargo Truck to Tipper Truck				
Vehicle Manufacturer	**Length**	**Width**	**Height**	**Ground Clearance**
Daf	**6 meters**	**2.6 meters**	**2.9 meters**	**0.91 meters**
Daf	**10 meters**	**2.6 meters**	**2.9 meters**	**0.91 meters**

3.6.3 Compatibility and Weight Check of Finished Modified Vehicles

There were no means of checking the weight of the vehicles after the various modifications. Though modifications that involved increase in vehicle capacity

(lengthening and increase in truck capacity), might have exceeded the manufacturer‟s gross vehicle weight ratings, there were no means of checking compatibility between this new weight, the engine and the braking systems. There were also no means of carrying out compatibility checks between the leaf springs and its associated components (U-bolt and clips), as well as its load carrying capacity.

3.6.4 Ground Clearance

It was observed that all imported heavy vehicles modified at Suame Magazine had their ground clearance increased to a height of about 2.5-3 feet (762-914 millimeters).

3.6.5 Documentation of Modifications Carried Out

At Suame Magazine, it was observed that there is no documentation before and after any modifications carried out.

3.8 Cost Analysis of Heavy Vehicle Modification

As stated in section 1.2 of Chapter 1, the cost of acquiring parts specified by particular manufacturers or a brand new vehicle meant for the Ghanaian road for whatever purpose could be extremely high. This has led people to go for alternative or used parts as recommended by their mechanics. Table 3.5 shows the cost of some of the most widely used new heavy vehicles in Ghana as quoted by the manufacturers against their cost in the used vehicle market while Table 3.6 shows the cost of selected heavy vehicle modifications.

Table 3.5 Cost of selected heavy vehicles (new) in Ghana in the old Ghanaian Cedis as at 2007

Manufacturer	**Vehicle Type**	**Cost of New Vehicle**	**Cost of Old Vehicle**
Mercedes Benz	Single Axle Trailer Head	¢850M	¢400M -¢500M
	Double Axle Trailer Head	¢950M	¢600M -¢700M
	Tipper Truck	¢1,320M	¢150M-¢400M (depending on axle type)
Renault	Single Axle Trailer Head	¢520M	¢320M
	Double Axle Trailer Head	¢720M	¢520M
Daf	Single Axle Trailer Head	¢500M	¢350M -¢400M
	Double Axle Trailer Head	¢750M	No quoted price
Man Diesel	Single Axle Trailer Head	¢800M	¢400M -¢500M
	Double Axle Trailer Head	¢1,000M	No quoted price

It should be noted that single axle heavy vehicles are rarely used in Ghana due to the limited load carrying capacity. Many of the modifications on trailer heads involve conversion from single axle to double axle. Double axle heavy vehicles have a higher load carrying capacity. Even with the extra load carrying capacity of the double axle heavy vehicles, overloading is still very common among the operators.

Table 3.6 Cost of selected heavy vehicle modifications in Ghana as at 2007

Type Modification	**Type of Trailer Head**	**Cost of extra axle**	**Frame**	**Miscellaneous/ Workmanship**	**Total**
Lengthening of trailer	Double Axle	No axle needed	¢8M	¢12M-¢17M	¢20M-¢25M
	Single Axle	¢7M	¢8M	¢18M	¢33M
Shortening of trailer	Double Axle	No axle needed	No frame needed	¢9M	¢9M
Cargo truck to tipper truck				¢40M	¢40M

The cost of carrying out these modifications when added to the initial cost of the vehicle is lower than the cost of a new vehicle. Table 3.7 shows the cost of new vehicles compared to the total cost of modified vehicles.

