IMPACT OF HEAVY GOODS VEHICLES ON SAFETY AND TRAFFIC MANAGEMENT IN THE TEMA METROPOLIS

BY

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DECLARATION

I hereby declare that this submission is my own work towards the MSc and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

The city of Tema with a seaport and many industrial facilities attracts a lot of freight traffic with a consequential adverse impact on safety. The total number of vehicles involved in road traffic crashes nationwide from 1991 to 2008 was 272,628 of which 12.1% were HGVs. Eleven percent (11.0%) of overall fatalities was HGV-related. Within the same period, the Tema Metropolis recorded a total of 8,214 vehicles involved in traffic crashes of which 15% were HGVs resulting in the death of 720 people of which 25% were HGV-related. The chance of recording an HGV-related traffic fatality in the Metropolis therefore was more than twice the national average. The objectives of this study were to establish the characteristics of accidents occurring in the Metropolis that involve HGVs, to determine whether HGVs are prone to specific types of accidents and to identify challenges posed to traffic management as a result of the presence of HGVs on some selected roads. Accident data for the period 2007-2009 were retrieved from the files of the Motor Traffic and Transport Unit (MTTU) of the Police Service in Tema and the Building and Road Research Institute (BRRI) accident database in Kumasi. Manual classified traffic counts and travel time and delay studies were conducted along Akosombo, Harbour, Hospital, Meridian and Valco Roads to determine traffic characteristics and the duration, location and causes of delays. Stakeholder consultations were held with various groups on issues of traffic management in the Metropolis. The analysis showed that there was rapid increase in the number of HGV-related accidents over the study period (2007-2009) with a total of 238 accidents, 21% occurred in 2007, 34% in 2008 and 44% in 2009. A total of 116 fatalities were recorded between 2007 and 2009 with 30% in 2007, 33% in 2008 and 37% in 2009 respectively. The number of vehicles involved in HGV-related accidents increased in percentage terms from 25% in 2007, 34% in 2008 to 41% in 2009. The analysis also revealed that link sections recorded more HGV-related accidents than intersections and HGVs are prone to rear-end, side swipe and right–angle types of collision. This report revealed that speed limit signage, inadequate marking and existing marking have faded with use and other pedestrian facilities are critical in the Metropolis. It is recommended that the Department of Urban Roads should improve and incorporate traffic management measures in all future road projects. In addition, the Task Force of the Metropolitan Assembly in collaboration with the MTTU of the Police Service should monitor the compliance with traffic management measures by all road users.

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1.1 Background

Freight transport in urban areas has a major impact on the quality of life, accessibility and attractiveness of the local community, but this is not always reflected in the amount of attention given to freight issues in the development of transport policies and planning strategies. There is, nevertheless, growing recognition by Governments of the problems of the freight transport sector and opportunities for improving its sustainability in the economics of various countries. The operations of Heavy Goods Vehicles (HGVs) are significant and form an important part of economic activities of any country. The bulk of freight transport is provided by HGVs as freight transport forms a vital link between suppliers and customers (TRB, 2003).

The usage of HGVs is carefully controlled in industrialised countries. Regulation and traffic management are used to minimise their danger and nuisance, especially in sensitive locations such as residential areas. Controls are also imposed to restrict axle weights so that roads are not damaged and to avoid inconvenience and danger to pedestrians and others through illegal parking.

HGV operations in developing countries are not adequately regulated. Lack of restrictions of entry into the operation of HGVs has led to the use of all kinds goods-vehicles. Often anyone can become a goods-vehicle operator without any strict qualification criteria for those who may drive the vehicles. Much of the long distance driving is undertaken with the aid of alcohol or drugs to keep awake whilst the vehicles themselves are frequently grossly overloaded (Transport Research Laboratory, 1994). Police enforcement of axle-load restrictions is often minimal and ineffective. Consequently, significant structural damage can occur to roads which were never designed for such loads. Trucks are often not only overloaded in weight but may often be unstable due to very high loads. In urban areas such trucks are often parked on the roadways in unlit streets of residential areas. Apart from their contribution to environmental problems and a number of road accident cases, they also cause congestion on highly trafficked corridors.

1.2 Need for the Research

From 1991 to 2008, a cumulative total of 272,628 vehicles were involved in road traffic crashes nationwide, 12.1% of which were HGVs. Within the same period, 25,598 people died as a result of road traffic crashes throughout the country. Eleven percent (11.0%) of these

fatalities was HGV-related. Urban localities recorded a total of 8,564 fatalities, 5.3% of which were HGV-related. Non-urban localities however accounted for a total of 16,972 fatalities with 13.9% being HGV-related. Generally, fatalities that resulted from HGV-related accident nationwide are on the rise within the stated period (National Road Safety Commission, 2008).

Tema Metropolis has a lot of industries that contribute to promotion of socio-economic development within the country and the West African sub-region. A lot of HGVs are therefore attracted to Tema Metropolis. It is important to indicate what the Ivorian crises has contributed to the number of HGV attracted to Tema as many countries within the West African sub-region are compelled to pick their imports from Tema. This has contributed to continuous growth of freight transportation. This appears, in part, to have impacted on safety and traffic management in the Metropolis and its environs as a number of HGV-related accidents is constantly rising.

Accordingly, this research therefore sought to investigate the involvement of HGVs in accidents and its impact on traffic management in the Tema Metropolis.

1.3 Objectives

Based on the foregoing, the objectives set to be achieved by this study are;

- To establish the characteristics of accidents occurring in the Metropolis that involve HGVs,
- To determine whether HGVs are prone to specific types of accidents,
- To identify challenges posed to traffic management as a result of the presence of HGVs on some selected roads in the Tema Metropolis.

1.4 Research Questions

The research questions to be addressed by this study will be:

- What has been the trend in HGV-related accidents over the years in the Tema Metropolis?
- What are the types of accidents involving HGVs over the past three years in the Tema Metropolis?
- What are the traffic management challenges due to the presence of HGVs?

1.5 Significance of the Study

This study although confined to selected roads in the Tema Metropolis will help policy makers to get a better understanding of the impact of HGVs on safety and traffic management situation on roads. This will go a long way to help in the redefining of the investments of safety and traffic management of roads in the country.

1.6 Organization of the thesis

This thesis is organized into five (5) chapters. Chapter one was devoted to background and the need for the research, objectives, research questions, significant of the study and limitations. The second chapter focuses on the review of the studies which involved impact of HGV on safety and traffic management. Chapter three is devoted to the methodology applied in the study. Chapter four describes the analysis and interpretation of the data. Chapter five contains the conclusions and recommendations of the study.

2 LITERATURE REVIEW

2.1 Introduction

The previous chapter provided the background and problems discussion leading to the research questions. In this section the review of earlier literature on the impact of HGVs on safety and traffic management is undertaken.

The rapid growth in truck volumes and its accompanying challenges have fostered a widespread recognition that smooth and efficient movement of goods (as well as people) is essential for economic well-being. Transportation organizations are increasingly faced with the dilemma of needing to accommodate trucking to foster economic development and sustain the quality of life associated with the consumer economy and while dealing with a public that is increasingly vocal in its demands that truck traffic and truck-related development be eliminated or minimized wherever possible. The growing importance of these challenges has caused public agencies to begin addressing this poorly understood component of transportation system planning, namely the movement of goods (National Road Safety Transport Commission of South Africa, 2002).

2.1.1 Heavy Goods Vehicle Safety

During 1990 the Australian Road Transport Federation commissioned a review of safety issues associated with heavy vehicles in Australia in response to increasing concern about heavy vehicle safety. The objectives of this work were to identify long and short-term actions designed to improve heavy vehicle safety based on their cost and effectiveness, and to identify the critical research issues and gaps in current technology. The role of road and traffic factors, vehicle design and maintenance factors, and driver and organizational factors were reviewed, and statistics on heavy vehicle safety in Australia were collated. The cost of heavy vehicle accidents was also estimated. Cairney (1991) summarized this work on 'Improving truck safety in Australia'. The main outcomes and recommendations of these reports were:

Road and Traffic issues

Among others, it has been recommended in the shorter term to conduct road safety issues of heavy vehicle routes; seal pavement shoulders. In the longer term, improve lane and shoulder widths. The most critical research needs identified were better information about the relationship between road geometry and accidents.