Table 3.7 Cost of new vehicles compared to the total cost of modified vehicles as at 2007

Manufacturer	**Trailer Head Type**	**Cost of New Vehicle**	**Cost of Old Vehicle + Cost of Lengthening**	**Cost of Old Vehicle + Cost of shortening**
Mercedes Benz	Single Axle	¢850M	¢433M-¢533M	¢409M -¢509M
	Double Axle	¢950M	¢620M-¢725M	¢609M -¢709M

Renault	Single Axle	¢520M	¢353M	¢329M
	Double Axle	¢720M	¢540M-¢545M	¢529M
Daf	Single Axle	¢500M	¢383M-¢433M	¢359M -¢409M
Man Diesel	Single Axle	¢800M	¢433M -¢533M	¢409M -¢509M

3.8 Interview with the Drivers and Vehicle Licensing Authority (DVLA)

The Drivers and Vehicle Licensing Authority (DVLA) was established in 1999 to ensure safety of vehicles on roads, set guidelines for vehicle construction and use for the public, and to provide for related matters.

According to DVLA, Kumasi, vehicle modifications are legal so long as they are within the stated guidelines (section 2.6.1) and do not contravene the Road Traffic Regulations of the Motor Traffic and Transport Unit of the Ghana Police Service. In setting the guidelines for heavy vehicle modifications, the DVLA considers vehicle standards set by the vehicle manufacturers. These guidelines are communicated to the general public through the media and bulletins (pasted on their notice boards).

Registration of heavy vehicles is done after and not before vehicle modification. Before any modification is carried out, the owner of the vehicle should inform the DVLA for authorization and obtain guidelines to aid him/her to carry out the modification. According to the Road Traffic (Amendment) Regulation, 1998, if the owner of a registered vehicle should change the use for which the vehicle was registered or carry out any physical conversion to alter the use for which the vehicle was registered, the vehicle owner is to inform the DVLA through the form type „B“. A proof of full payment of the sum of one million and thirty

thousand cedis (¢ 1,030,000), which is payment for physical conversion should also be tendered so as to amend the vehicle records.

A check is conducted on every heavy vehicle by the DVLA every 6 months at their precincts to ascertain if there has been any contravention of any of the Road Traffic Regulation Acts. The DVLA works with the Ghana Police Service (responsible for apprehending offenders) in enforcing the laws governing heavy vehicle modification in order to ensure continual compliance of the modified vehicle to the road traffic regulations during its service life.

3.9 Interviews with the Ghana Police Service

The Motor Transport and Traffic Unit (MTTU) of the Ghana Police Service is responsible for enforcing the laws governing vehicle modification in Ghana. The Ghana Police Service also has the power to inspect any vehicle while in operation so as to ascertain the vehicle‟s compliance with the road traffic regulation as stated in the Part VII of LI 953, section 85 (section 2.8)

According to the Ghana Police Service, it is illegal to modify vehicles unless otherwise authorized by the DVLA. Any modification that does not conform to the Road Traffic Act or guidelines, which have been specified by the DVLA in the Legislative Instrument (LI), is considered a criminal act by the police. They look out for areas of contravention (length, vehicle loading height, and weight), depending on the vehicle type, by checking the vehicle papers to see if it tallies with the vehicle. If there is doubt of the vehicle weight, the officers of the MTTU may at any time require the vehicle to be driven to any convenient place to have its net or gross weight or axle weight checked to ascertain its compliance (Section

47of LI 953, 1974) and any default carries a penalty. These penalties include fines or term of imprisonment or both depending on the gravity of the offence.

3.10 Interviews with the Ghana Standards Board (GSB)

The GSB was established in 1973 as the only national statutory body with the overall responsibility to establish and promulgate standards for quality infrastructure and assurance.

According to the GSB, standards are only set for new products. The GSB does not develop standards for used products, which is the case for most vehicles that are imported. This is because the extent of usage cannot be verified. So to create a fair play, standards are set for new products (vehicles inclusive) rather than for used products. There are also no standards governing which type of vehicle is allowed on a particular road. Ghana does not manufacture vehicles and therefore relies on standards set by the countries where these vehicles are manufactured and imported from.

CHAPTER FOUR

DISCUSSION OF RESULTS (IMPLICATIONS OF THE MODIFICATIONS)

The most important of all the implications of vehicle modifications is the issue of passenger safety and the dangers the modified vehicles may pose to other road users. The effect of the modifications on vehicle performance is therefore been of great concern.

Mechanics at Magazine do not see any connection between the modification they carry out and safety. They relate modification exclusively to vehicle performance. Mechanics see safety to lie in the hands of the operators while they

are more interested in how the vehicle performs after the modifications. For example, the mechanics do not see that the increase in the ground clearance of the vehicle leads to an increase in its center of gravity. This renders the vehicle unsafe as an increase in its center of gravity is a major cause of overturning in heavy vehicles. This attitude is due to their narrow understanding of safety.

4.1 Possible Implications of Heavy Vehicle Modifications on Road Safety in Ghana

Material effect: Many of these modifications affect vehicle safety. From the material resources and other processes that go into these modifications as discussed in Chapter three, it has been identified that the modifications may pose serious threat on safety. The defects (cracks, deformation, and corrosion) associated with most of the materials used at Suame Magazine reduce the strength of the materials to withstand the stresses that arise when the vehicle is in operation. Apart from reduction in the fatigue strength of the material, corrosion leads to a gradual loss of the material. When these materials are used, they are already weak and can no longer withstand the loads on them when the vehicle is in operation. Also, the defects associated with the joining method used at Suame Magazine are due to poor joining practices and they may have great implications on the safety of the vehicle while in operation as these points of weld are highly prone to failure.

When these vehicles are modified to carry more loads in the case of lengthening of trailer bed, or increasing cargo capacity or the vehicle type is changed completely and the manufacturer‟s gross vehicle weight rating (GVWR) is exceeded, there is an adverse effect on the engine and the load support system. In most cases, compatibility between the engine, braking or the load support system and the new GVWR is not checked.

Overloading Effect on Engine: Where the vehicle weight limit has been exceeded, the engine does more work so as to produce enough power to move

the vehicle. The extra work done leads to a reduction in engine speed. It also increases the fuel consumption, heat generation, which in turn increases the demand on the cooling system, and wearing rate which leads to unusual noise and smoke. While all these are happening, the time for accomplishment of whatever purpose the vehicle is serving is prolonged (due to inadequate engine power and reduced engine speed). Also, when there is excessive vibration of the engine due to overload, the joints produced at Magazine may not be able to withstand the vibration and they may therefore give way. This will result in the vehicle body falling apart.

Effect on Lighting: Finding the exact cables for the lighting systems to join to the existing one in order to meet the desired length could be difficult and sometimes impossible. In such a situation, the rear lighting systems are sometimes left unattended to or alternative systems which may not perform adequately are fitted.

Effect on Braking systems: The situation of the lighting system also goes for the braking system. But the alternative brake hoses used may not be able to withstand the required braking pressure and therefore may break when in operation. Another problem with such alternative braking systems is that, there are no measures or tests to ascertain the efficiency of the system.
This may be responsible for some road accidents where heavy vehicles roll back on hills.

Effect on Load support system: An area of great importance where these modifications show an adverse effect on vehicle safety is in the load support system (leaf springs). This particular modification leads to an increase in stress concentration at the point of weld and makes it highly prone to failure while in operation. When the loading or weight limit specified by the manufacturers has been exceeded, the need to change the spring so as to meet the present demand arises. Instead of changing the whole of the leaf spring assembly, the number of

leaves is rather increased. Compatibility of the suspension parts is not verified (adding leaves result in overloading of the suspension parts) due to lack of verification equipment. Failure of these suspension parts could be fatal during operation as discussed in section 2.10 on inappropriate repair and reassembling of leaf springs.

Chassis alteration: Modifications such as lengthening and increasing cargo truck capacity involve altering of the vehicle chassis which is against the law of vehicle modifications (section 2.6.1, Ghana Heavy Vehicle Construction and Use Guidelines). The Road Traffic Act under ***width and length*** states:

'No heavy vehicle must have a chassis which has been altered so as to be longer than the chassis length given in the specifications issued for that type of vehicle by the manufacturer of the vehicle.'

Vehicle Ground clearance: The increase of the ground clearance of the modified vehicles to about 2.5-3 feet (762-914 millimeters) leads to an increase in the center of gravity of the vehicle.

A high center of gravity is a possible cause of vehicles overturning while in operation.