Vehicle factors

This is to promote seat belt wearing and develop more appropriate seat belt anchoring standards; fit speed limiters; develop appropriate standards for brake inspection and maintenance.

Driver and Organizational Factors

Under this factor, recommendation is given to carry out driver health checks, and provide alcohol and drug counseling; provide driver education programs which emphasis issues other than driving techniques; review operating schedules; provide a driver education program that focuses on attitudes and responsibilities, and make driving records available to employers; conduct a survey of driver exposure and a review of the aims and outcomes of driver training programs. Under the Australian Road Transport Federation program "Sweatman (1991)" addressed issues relating to vehicle mechanical design, vehicle maintenance and driver aids.

The objectives of his work were:

- How design and mechanical factors and inadequate maintenance contribute to the causation of heavy vehicle crashes;
- How can significant gaps in current knowledge be remedied;
- Identify possibilities that may reduce heavy vehicle crashes through better vehicle design, maintenance practices, and the use of driver aids.

Sweatman outlined and considered contributing factors to crashes, and associated countermeasures that may be classified as affecting the following aspects of the crash process: exposure of heavy vehicles in traffic; crash avoidance; crash consequences for heavy vehicle occupants; crash consequences for other road users. The major contributions to heavy vehicle exposure were identified to be size and weight regulations, and the extent to which the freight task would be carried on fewer, heavier vehicles. Effects of axle groups, suspensions and tyres on road wear and effects of configuration, coupling and dimensional factors on vehicle stability and road space requirements are important in this respect. Sweatman considered that crash avoidance is influenced by: driver alertness and response; visibility from the cab; driver information flow; driver experience and skill; vehicle conspicuity; braking performance; dynamic stability; load security. These factors are affected to various degrees by: vehicle speed; vehicle loading condition; vehicle mechanical condition; road and roadside factors and the environment (National Heavy Goods Vehicle Safety, 2002).

While driver factors apply to heavy vehicle drivers and other road users, the braking, stability and load security issues tend to be specific to heavy vehicles. Crash consequences for heavy

vehicle occupants are affected by: crash sequence (in particular whether roll over occurs); cab crashworthiness; driver and passenger restraints systems; load security and cab protection; load commodity. Crash consequences for other road users are affected by: heavy vehicle front, rear and side aggressiveness; heavy vehicle load commodity; car crashworthiness and car driver restraint systems.

Sweatman (1988) purported that the design, usage and regulation of heavy vehicle are changing rapidly and that the road community must keep abreast of these changes. He provided an overall view of heavy vehicle safety and highlighted the importance of vehicle braking, geometric performance, dynamic stability, trailing fidelity and ride quality as key elements in heavy vehicle safety.

Prem et al (2000) conducted work to identify and develop a range of objective performance measures that could be used to evaluate the safety related performance of heavy vehicles. They noted that the design and general operation of heavy vehicles in Australia is controlled by Australian Design Rules (ADRs) and separate regulations within each jurisdiction. The regulations as they stand do not address a number of critical issues that relate to the on-road safety-related performance of heavy vehicles. They estimated the characteristics of the current heavy vehicle fleet and translated these into minimum performance levels that could be applied to heavy vehicle evaluations. The outcomes of this work are considered an essential part of achieving national consistency in the overall on-road performance of the heavy vehicle fleet, as well as eliminating the risk of introducing new or innovative combinations that are less safe than those in the current fleet. The work provided a pivotal input to the National Road Transport Commission (NRTC) and Austroads projects that are central to the development of a performance based standards

2.1.2 Speeds of HGVs

ARRB TR conducted a study for Austroads on "Speeds of Heavy Goods Vehicles compliance with Speed and Mass: Evidence from Weigh-in-Motion devices", (George 2002). Weigh-in-motion data were gathered from all states and territories and the report outlines the incidences of heavy vehicles observed exceeding the posted speed limit and the prescribed axle mass limits. The observed incidences of vehicles both speeding and exceeding the mass limits were also reported. The impact and implications on heavy vehicle safety of both speeding and overloaded vehicles were also investigated as part of this study. The study investigated 6 years of data from the years 1995 to 2000 with more than 45 million observations. The

analysis of the data in this work concentrated on the two vehicle types that represented the largest number of observations: two axle rigid vehicle (Austroads class 3) and six axle articulated vehicle (Austroads class 9 vehicles). Overall, the aggregated Australian data averaged over the years 1995 to 2000, 17% of the observed Austroads class 3 vehicles and 26% of the observed Austroads class 9 vehicles were detected exceeding the posted speed limit.

2.1.3 HGVs Involvement in Road Accidents

The characteristics of heavy goods vehicle (HGV) accidents are different from passenger car accidents mainly because of the special attributes of HGVs. They are much heavier and larger in dimensions than passenger cars, they have less effective acceleration than passenger cars and have problems to maintain their speed on upgrade, and, they have lower deceleration in response to breaking than other categories of vehicles. The HGV structure seems to be incompatible with light vehicles; one of the most frequent causes is when the other vehicle wedged into HGV. The result is that HGV accidents often are more serious than other vehicles involved in road accidents (Chaumel et.al. 1986).

The reason why HGV-related accidents should differ from other vehicle-related accidents also means that we should expect a difference in accident rates for different weight classes of HGVs. However, a survey of the literature did not result in any conclusive evidence on the relationship between truck configuration and accident risk (Braver et.al. and Nilsson 1996). National Highway Traffic Safety Administration (1992) concludes that single-unit trucks give rise to more injuries in collisions than tractor-trailer combinations. However, this could be explained by the fact that combination truck operates predominantly long-haul, high-speed, in rural environment, while single-unit trucks are used more often in an urban environment, at lower speeds, in daytime during the work week.

As the number of trucks increases with a given flow of other vehicles, we may expect different reactions on the accident probability with different vehicle elements. Jovanis and Chang (1986) report an effect on overall accidents from truck traffic in a study of the Indiana Toll Road. The total number of accidents increases at a decreasing rate as the truck traffic increases. Later studies (Joshua and Garber (1990), Miaou (1994)) on more general data have supported the conclusion that truck traffic has an influence on the total number of accidents.

2.2 Theoretical Framework

2.2.1 General

Increasing movement of freight brings associated pressures to develop land for freight-related uses. Industrial uses are constructed to manufacture and assemble the goods demanded by the public. Warehouses and terminal facilities are developed to store and transfer the goods by trucks. The potential impact on the economy has been frequently cited as a challenge associated with traffic congestion, as trucks inefficiently spend time in slow-moving traffic, perhaps even missing critical delivery deadlines as a result. The increasing use of just-in-time delivery means that a larger share of truck movements are time sensitive, and even though shippers plan their schedules to account for recurring congestion, they cannot always allow enough slack to account for traffic incidents or unusual delays. With delays, and the need to accommodate them, transportation costs may rise and productivity across the supply chain fall (TRB 2003).

2.3 Challenges of Freight Transport in Urban Areas

Complexity of operations and conflicting goals make urban goods transport a contentious area. Urban goods transport plays an important role in the of quality of life in urban areas, since a large share of the traffic moves take place in areas with a high density of population and mixed use of public space, where external costs of transport are easily felt. The various problems both encountered and caused by urban goods transport, which have implications on the local, national and international agenda are discussed below.

Accessibility and Traffic Congestion

Accessibility problems encountered by urban goods transport are often caused by the following reasons: insufficient urban goods transport infrastructure, access restrictions and traffic congestion. Although delivering goods to city centres is essential for maintaining economic and social functions of cities, freight vehicles in many cities encounter the problem of not having the infrastructure necessary to function properly. There is a serious lack of parking places for freight vehicles, both on-road and off-road, which can be used for loading or unloading. Even where such places exist, they are often illegally occupied by other vehicles, since restrictions allowing only freight vehicles to use such places are rarely enforced. This results in freight vehicles being forced to double park on roads when they stop for delivery, causing disruption to traffic and safety problems. To address this problem, the varying needs and interests of all stakeholders must be taken into account (Melbourne, 2002)

Environmental Impact

Freight transport contributes to global emissions as well as local air pollution and a reduction in the quality of the environment in urban areas in general. With improvements in passenger vehicles, such as the breakthrough of catalysts and environmentally friendly fuels, freight vehicles have become more prominent as an environmental problem. The fact that many trucks use older technology (diesel engines) also contributes to them becoming significant generators of local pollutants, including particulates (United Kingdom Department of the Environment, Transport and the Regions, 2000).