Vehicle length: For trailer lengthening, the finished length is between forty to forty-six feet which violates the thirty-six specified by the DVLA. This makes it difficult for the vehicles to negotiate bends or move safely at roundabouts.

Loaded height of Vehicles: compared to the eleven feet stated by the DVLA many of the loaded modified vehicles seen on the roads are loaded up to fifteen feet from ground level. This leads to the vehicle falling on its sides when negotiating bends or the extra load may cause it rolling backwards when going up hills because many of the alternative braking systems cannot support the loads. Figure 4.1 shows a loaded cargo truck measuring about fifteen feet in height.

Figure 4.1 An overloaded cargo truck exceeding permitted load height

This violation in length and height may also pose serious danger, leaving the roads unsafe for other road users. Table 4.1 shows the differences between the DVLA specified dimensions for heavy vehicle and that of the modified heavy vehicles at Suame.

Table 4.1 Comparison of the DVLA specified dimensions with that of the modified heavy vehicles at Suame

Dimension Type	**DVLA (maximum dimensions)**	**Modified vehicle dimensions**
Vehicle length	10 meters (36ft) for trailers	12-14 meters (40-46ft) for trailers
Vehicle Width	2.5 meters	2.6 meters
Vehicle Height	3.4 meters (11ft) when loaded	2.7-2.9 meters (15ft) before loading
Ground Clearance		762-914 millimeters

Vehicle weight: The excess weight of the vehicles after the modifications causes instability in the vehicles while in operation. It also leads to inability of the vehicle to ascend long and steep hills on the roads and this could lead to the vehicle rolling backwards under the excess weight.

Based on the work done by Zeiler et al (2004), exceeding vehicle manufacturer"s gross vehicle weight rating (GVWR) also reduces the fatigue performance of the vehicle.

Vehicle documentation: lack of proper documentation makes it difficult for both the mechanics and the DVLA in keeping proper records of modified and registered vehicles.

4.2 Legal Implications of Heavy Vehicle Modification

The act of welding leaf springs or neglecting the rear brakes of vehicles for any reason as done at Magazine goes against section 25 of the Road Traffic Act which states:

'A person tampers with a motor vehicle with intent of causing the malfunctioning of the brakes or other part of its mechanism commits an offence and liable on a summary conviction to a fine not exceeding 100 penalty units or to a term of imprisonment not exceeding 6 months or both'

(100 penalty units = ¢ 2,000,000)

It is difficult to carry out adequate inspection by the authorities on these modified vehicles since there are no documentations (design drawings) before the modification and no documentation of the major modifications carried out on the vehicles at Suame Magazine. Once the vehicle leaves the workshop, the original shape and size of the vehicle only exist in the memory of the artisans who carried out the modifications. Once these artisans are not available, no information regarding the history of the modified vehicle can be obtained

Though the law allows for vehicle modification, many of the modifications carried out at Magazine do not conform to the laid down guidelines by the DVLA for heavy vehicle modifications.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The main objective of this thesis was to conduct a study at Suame Magazine and identify the various modifications that are carried out, who caries them out, why and how they are carried out, if they are based on sound design principles, and their implications on vehicle safety and performance as well as their legal implications. From the study conducted, the following results and conclusions were made:

1. The various modifications carried out on heavy vehicles were identified to be cargo to tipper truck conversion, lengthening and shortening of trailer bed, reassembling or repair of cracked or broken leaf springs, increasing the bucket capacity of trucks, and modifying vehicle parts to work with available spare parts.

2. The modifications are carried out by mechanics with little or no theoretical background in automobile and their highest level of education is the senior secondary school.

3. The reasons for the modifications were identified to be the high cost of acquiring a brand new vehicle and the non-availability and cost of purchasing authorized spare parts.

4. Modifications are not based on sound design principles as they pose danger to operators and road users.

5. The act of modifying leaf springs (re-assembling and welding of broken or cracked springs) as carried out at Suame Magazine poses great danger since there is no way of ensuring that the filler metal (welding electrode used in the welding) have the same metallurgical constituents as the pieces being welded together. No heat treatment is carried out after the welding
6. Lack of adequate inspection of the modified vehicles before registration by the DVLA (in charge of vehicle registration, licensing, and vehicle modifications) is partly responsible for the poor outcome of the modified vehicles, which could lead to failure in operation.

7. Absence of vehicle documents from the manufacturers make it difficult for the DVLA to ascertain the legality of the modifications since this document is meant to be a reference during vehicle inspection

5.2 Recommendations

1. It is recommended that the DVLA should test and give approval certificates to artisans. Only artisans with such certificate should be allowed to operate on these heavy vehicles. The artisans should also be requested to provide the DVLA, quarterly report or records containing vehicle plate number, engine number, chassis number, vehicle

registration number, modification carried out on the vehicle, and client particulars of their operations.

2. The owners of these heavy vehicles should also be requested to provide the vehicle specifications which must include the engine capacity and specify the type of modification desired before obtaining an approval document from the DVLA for the modification. The DVLA should also give detailed specifications of the various modifications which are approved including the load support, drive shaft, brake systems, lighting system and the ground clearance

3. It is also recommended that an efficient co-ordination and cooperation be established among the stakeholders through seminars and workshops at the cost of the artisans and heavy vehicle owners and certificates be awarded. This avenue can be used to educate the artisans and vehicle owners on the Ghana Traffic Regulation Act and vehicle alteration guidelines.

4. This thesis looked into the resources and processes that go into heavy vehicle modifications without any after modification test. It is recommended that future studies look into each modification in details and if possible carry out performance test after the modification so as to identify specific acts and problems which might compromise the safety of operators, road users, and the vehicle performance.

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APPENDIX A

Act 683 **Road Traffic Act, 2004**

CONSTRUCTION AND USE OF MOTOR VEHICLES AND EQUIPMENT

Use of vehicle in a dangerous condition

80. (1) A person commits an offence if that person causes or permits another person to use, a motor vehicle or trailer on a road when

(a) the condition of the motor vehicle or trailer, or of its accessories

equipment,

(b) the purpose for which it is used,

(c) the number of passengers carried by it, or the manner in which they are carried, or

(d) the weight, position or distribution of its load, or the manner in which it is secured,

is such that the use of the motor vehicle or trailer involves a danger of injury to any person or damage to property.

(2) A person who commits an offence under subsection (1) is liable on summary conviction to a fine not exceeding 500 penalty units or to a term of imprisonment not exceeding 2 years or to both.

Regulation of construction, weight, equipment and use of vehicles

81. The use of motor vehicles and trailers on roads, their construction and equipment and the conditions under which they may be so used shall be prescribed by Regulations.

Contravention of requirement for brakes, steering-gear or tyres

82. A person who

(a) contravenes or fails to comply with a construction and use requirement for brakes, steering-gear,

(b) uses on a road, a motor vehicle or trailer which does not comply with such a requirement, or causes or pem1its a motor vehicle to be so used, or

(c) uses or permits to be used on a road, a motor vehicle or a trailer, the tyres of which are not of the required specification for the vehicle or trailer or that are worn out,

commits an offence and is liable on summary conviction to a fine not exceeding 250 penalty units or to a term of imprisonment not exceeding 12 months or to both.

Failure to comply with requirements for weights of commercial vehicles

83. A person who

(a) contravenes or fails to comply with a construction and use requirement of any weight applicable to

(i) a cargo vehicle, or

(ii) a motor vehicle or trailer adapted to carry more than eight passengers, or

(b) uses on a road a vehicle which does not comply with such a requirement, or causes or permits a motor vehicle to be so used,

commits an offence and is liable on summary conviction to a fine not exceeding 250 penalty units or to a term of imprisonment not exceeding 12 months or to both.

Contravention of other construction and use requirements

88. A person who

(a) contravenes or fails to comply with any construction or use requirement other than one within section 82 (1)(a) or 83(1)(a), or

(b) uses on a road, a motor vehicle or trailer which does not comply with such a requirement, or causes or permits a motor vehicle or trailer to be so used,

commits an offence and is liable on summary conviction to a fine not exceeding 250 penalty units or to a term of imprisonment not exceeding 12 months or to both.