Safety

Roads in urban areas are often congested due to high traffic volume, limited space for infrastructure, signalised intersections on trunk roads, traffic entering and exiting from roads and buildings, on-road parking and pedestrian traffic. The densities of facilities, such as roadside buildings are also features in urban areas. In this situation, the following road safety problems arise.

i. Problems caused by on-road loading/unloading

Due to lack of adequate facilities in buildings, loading and unloading tends to be carried out on-road. In central business districts where on-road parking is common, even when on-road loading/unloading facilities exist they tend to be used by other vehicles, resulting in loading and unloading often being carried out from vehicles that are double parked. This leads to traffic congestion, and vehicles changing lanes to avoid double-parked vehicles increase the risk of accidents.

ii. Problems caused by population and building density

Freight vehicles often transit residential streets to avoid congested trunk roads. As a result, accidents involving freight vehicles may increase and have serious impacts, including the involvement of pedestrians or destruction of roadside buildings. Also, when accidents involving large freight vehicles occur on the roads, they could have serious effects on the roads by shedding of loads. Furthermore, accidents on crowded roads in urban areas aggravate traffic jams.

iii. Problems caused by excessive demands in deliveries

There are cases when excessively strict delivery deadlines lead to dangerous driving, causing accidents. For example, when drivers' salaries are based on number of deliveries, drivers try

to make as many deliveries as possible and may drive aggressively and unload carelessly from double-parked vehicles, thus increasing accident risks.

iv. Problems caused by characteristics of vehicles and loads

Generally, accidents involving freight vehicles are greater in scale than those involving passenger cars, and often include shedding of loads. The social loss caused by such accidents is greater, since it takes more time to deal with the accidents, leading to long traffic jams. Also, there are cases when vehicles and Trucks that exceed height restrictions pass under elevated railways, roads or pedestrian crossing bridges collide with such structures. Another important aspect is that other road users tend to lack knowledge of the limitations and manoeuvrability of large freight vehicles, which differ from those of passenger vehicles. The lack of understanding that large freight vehicles are not able to stop or change directions quickly could result in collision with such vehicles (Australia Federal Office of Road Safety, 1997)

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Losses in Productivity Due to Congestion

The potential impact on the economy has been frequently cited as a challenge associated with traffic congestion, as trucks inefficiently spend time in slow-moving traffic, perhaps even missing critical delivery deadlines as a result. The increasing use of just-in-time delivery means that a larger share of truck movements are time sensitive, and even though shippers plan their schedules to account for recurring congestion, they cannot always allow enough slack to account for traffic incidents or unusual delays. With delays, and the need to accommodate them, transportation costs may rise and productivity across the supply chain fall. These challenges are characterized as increased transport costs and productivity loss (TRB 2003).

2.4 Planning for Increasing Truck Traffic

Planning for trucks can vary from broad-level state wide plans, to localized facility or land-use planning, to the forecasting of truck volumes to help determine future infrastructure needs. Sometimes the planning is purely for goods movement, whereas other times goods movement is addressed as part of a comprehensive transportation planning process. Planning usually involves an inventory of existing facilities and the documentation of current conditions, and often the products of the planning will include recommendations for short-term programming of improvements as well as identification of long-term improvement needs Planning activity involves more detailed planning for a localized area. One type is the

planning of intermodal facilities to improve the efficiency of freight transfers between modes. Another type is planning for development in areas that will attract heavy volumes of truck traffic such as truck terminals, warehousing, and industrial uses (TRB. 2003).

2.5 Speed of HGVs

In 2002 the RTA undertook surveys of heavy vehicle speeds on all major freight routes. These surveys showed that a significant proportion of heavy vehicles were exceeding the speed limit. For example, on the various Highways 15% of heavy vehicles are travelling at faster than 100km/hr.

Reasons for speeding

A survey indicated that heavy truck drivers speed for similar reasons to other drivers. A recent study of licensed drivers in NSW found that drivers say they are more likely to speed when they are late, no danger and confident they will not be caught by the police. Some truck drivers are economically induced to speed in order to make greater profits. Transport Workers' Union of Australia12 also noted that some drivers say that they speed so that they can get more rest during or at the end of the trip. The countermeasures aimed at improving heavy truck speeding are education, improving the work environment, enforcement and penalties, road environment based countermeasures and vehicle based countermeasures (RTR, 1998).

2.6 Road Worthiness of HGVs

The Road Transport (Vehicle Registration) Regulation 1998 outlines the requirements for registering heavy vehicles and their minimum mechanical fitness standard. Heavy truck mechanical defects cause or contribute to crashes in a number of ways. Some mechanical defects cause complete failure of components (eg tyre blow outs), while other mechanical defects reduce performance and therefore reduce a vehicle's ability to avoid a crash (eg as a result of worn or poorly adjusted brakes).

Crashed vehicle study

A RTA Crashed Vehicle Study from 1995 to 1998 examined about 4,500 vehicles involved in crashes in NSW. This included over 400 heavy articulated trucks, 350 heavy rigid trucks and over 150 buses and coaches. The mechanical defects found were graded by their degree of seriousness. The crashes investigated were those that met at least one of the following criteria:

- A person was killed or injured.
- There was over $500 damage to property other than the vehicles involved.
- One of the parties failed to stop and exchange information.
- One or more of the drivers was reported as being under the influence of alcohol or other drugs.
- One or more of the vehicles was required to be towed away.

The research found that 29% of rigid trucks and 25% of articulated trucks involved in crashes had serious or dangerous faults.

2.7 Management Strategies for Truck Volume

The management strategies discussed in this section covers issues relating to increasing truck volume and the types of challenges to which the strategies apply. The following provides the strategies:

Roadway Facilities for Trucks

In some locations, truck volumes or operational requirements may justify physical separation of trucks or commercial vehicles from light-duty traffic (automobiles). The following types of roadway facilities have been considered:

- Dedicated roads for trucks or commercial vehicles,
- Special use lanes for trucks or commercial vehicles,
- Truck climbing lanes, and
- Dedicated truck ramps.

Operational Strategies

Operational strategies address the management and use of the available infrastructure. The following have been considered:

- Lane restrictions,
- Time-of-day restrictions,
- Roadway restrictions or prohibitions,
- Parking restrictions or prohibitions,
- Improvements in intermodal operations.

Enforcement and Compliance

Enforcement of existing laws and regulations is often viewed as an effective means of ensuring safety and protecting infrastructure investments. Some of the significant enforcement challenges include trucks that exceed weight limits and excessively damage pavement, trucks that fail to meet equipment standards, and drivers who exceed limitations on hours of operation. Specific improvement strategies in this category include:

- Additional inspection stations,
- Additional truck inspections,
- Electronic screening,
- Enhanced enforcement to remove noncompliant trucks, and
- Enhanced enforcement of operator hours.

Signing

Two types of signing improvements are particularly relevant to managing increasing truck traffic. These are:

- Improved warning signs, used to warn drivers of safety hazards; and
- Improved directional or information signs, to help drivers reach a destination or find a location.

Improved Highway Design

Improvements in highway design include upgrades implemented at specific locations and changes to the design standards used for future highway improvements. Strategies to improve highway design include:

- Improved highway geometrics,
- New or upgraded structures,
- New or improved pavements, and
- Modified design standards.

Intelligent Transportation Systems

ITS are systems that use information, communication, sensor, and control technologies to improve transportation system efficiency and safety. The U.S Department of Transportation has developed a national ITS program plan that includes seven major elements—those most likely to be implemented by public agencies to enhance highway operations and safety for trucks fall into the categories of commercial vehicle operations (ITS/CVO) and Advanced Vehicle Control and Safety Systems (AVCSS).

2.8 Traffic Management of HGVs in Australia

The road toll for all vehicles, including heavy vehicles, has been in decline over the last decade, despite the significant growth in number of vehicles and enhancements in vehicle performance technology. Truck crashes and fatalities peaked during the late 1980s, and then dropped significantly in the early 1990s. Even though the number of trucks on the roads has increased, as have the kilometres travelled and the tonne-kilometres, the amount of road trauma has remained relatively stable since then. While maintaining this level of safety and successfully avoiding an increase in negative safety trends is important, there is still more that can be done throughout the cooperative efforts of all stakeholders. It is important that the downward trend remains, increasing the level of safety, through the continued development and implementation of initiatives under the National Heavy Vehicle Safety Strategy (NHVSS) by all key players; industry, government and stakeholders.

The components of capacity management system are:

- increased seatbelt usage by heavy vehicle drivers;
- Routine Guidance
- Speed reduction for HGVs;
- Reduced driver impairment
- Safer heavy vehicles.
- Enhanced driver and industry management;
- Traffic information including information on combined transport facilities

2.9 Traffic Management of HGVs across the Swiss Alps

Goods transport has a major impact on the economy any country but receives little attention in comparison to passenger movement. The delivery and collection of goods in any community, especially in the core areas of the community, have a major impact on its economic strength, quality of life, and the accessibility and attractiveness of the community. While traffic and its impacts in urban areas have received attention in recent years, much of this attention has been directed at public passenger transport and private car traffic, and relatively little attention has been paid to urban goods transport. However, due to the increase in urban goods transport and the resulting problems, there is growing concern about urban goods transport and its management. A HGV capacity management system is part of the measures proposed by the Transport Ministries of the Alpine countries aiming at a more different use of the existing road infrastructure, at increased road user safety and at reduced traffic congestion on the bottlenecks that constitute the alpine passes. As part of HGV traffic management on the major routes, strategies have been adopted to manage HGV's effectively and efficiently to ensure

safety at all times. To ensure efficient HGV management, a HGV Service Centres with waiting areas were built on either side of the two transalpine routes (Swiss Ministry of Transport, 2001).

The HGV Service Centres fulfil the following functions:

- Reception and dispatching HGVs on the tunnel route within the reservation system.
- Parking area for HGVs in case of traffic incidents other adverse weather conditions;
- HGV parking during night ban;
- HGV traffic enforcement centre
- Sanitary facilities
- Garage and repair shop
- Petrol station
- Shopping
- Information centre and. Lodging

During regular service the procedures for HGV's were followed as follows:

- At the HGV Service Centre site HGV's use a special exit ramp of the motorway and are directed towards the HGV Service Centre.
- Arrival at the HGV Service Centre and manual sampling by traffic police of HGV's that are sent for a safety check to the enforcement centre within the Traffic Centre. The safety check includes checking driver condition, driving hours, vehicle condition, loading, and others.
- In the waiting area, vehicles are parked and the driver walks to the dispatching desk (manned) or to an electronic kiosk.
- HGVs that pass the checks are given tags to enable them proceed on the journey.

The stated strategies will improve safety and flexibility of the traffic management and also improve the ability of the truck companies to plan the trips well. It will also give the traffic management centre better information of the HGVs traffic demand.

2.10 The RTMS. A Self Regulatory Initiative in HGV Transport in South Africa.

Inappropriate loads on heavy trucks can result in crashes that lead to injuries and even fatalities. If a load is placed inappropriately or moves it can cause instability in the vehicle that leads to difficulties with braking and turning movement, and can result in the vehicle turning over. Alternatively, loads can come free of the vehicle altogether and hit other road

users. Overloading of HGVs cause accelerated road deterioration. Inadequate vehicle maintenance, driver fatigue and poor driver health are also associated with overloading, (RTMS, 2003).

The long term objectives of the scheme are intended to:

- Improve efficiency for scheme members by reducing the impact of conventional regulatory enforcement
- Raise levels of compliance for non- accredited operators through more effective deployment of enforcement resources
- Reduce accelerated road infrastructure damage caused by overloaded vehicles
- Improve road safety

The implementation of the LAP in the forestry industry was successful. This gave birth to the Road Transport Management System (RTMS). RTSM is an industry-led voluntary self-regulation scheme that encourages consignees, consignors and transport operators engaged in the road logistics value chain to implement a vehicle management system that preserves road infrastructure, improves road safety and increases the productivity of the logistics value chain. The RTMS has standards on:

- Loading
- Driver Wellness
- Vehicle Operations and
- Productivity

Furthermore, the RTMS offered support for the implementation of the following components:

- National Standards
- Auditors
- Tools (manuals, templates, implementation guidelines)
- Information portals (website, data sharing)

2.11 Urban Transport Planning and Traffic Management Studies in Tema

The Department of Urban Roads in 2004 contracted DHV of the Netherland in association with Municipal Development Collaborative (MDC), Ghana to carry out urban transport planning and traffic management studies for Tema. Seven roads were selected for the studies. The studies included travel time and delay studies to identify bottlenecks impeding traffic flow.

2.11.1 Identification of traffic flow impedances in the road network system

Tables 2-1 and 2-2 give summary of the congestion levels of the roads, indicating worst sections and major cause(s) of congestion.

Table 2-1: (Ante Meridiem) Ranking of congestion Levels in the Tema Road network system

Route Name	Functional Class	Length of pavement (Km)	CI for the entire route	Worst Section	Length of worst section (km)	CI for the worst section	Bottleneck to Traffic Flow
Beach Road	Minor Arterial	9.85	2.98	Beach road junction-Sakumono Junction.	2.35	7.58	Intersection control
Lashibi Road	Minor Arterial	11.25	2.75	Celestial Sch. Comp-Ashiaman R/A	1.25	3.44	Intersection control
Katamanso Road	Minor Arterial	8.45	2.33	St. Peter's Meth. Church- The Bridge	0.90	6.81	Intersection control
Hospital Road	Minor Arterial	4.8	1.7	Motorway R/A-Unique Flora C	0.25	2.91	Intersection control/ road indiscipline

Source: (DHV & MDC, 2005)

Table 2-2: (Post Meridiem) Ranking of congestion Levels in the Tema Road network system

Route Name	Functional Class	Length of pavement (Km)	CI for the entire route	Worst Section	Length of worst section (km)	CI for the worst section	Bottleneck to Traffic Flow
Beach Road	Minor Arterial	9.85	2.98	Beach road junction-Sakumono Junction	2.35	2.36	Intersection control/ road indiscipline
Lashibi Road	Minor Arterial	11.25	2.75	Spintex Rd Junction-Sakumono Comm. Hospital	0.40	4.59	Intersection control/ road indiscipline
Katamanso Road	Minor Arterial	8.45	2.33	Ashaiman Rd T.L- St Peter's Meth. Church	0.80	3.64	Intersection control/ road indiscipline
Hospital Road	Minor Arterial	4.8	1.7	5th Avenue T.L- Herman Germiner st.	0.90	14.57	Intersection control/ road indiscipline

Source: (DHV & MDC, 2005)

Tables 2-1 and 2-2 indicate bottlenecks to traffic flow along the roads. These are mainly intersection control and road user indiscipline especially drivers.

2.11.2 Parking Surveys in the Tema Metropolis

As part of urban transport planning and traffic management for Tema Metropolis the DHV and MDC also carried out field data collection and analysis as follows:

- Inventory of parking facilities both on- street and off street parking
- Accumulation, Duration and Turnover surveys for parking facilities
- An assessment of the impact of changing land use and development of high rise structures on parking
- Studies along routes for the location of lay-bys

As a result of the analysis the consultant recommended the following for parking in the Metropolis.

Interim measures/short term

- Allow for on street parking only on one- way streets
- reserve lay-byes and designated bus stops for the use of public transport
- Prohibit parking along 20m from any intersection

Long term measures

- Provide designated parking places for HGVs
- Sensitise residents, shoppers and shop owners about the introduction of parking fees
- Provide additional off- street private car parks

Traffic Management improvement plans

- Intersection improvement
- Crosswalk improvement
- Sidewalk development and improvement for pedestrians
- Improvement of Traffic Control Devices and Road Furniture
- Public Transport Improvement

2.12 Accident prone spots Identification and Analysis on Urban Road Network

Traffic Management System (TMS) forms the core of the remedial measures recommended for adoption in order to improve the worst accident prone spots. Standard engineering measures are adopted to achieve efficient and safe movement of both vehicular and pedestrian traffic on existing urban road network.

The standard traffic management scheme for implementation to solve the road safety problems on urban road network includes the following:

- Traffic Signs
- Pavement Markings
- Pedestrian Safety Facilities
- Handrails
- Street lighting (Ministry of Roads and Highways Signs and Markings Manual, 1991)

In August 1999, the Ministry of Transportation acting through the DUR, contracted the BRRI to undertake Consultancy Services for the Indenisation and Analysis of Accident Prone spots on Urban Road Network in Ghana. The study involved the identification of blackspots in the five major cities of Ghana, namely Accra, Kumasi, Sekondi- Takoradi, Tema and Tamale and the analysis of some 100 worst accidents locations with the view of establishing the main causes of accidents and subsequently recommending the appropriate remedial actions to be taken at each identified locations.