Liability of owner and other persons for breach of construction and use requirements

89. When a person contravenes or fails to comply with a construction and use requirement relating to the construction or equipment of a motor vehicle or trailer or the conditions under which it may be used on a road, the owner as well as any other person who has custody or control of the motor vehicle or trailer also commits the offence of which that person is guilty.

APPENDIX B

Interview Guides

Interview Guide for Mechanics

1. What is your level of education?
2. How long does it take to learn as an apprentice?
3. What is the nature of the training?

*Is it only when a job is on ground?

*Or also in he absence of a

job 4. What do you do when

there is no job?

5. What is your area of specialization?
6. What are the various modifications carried out at Suame Magazine?

7. Why are these modifications done?

8. What goes into these modifications?

* Processes

* Materials

9. How do you access your work?

10. What specific modifications do you carry out?

11. Are there any regulatory bodies that check what you do?

12. Who are they?

13. Do you require any permit to work?

Interview Guide for DVLA

1. What is the work of the DVLA?
    - When was it established?
    - Why was it established?
2. What are the standards of the vehicle allowed on the roads?
3. Is the public aware of these standards?
4. How are these standards communicated to the public if there are?

5. What is the exact procedure for vehicle registration?
6. Are modifications of vehicles legal?
7. Are vehicle registration done before or after the modification?
8. What types of vehicles are allowed for modification (light or heavy vehicles)?
9. Do these laws affect vehicle importation?
10. What are the laws governing these modifications?
11. How long have these laws been in existence?
12. Do people obey these laws?
13. What are the penalties for disobeying these laws?
14. What bodies are involved in enforcing these laws?
15. Do you work independently of these bodies?
16. Are owners of vehicle required to seek authorization before any modification is carried out?
17. If yes, who gives the authorization?
18. On which criteria are the authorization based?
19. Are there checks conducted after the modifications?
20. If there are checks, how often are these checks conducted?
21. Who does these checks?
22. Where the checks carried out?

Interview Guide for the Ghana Police Service

1. What is the work of the transport unit of the police department?
2. What are the standards of the vehicles allowed on our roads?
3. Is the public aware of these standards?
4. How are these standards communicated to the public if yes?
5. Are modifications of vehicles legal?
6. What types of vehicles are allowed for modifications (light vehicles or heavy vehicles)?
7. What are the laws governing these modifications?
8. How long have these laws been in place?
9. Do people obey these laws?
10. What penalties are there for disobeying any of these laws?
11. What other bodies are there in enforcing these laws?
12. Do you work independently of those other bodies?
13. Are owners of vehicles required to seek authorization before any modifications are carried out?
14. If yes, who gives the authorization?
15. On which criteria is the authorization based?
16. Are there checks conducted after the modification?
17. If there are checks, how often are these checks conducted?
18. Who does the checks?

19. Where are the checks conducted?

20. When vehicles are in operation, what exactly do you look out for?

Interview Guide for the Ghana Standards Board

1. When was the Ghana standards board established?
2. Why was it established?
3. Are there any standards vehicle imported into the country must meet?
4. Who established these standards (if any)?
5. What are some of these standards?
6. When were these standards established?
7. On what criteria are the standards established?
8. Are the standards enforced?
9. Who enforces them?
10. When there is change in the standards, how is it communicated to the public or other transport policy makers or enforcers?

APPENDIX C

Application to Register a Trailer

FORM B

FORM OF APPLICATION TO REGISTER A TRAILER

(*Regulation* 2)

(1) Full name of applicant (BLOCK LETTERS) ..		
(2) Usual address		
(3) Description of trailer:—		
Type of body		
No. of wheels		
(4) Net weight of trailer		
(5) Weight of freight or load which vehicle is constructed to carry.		
(6) Sizes of tyres (as stated thereon by manufacturer)	*Front*	*Rear*
(*a*) Rim diameter		
(*b*) Width		
(7) Axle weight of each axle. (To be given if required by the licensing authority.)		
(8) Number and date of certificate of roadworthiness (To be produced to the licensing authority.)		