2.12.1 Road accident and Casualty Distribution for Tema

Table 2-3 indicates road accident and casualty distribution for the period 1996 to 1998. The table reveals that the number of accidents increased over the three year period. Out of a total of 691 accidents that occurred within the period, 28% occurred in 1996, 27% in 1997 and 42% in 1998. The table also shows that out of a total of 507 casualties recorded within the period, 8% were fatal, 33% sustained serious injuries and 59% sustained slight injuries. The period also witnessed a total of 888 vehicular involvements in accidents.

2.12.2 Analysis for Blackspots for Tema

The analysis identified ten top worst locations in the Tema Metropolis, one each of which is located on the African Unity Road (SSNIT Flats- Salifu Dagati Junction), G.T.P Roundabout, Lumumba Road, Hospital Road, Salifu Dagati/ Lumumba Road Junction and Aggrey Road/ Dagati Junction. Two are located on the Meridian Road (Accra- Tema/ Community 3 Junction), and African Unity Road Junction Rotary Avenue) and Main Harbour Road (Naval Base Road and Harbour Roundabout- Police Headquarters Junction). Table 2-4 provides the summary of the analysis for Tema. The table revealed that excessive speed under prevailing urban conditions, poor night visibility, weaving capacity problems, inadequate marking and existing marking have faded with use, pedestrians share road space with vehicles and inadequate junction layout were major circumstances under which most accidents occurred.

Table 2-3: Road Accident and Casualty Distribution

Year	Accident						Casualties					
	Fatal	Serious	Slight	Damage only	Total	% of Total	Killed	Serious Injuries	Slight Injuries	Total	% of Total	Vehicle Involved
1996	22	28	46	100	196	28	10	43	70	123	24	266
1997	26	29	48	103	206	27	14	39	98	151	30	297
1998	30	32	105	122	289	42	15	87	131	233	46	325
Total	78	89	199	325	691	97	39	169	299	507	100	888

Source: BRRI, 2001

Table 2-4: Summary results of Blackspots Analysis

No.	Accident Location	Main Accident Types	Accident Circumstances and Environmental Factors	Causes of Accidents	Remedial Measures
1.	African Unity Road (SSNIT Flats - Salifu Dagarti Junction)	· Left-turning · Pedestrian accidents (minor)	- A cross-junction on a main road: turning vehicles problems. - Inadequate junction layout. - No pavement markings and inadequate signs installed. - Drivers may see turning vehicles too late. - No streetlights to improve night-time visibility. - pedestrians share road space with vehicles.	- Drivers see turning vehicles too late. - No or inadequate traffic control devices. - Poor junction lay-out. – Poor night visibility - Lack of pedestrian facilities.	• Redesign the junction and provide adequate traffic control devices. • Provide safe pedestrian crossing space. * Provide streetlighting.
2.	Meridian Road (Accra-TemaJ Community 3 In.)	· Left-turning · Rear-end · Head-on (minor)	- A Tee-junction on main Accra-Tema road. - No protection for left-turning vehicles on main road. - Drivers may see turning vehicles too late. - No road signs. - Inadequate markings; and existing mark-ings have faded with use. - Darkness (poor night visibility).	- Drivers see turning vehicles too late. - Lack of protection for left-turning vehicles. - Lack of road signs. - Inadequate pavement markings. - Poor night visibility. - Excessive speed.	• Redesign the junction and provide adequate traffic control devices. • Provide streetlighting.
3.	Meridian Road (African Unity Road In. -Rotary Avenue	· Run-off road accidents	- Road section on main Accra- T ema coastal road. - Fairly flat and straight section. - Centreline marked but faded with use. - No edge line marking. - Excessive speed.	- Excessive speeding under prevailing traffic conditions. - Inadequate markings or markings not functioning.	• Remark road section. • Inform drivers to slow down.
4.	G.T.P. Roundabout	· Rear-end · Side-swipe	- Roundabout entering and merging traffic problems. - Weaving capacity problems. - Inadequate road signs especially chevron boards, etc. - roads marked but faded with use. - hiqh approach speeds.	- drivers may not expect a roundabout. - Lack of appropriate standard road signs. - road markings not functioning. - Excessive soeed.	• Provide all the road signs including chevron boards. • Re-mark the road. • Inform drivers to slow down.

Source: BRRI, 2003

No.	Accident Location	Main Accident Types	Accident Circumstances and Environmental Factors	Causes of Accidents	Remedial Measures
5.	Lumumba Road	· Side-swipe · Pedestrian accidents (minor)	- A major collector road - Pedestrians share road space with vehicles - Unattractive gravel shoulders as pedestrians' footways. - No centreline markings to designate vehicle lanes. - No signs for side roads. - Improper use of lay-bys. - Drivers may not see other vehicles entering road from lay-bvs.	• Drivers see other vehicles from lay-bys too late. - Lack of roadline markings. • Lack of road signs. • Inappropriate vehicular movements at lay-bys. • Lack of attractive pedestrian facilities.	• Provide road signs and markings. • Improve road shoulders for pedestrian use. • Inform drivers of lay-bys.
6.	Hospital Road	· Side-swipe · Head-on	- Several openings from service road to main road. - Inadequate signs provided. - No pavement markings. - Darkness (poor night visibility). - Trotro/taxi stop on main road to pick or drop passengers.	• Lack of appropriate road signs; and no pavement markings. - Poor night visibility. • Lack of lay-bys for south-bound traffic.	• Provide road signs and markings. • Provide lay-bys at appro-priate locations. * Install streetlights.
7	Salifu Dagarti/ Lumumba Road Junction .	· Pedestrian accidents · Side-swipe · Left-turning (minor)	- School and Filling Station located at junction. - Pedestrians share road space with vehicles. - Pedestrian crossing poorly located and no cover slabs over drain for easy crossing to school. - No marking at junction. - Inadequate signing of junction. • Darkness (poor niqht visibility).	- Lack of road signs to inform or warn drivers of junction. - Poor location of pedestrian crossing facility. - Lack of pavement markings at junction. - Poor night visibility.	* Provide road signs and pavement markings. * Relocate pedestrian crossing. * Provide streetlighting.
8.	Main Harbour· Naval Base Road	· Pedestrian accidents · Rear-end	- Road passes through active commercial (fish market) and industrial area. - Pedestrians share same road space with vehicles. - Unattractive road shoulders for pedestrians' use. - Darkness (poor night visibility	• Lack of exclusive and attractive pedestrian space. - Lack of pavement markings and lay-bys. - Poor night visibility. - Excessive speed.	* Improve road shoulder for pedestrian use. • Provide traffic calming. • Provide roadline markings. • Provide streetlighting.

Source: BRRI, 2003

No.	Accident Location	Main Accident Types	Accident Circumstances and Environmental Factors	Causes of Accidents	Remedial Measures
9.	Main Harbour Road (Harbour R/about - Police Headquarters Junction)	· Pedestrian · Rear-end	- A major arterial road. - Pedestrians cross major road at un-approved points. - Pedestrians cross wide and major road haphazardly. - Inadequate pedestrian crossing signs and signs for side roads. - Sudden stopping and close following vehicles. - Hiqh vehicular speeds.	- Pedestrians are unrestrained to cross a major road. - Pedestrians may not be aware of the dangers in haphazardly crossing a wide and major arterial outside approved crossing points. - Excessive speed. • Lack of appropriate standard road sians.	* Provide handrails at appropriate locations to restrain pedestrians. * Provide appropriate road signs. * Educate pedestrians about the dangers of haphazardly crossing a major arterial.
10.	Aggrey Road/Salilu Dagarti Junction	· Rear-end	- A cross-junction in an urban environment. - The junction is not clearly seen at night. • Aggrey School is located near the junction. - No roadline markings. - Inadequate road signs: no signs on the Aggrey Road approaches. - Darkness (poor night visibility).	- Stranger drivers may not expect a junction particularly at night. - Lack of road signs and pavement markings. - Poor night visibility. - Sudden stopping and close following of vehicles.	* Provide signs and pave-ment markings to assist drivers . * Provide streetiighting.