I declare that this application to register a trailer contains a full and true account of the particulars which the law requires me to state.

DATED this.....day of....., 19.....

Signed.....
(*To be signed by the owner or his authorised agent*)

Identification mark allocated by licensing authority.....
(*To be filled in by licensing authority*).

APPENDIX D

Road Worthiness Check List

Driver and Vehicle Licensing Authority (DVLA), Ghana

Road worthiness checklist

Date:.....

Vehicle Reg. No:..... Chassis No.....Odometer Reading.....

Receipt No.: ..... Vehicle presented by: .....

Status Legend: [✓] Pass [×] Fail [N/A] Not Applicable

(TO BE COMPLETED BY THE TECHNICAL OFFICER)

	Area		Items to be checked	
1	Brakes	a	Brake lining disc, drum	
		b	Tubes, Hoses & Reservoir	
		c	Service/Foot Brake	
		d	Hand/ Parking Brake	
		e	Fluid/ Air Leaks	
		f	Performance	
2	Steering	a	Steering Pot, Linkage	
		b	Fasteners	
		c	Ball Joints & King Pins	
		d	Wheel Bearings	
		e	Backlash	
		f	Performance	
3	Wheels & Tyres	a	Damages, Repairs, Properly inflated	
		b	Tread Depth / Wear	
		c	Studs & lug nuts- (Correct No. & Size)	
		d	Securely attached / tightened	
		e	Rim Condition	
4	Lights	a	Head lamps (securely mounted & correctly oriented)	
		b	Turn Signal indicators / lights	
		c	Brake lights	
		d	Parking & Number Plate lamps	
		e	Reversing Lamps	
		f	Hazard lights	
		g	Additional lights (non-complying)	
5	Windscreen & windows	a	Badly scratched in primary vision area	
		b	Crack in wiper swept area	
		c	Discoloration & Visibility	
		d	Internal obstructions to driver's view	
		e	Tint on front window (not allowed)	
6	Screen Wipers & Washers	a	Wiper Blades (available & not worn)	
		b	Wiper Performance	
		c	Windscreen washer system, (functional and correctly aimed)	
7	Mirrors	a	Interior rear view mirror	
		b	Exterior driving mirrors	
		c		

	Area		Items to be checked	Status
8	Electrical	a	Horn	
		b	Wiring (insulated clipped)	
		c	Battery	
		d	Terminal, Connectors, etc	
9	Body & Chassis	a	Reg. Number plates	
		b	Reflectors (front & rear)	
		c	Corrosion / Rust /sharp edges	
		d	Damages to Bodywork	
		e	Structural Failure	
		f	Mechanical attachment	
		g	Fuel tank/ filler cap	
		h	Cleanliness	
10	Seats & Seat Belts	a	Belts secured and functional	
		b	Seating arrangement	
		c	Sharp or pinch points / Items	
11	Exhaust Systems	a	Silencer	
		b	Emission Level	
		c	Noise Level/Exhaust leakage	
		d	Exhaust Suspension System	
12	Control & Switches	a	Pedal Pads	
		b	Door handle and locks	
		c	Window controls	
		d	Headlamp dipper switch	
13	Instrument Panel & Gauges	a	Speedometer	
		b	Odometer	
		c	Fuel Gauge	
		d	Panels, Dash Light	
14	Engine & Transmission	a	Fuel & Oil Leaks	
		b	Radiator Cap	
		c	Fan Belt (Condition & Adjustment	
		d	Hoses (Condition,/Arrangement)	
15	Accessories	a	Warning Triangle	
		b	Jack & wheel nut spanner	
		c	Spare tyre (present/ condition)	
		a	Fire Extinguisher	
16	Suspension System	a	Shock Absorbers	
		b	Springs	

I certify that I have inspected this vehicle and, to the best of my knowledge and abilities, declare that it is ☐ / not ☐ in a roadworthy condition at the time of inspection.

Inspected by:..... Staff No:..... Signature.....

Comments .....