Source: BRRI, 2003

3 METHODOLOGY

3.1 Study Area Description

Tema is a coastal city situated about 30 kilometers east of Accra, the capital city of Ghana. It shares boundaries on the North East with the Dangbe West District Assembly (DWDA), on the West with the Accra Metropolitan Assembly (AMA) and on the Northwest with the Ga East, Adenta and Ashiaman Municipal Assemblies, East by Akuapim South District Assembly and the South by the Gulf of Guinea. The Metropolis covers an area of 396 sq Km approximately and lies within the coastal savannah zone.

Tema is situated on the Greenwich meridian with the 0º longitude passing through it and serves as the administrative capital of the Tema Metropolitan Assembly. Tema has a lot of concentrated Industries. Most of the country's major factories are located in Tema. This is largely due to the presence of the harbour. The year 2010 total population projected from 2000 population Census of the Metropolis was 440,293 (Source: Ghana Statistical Service, 2000 population Census).

Figure 3-1 shows the outline of study area roads in Tema.

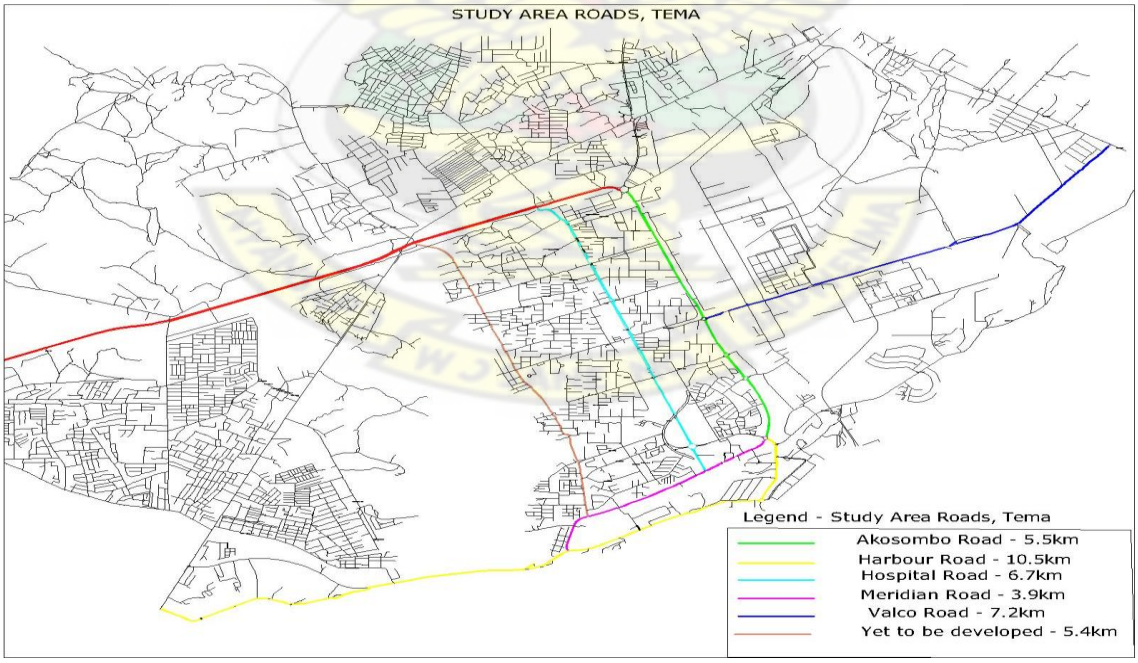

Figure 3-1: Study Area Roads Network in Tema

Figure 3-1 shows a network of roads to form a grid. There are other roads that connect the grid to facilitate movement in and out of the Tema Metropolis. Parts of the grid have been

developed. The fourth road to complete the grid is yet to be developed. It has not received any engineering proposal for its development and still remains an issue for consideration. For the purpose of this research, five roads were selected and described in the following subsections.

3.1.1 Akosombo Road

The road is a minor arterial. It is a paved two lane dual carriageway of length 5.5 Km. It emanates from Tema community one and links the Tema motorway, Aflao and Ho trunk roads.

The road has well defined lanes and sidewalks at the left hand side of the road whilst the right side of the road has not been provided with sidewalk. The sidewalk is constructed to standard which is being used by non motorised traffic.

The road recorded ADT of 33,720 veh/day with 15.2% of it made up of HGVs. Figure 3-2 shows images of the road.

Figure 3-2: Images of Akosombo Road (road signs, marking, walkways, laybyes are absent)

3.1.2 Harbour Road

The road is a minor arterial which emanates from the Harbour roundabout at Tema through the Harbour to Accra and covers a length of 10.5 Km. it is a paved two lane dual carriageway from the Tema community one to the Tema Harbour of length 2.5Km. The rest of the road is a paved two-way single carriageway. The dual carriageway has well defined lanes, sidewalks and bicycle lanes. The sidewalks and bicycle lanes are well constructed which is being used as shared facilities by both pedestrians and bicycles. The other section has not been provided with NMT facilities.

The road recorded ADT of 28,720 veh/day with 13.2% of it made up of HGVs. Figure 3-3 shows images of the road.

Figure 3-3: Images of Harbour Road (road signs, marking, walkways, laybyes are absent)

3.1.3 Meridian Road

The Meridian road is a distributor/collector road and runs South/West between the Harbour roundabout to Harbour Junction. The road is a paved two-way single carriageway of 3.9Km. The road has no well defined NMT facilities. The existing condition of the road is deplorable. Vehicular conflicts occur on this road due to the Cocoa Depot located at Harbour Junction. It attracts a lot of HGVs from all parts of the country. This has contributed to congestion on the road since a lot of HGVs always park on the side of the road creating friction between other road users.

The road recorded ADT of 15,692 veh/day with 5.4% of it made up of HGVs. Figure 3-4 shows images of the road.

Figure 3-4: Images of Meridian Road (road signs, marking, walkways, laybyes are absent)

3.1.4 Valco Road

The Valco road is paved two-way single carriageway of 7.2Km. The road is distributor/collector which runs East/ West of Akosombo road. The road has no NMT facilities. The existing condition of the road is deplorable. There are no traffic management measures on this road which leads to Tema Oil Refinery with high HGV activity.

The road recorded ADT of 13,375 veh/day with 3.6% of it made up of HGVs. Figure 3-5 shows images of the road.

Figure 3-5: Images of Valco Road (road signs, marking, laybyes, walkways are absent)

3.1.5 Hospital Road

The road is a distributor/collector arterial which links between Meridian road and the Tema Motorway through the Ashiaman Overpass. The Meridian Road end 1.2km and Motorway end 0.8km of the Hospital Road is a two lane paved dual carriageway. The rest of the road is paved two-way single carriageway with a parallel service road.

The road has well defined lanes without walkways. Traffic management measures on this road are inadequate. This and other factors contribute to accidents on the road.

The road recorded ADT of 21,860 veh/day with 1.9% of it made up of HGVs. Figure 3-6 shows images of the road.

Figure 3-6: Images of Hospital Road (road signs, marking, walkways, laybyes are absent)

3.2 Accident Data

Accident data for the study was collected from the files of the Motor Traffic and Transport Unit (MTTU) of the police service in Tema, and the BRRI accident database in Kumasi. The retrieved Data from the police covered the year 2009, and was collected carefully by studying all Accident Dockets for the years and recorded on a form prepared for that purpose. The rest of the data, covering 2007and 2008 was obtained from the BRRI by querying the Micro-Computer Accident Analysis Package (MAAP). Data from the two sources covered the following:

- Severity/casualty level
- Pedestrian involvement,
- Number and type of vehicles involved,
- Date of accident occurrence,
- Cause or contributing circumstances,
- Location of accident
- Collision type.
- Accident type (i.e., HGV -related or others).

Appendix 1 indicates a sample form for accident data collection

3.3 Traffic Data

3.3.1 Manual Classified Counts

To determine the traffic volume by type of the various categories of vehicle in the traffic stream, traffic counts were conducted on the selected roads. Manual directional counts were conducted at 15 minutes intervals for 24 hours from 00:00 Greenwich Meridiem Time (GMT) to 24:00 Greenwich Meridiem Time (GMT). Vehicles were classified according to the schedule shown in the Table 3-1.

Table 3-1: Vehicle Categorisation

Vehicle Category	Description
Light	
Cycles	
Motor Bikes	
Taxis/Cars	Taxis, private or hired and saloon or estate cars.
Pick-Up/Vans	Pick-ups, station wagon, vans. jeeps, etc.
Small Bus	Mini buses and generally vehicles with sitting capacity up to 1 9
Medium	
Medium Bus/Mummy Wagons	Medium buses include those with Seating capacity between 19 and 33. Mammy wagons being special trucks with wooden bodies for conveying goods.
Large Bus	34 seater buses and above.
Light Truck	2-axle trucks with single rear wheels or 2-axle trucks less than 10tons with twin rear wheels
Heavy	
Medium Truck	2-axle trucks with twin rear wheels.
Heavy Truck	3-axle trucks, including tankers.
Semi- Trailer (Light)	Semi-trailers with any configuration of 3-axles.
Semi- Trailer (Heavy)	Semi-trailers with any configuration of 4-axles.
Truck Trailer	Large trucks with any configuration of 5-axles
Extra Large Truck & Others	These are extra-large trucks with any configuration of 6-axles. Also includes tractors, bulldozers. Graders or heavy agricultural or

Source: GHA Road Design Guide

3.3.2 Travel Time and Delay Studies

Travel time and delay studies were conducted using Floating Car Method. A test vehicle was driven such that it 'floated' in the traffic stream by referencing its relative position in the traffic stream throughout the trip. i.e. the driver of the test vehicle overtook as many vehicles as overtook his vehicle. The distance driven, the location and the time the vehicle passed selected checkpoints were recorded. The survey recorded data on duration, location and causes of delay. Computations of speeds and average speed on the roads were made. **Appendix 13** provides a sample form for the survey.

3.3.3 Stakeholders Consultation

Separate consultations were held with the Metropolitan Assembly staff, drivers of HGVs, transportation unions and the Department of Urban Roads staff on pertinent traffic management issues on the selected roads for study. The consultation was necessary to complement the observations made on traffic management issues during the travel time and delay studies. It was intended to gain information from the stakeholders to enhance the provision of traffic management facilities to facilitate vehicular movement within the metropolis. The stakeholders were presented with the background information about the research such as the need for the research and the objectives. A range of questions which varied according to the stakeholder were asked but generally included the following:

- To what extent could efficiency and vehicle utilisation be improved within the metropolis with regards to traffic management
- What would be the effect of restricting HGVs to different classes of roads
- What role could be seen for HGVs in the movement of goods
- What benefits would companies derive from the use of HGVs
- What factors might constrain the use of HGVs
- What other issues related to HGVs usage should be considered in your opinion.

The consultations were interactive to explore opinions. Interactions on the topics were to gain subjective impression of general views on pertinent issues on traffic management. Findings have been summarised in a way that reflects the balance of opinions across the stakeholder consultations. Considerable concern was expressed by stakeholders on the need for improvement in the provision of road infrastructure to incorporate traffic management facilities within the metropolis. Undesignated terminals for HGVs affects the benefits to be derived from the operations of HGVs. Regular training of HGVs drivers was highlighted by the stakeholders as key to the issues of traffic management.

4 ANALYSIS AND DISCUSSION OF RESULTS

4.1 Traffic Characteristics

4.1.1 Traffic Growth Rates by Road Corridor

Traffic growth rates computed from counts undertaken by BRRI in October 2000 and DHV and MDC reports on urban transport planning and traffic management studies in August 2005. These sources provided the most recent past traffic data. A 24 hour count was conducted to determine traffic conditions prevailing on the road. Estimation of traffic growth from the data reported from the two reports were done using the compound growth equation below,

$F = P(1+r)^n$ where:

F = future AADT

P = present AADT

r = growth rate (percentage per period divided by 100)

n = period separating *P* and *F*

The results of the computation are displayed in Tables 4-1 and 4-2 below. The tables show that between the periods 2000-2005 the annual growth rate more than doubled for all categories of vehicles as well as volume of HGVs for individual roads. Similarly, in the period 2005-2010 the annual growth rate for all categories of vehicles and volume of HGVs also more than doubled. Tables 4-1 and 4-2 also reveal that increase in traffic volume result in increase in the number of HGVs.

Table 4-1: Traffic Growth Rates on the Selected Roads (2000-2005)

Road	24-hr Volume				% Annual Growth Rates	
	BRRI Data October, 2000		DHV & MDC, August, 2005			
	All Categories	HGV	All Categories	HGV	All Categories	HGV
Akosombo	26,453	3,997	28,478	4,321	1.5	1.6
Hospital	16,879	339	18341	361	1.7	1.3
Harbour	22,789	2,897	24,579	3,161	1.5	1.8
Meridian	12,512	649	13,456	704	1.5	1.6

Table 4-2: Traffic Growth Rates on the Selected Roads (2005-2010)

Road	24-hr Volume				% Annual Growth Rates	
	DHV & MDC, August, 2005		Current Data, February, 2010			
	All Categories	HGV	All Categories	HGV	All Categories	HGV
Akosombo	28,478	4,321	33,720	5,136	3.4	3.5
Hospital	18,341	361	21,860	410	3.6	2.6
Harbour	24,579	3,161	28,720	3,789	3.2	3.7
Meridian	13,456	704	15,692	853	3.1	3.9

4.1.2 Traffic Composition

The proportions of various categories of vehicles in the traffic stream are presented in Table 4-3.

Table 4-3: Proportions of Categories of Vehicles on the Selected Roads (February, 2010)

Vehicle Group	Road Name									
	Akosombo Road		Harbour Road		Hospital Road		Meridian Road		Valco Road	
	ADT	% of Total	ADT	% of Total	ADT	% of Total	ADT	% of Total	ADT	% of Total
Light	22,602	67.0	19,779	68.9	21,151	96.8	12,731	81.1	12,525	92.3
Medium	5,982	17.7	5,152	17.9	299	1.4	2,108	13.4	564	4.2
Heavy	5,136	15.2	3,789	13.2	410	1.9	853	5.4	487	3.6
Total	**33,720**	**100**	**28,720**	**100**	**21,860**	**100.0**	**15,692**	**100.0**	**13,576**	**100.0**

The highest ADT of 33,720 was recorded on Akosombo road, 15% of which was made up of HGVs. The high traffic volume recorded on the road is largely due to its connectivity to the Motorway, the Aflao Road and the Ho Road. These roads carry traffic into and out of the Accra-Tema Motorway. The lowest ADT of 13,576 vehicles per day was recorded on the Valco Road, 3.6% of which was made up of HGVs. Observation made from the table also shows that light vehicles are the predominant mode of transportation within the Metropolis.

4.1.3 Accidents and Traffic Distribution by Road Corridor

Table 4-4 shows the distribution of HGV-related accidents and traffic on the selected roads for study.

Table 4-4: HGV-Related Accidents and Traffic Composition by Road Corridor (2007-2009)

Road Name	Akosombo Road	Harbour Road	Meridian Road	Hospital Road	Valco Road	Others	Total
No. of Crashes	91	78	13	6	8	43	238
% of Total	38	33	5	3	3	18	100
ADT (A)	5,136	3,789	853	410	487		
Road Length (KM) (B)	5.5	10.5	3.9	6.7	7.2		
AXB	28,248	39,785	3,327	2,747	3,506		

As can be seen from the table, the occurrence of HGV-related accidents to volume of HGV indicates that Akosombo and Harbour Roads are most prone to HGV-related accidents in the Metropolis. The table shows that Akosombo Road recorded the highest HGV-related accidents of 91, the figure represents 38% of the total accidents. The table reveals that out of the 238 HGV-related accidents that occurred in the Metropolis over the period, 33% were recorded on the Harbour Road. Other roads not selected for this research accounted for 18% of the total accidents.

4.1.4 Traffic Distribution by Time of Day

Distribution of traffic by time of day is shown in Figure 4-1.

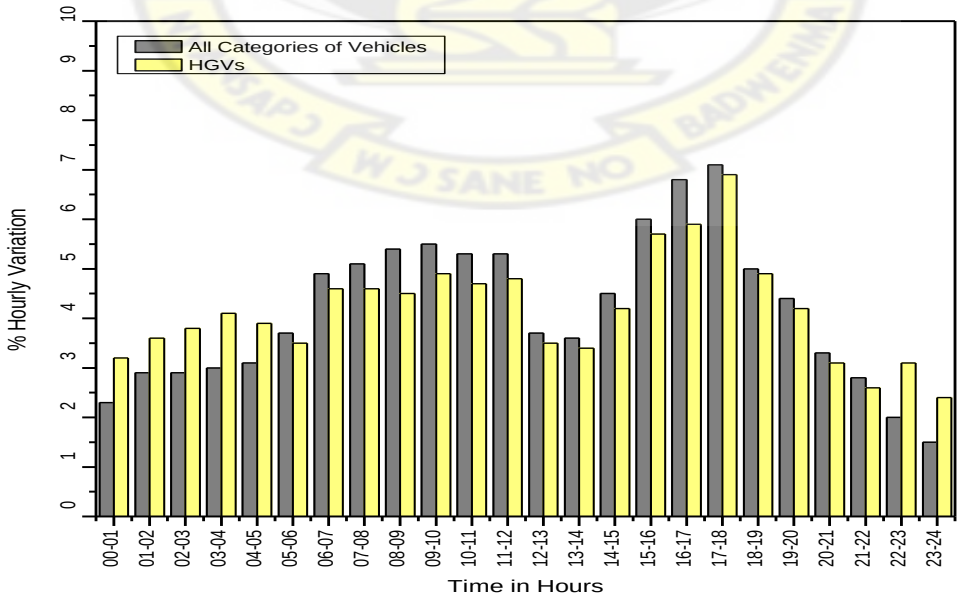

Figure 4-1: Distribution of Traffic by Time of Day

Observation made from the figure indicates that day light hours between 06.00 and 18.00 recorded a higher proportion of traffic volume (58%) than the night time and dawn hours between 18.00 and 06.00 (42%) for all categories of vehicles. Similarly, for HGVs day light hours between 06.00 and 18.00 recorded a higher proportion of 56% than night and dawn time hours between 18.00 and 06.00 of 44%. As can be seen from Figure, the highest proportion of both all categories of vehicles and HGVs was recorded between the hours of 17.00 and 18.00.

4.2 Accident Characteristics

4.2.1 Accident Frequency

Table 4-5 shows overall accidents in the Metropolis within the period 2007-2009. The table reveals that 829 accidents occurred over the period.

Table 4-5 : Number of Accidents in the Tema Metropolis (2007-2009)

Year	Fatal		Hospitalised		Minor Injury		Damage Only		All Accidents	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2007	35	30	57	31	15	29	113	24	220	27
2008	38	33	60	33	17	33	173	36	288	35
2009	43	37	65	36	19	37	194	40	321	39
Total	116	100	182	100	51	100	480	100	829	100

Observation made from the table indicates that accidents increased consistently with 27% of all accidents recorded in 2007, 35% in 2008 and 39% in 2009. A total of 116 fatal accidents were recorded, representing 14% of all accidents with 30% occurred in 2007, 33% in 2008 and 37% in 2009.

Accidents that resulted in minor injury and property damage only are on the rise. The table reveals that minor injury represents the least number of accidents, whereas accidents resulting in property damage are the most represented.

4.2.2 HGV- Related Accident Frequency

Table 4-6 indicates that the total number of HGV-related accidents in the Tema Metropolis was 238 representing 29% of all accident within the period. The table reveals that there has

been a rapid increase in the number of accidents within the period with 21% in 2007, 34% in 2008 and 45% in 2009.

Table 4-6: HGV- related Accidents in the Tema Metropolis (2007-2009)

Year	Fatal		Hospitalised		Minor Injury		Damage Only		All Accidents	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2007	8	26	12	26	5	17	25	19	50	21
2008	10	32	16	35	11	38	45	34	82	34
2009	13	42	18	39	13	45	62	47	106	45
Total	31	100	46	100	29	100	132	100	238	100

The table reveals that 31 accidents representing 13% of the total HGV-related accidents resulted in fatalities. The table also reveals that accidents that resulted in hospitalisation of victims, minor injury and property damage declined over the period.

Tables 4-5 and 4-6 indicate that by proportion of overall accidents, HGV-related accident increased by 11% within the period. Also tables 4-5 and 4-6 indicate that HGV-related accident more than doubled whereas overall accidents increased by 46%.

Table 4-7 indicates that HGV-related Killed and Severely Injured (KSI) accidents increased 1.6 times, whereas KSI for all accidents increased only by 1.2 times over the period.

Table 4-7: Killed Severely Injured (KSI) Accidents

Year	HGV-Related Accidents	All Accidents	Proportion: HGV-Related to All Accidents
2007	20	92	0.22
2008	26	98	0.27
2009	31	108	0.29
Total	77	298	0.26

Observation made from the table reveals that the proportion of HGV-related KSI to all accidents KSI increased from 22% to 29% over the period. The rise in the number of HGV-related accidents relative to all accidents could be due to the constant growth in the number of HGVs as a result of the industries and the seaport in Tema.

4.2.3 Casualty Frequency

Table 4-8 shows the number of casualties within the period. The table indicates that a total of 854 casualties were recorded within the period of analysis. Twenty five percent (25%) of this figure was recorded in 2007, 30% in 2008 and 44% in 2009.

Table 4-8: Number of Casualties (2007-2009)

Year	Fatal		Hospitalised		Injury		All Casualties	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2007	47	26	41	22	128	26	216	25
2008	55	31	64	35	141	29	260	30
2009	77	43	79	43	222	45	378	44
Total	179	100	184	100	491	100	854	100

Observation made from the table reveals that the pattern of change of casualties recorded from 2007 to 2009 is on the rise. The table reveals that a total of 179 people died from casualties that occurred within the analysis period and the figure represents 21% of all casualties produced. The period also witnessed a total of 184 people being hospitalised as a result of their involvement in casualties, and the figure represents 22% of all casualties recorded.

4.2.4 HGV- Related Casualties

Table 4-9 shows casualties resulting from HGV-related accidents within the time frame 2007-2009. As can be seen from the table, a total of 267 casualties were recorded within the three years of analysis representing 31% of all casualties with 18% in 2007, 33% in 2008 and 49% in 2009.

Table 4-9: Number of Casualties from HGV-Related (2007-2009)

Year	Fatal		Hospitalised		Injury		All Casualties	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2007	8	15	13	24	27	17	48	18
2008	17	32	18	33	54	34	89	33
2009	28	53	23	43	79	49	130	49
Total	53	100	54	100	160	100	267	100

Table 4-9 indicates that 53 people died from HGV-related casualties within the period of analysis and the figure represents 20% of all casualties produced with 15% in 2007, 32% in 2008 and 53% in 2009. The year 2009 recorded the highest proportion of casualties of 49%. The pattern of change of casualties from 2007 to 2009 as can be seen from the table is on the rise. The table reveals that accidents resulting from various degree of injury recorded the highest proportion of 60%. On the other hand, fatalities recorded the lowest proportion of accidents and the figure represents 20% of the total HGV-related casualties.

KSI casualties and the proportion of fatalities to both HGV-related and all casualties are indicated in Table 4-10.

Table 4-10: KSI casualties and Proportion of Fatalities to All Casualties (2007-2009).

Year	HGV- Related			All Casualties			(KSI) Casualties	
	Fatalities (F)	All Casualties AC	Proportion F to AC (%)	Fatalities (F)	All Casualties AC	Proportion F to AC (%)	HGV-Related	All Casualties
2007	8	48	17	47	216	22	21	88
2008	17	89	19	55	260	21	35	119
2009	28	130	22	77	378	20	51	156
Total	53	267	20	179	854	21	107	363

As can be seen from the table, KSI casualties more or less doubled within the analysis period. However, the KSI casualties resulting from HGV-related casualties more than doubled. The table also reveals that the proportion of deaths from HGV-related casualties more than tripled within the period of analysis.

4.2.5 Vehicular Involvement in Accident

Table 4-11 indicates that the pattern of change in the number of vehicles involved in accidents compared to the number accidents is on the rise. As can be seen from the table, vehicles involvement in accidents within the analysis period increased 1.3 times.

Table 4-11: Vehicular Involvement in All Accident (2007-2009)

Year	Number	% of Total Vehicles	Number of Accidents	Vehicle/Accidents
2007	465	29	220	2.1
2008	545	34	288	1.9
2009	598	37	321	1.9
Total	1,608	100	829	1.9

Observation made from the table indicates that the highest percentage of 37% of the total number of vehicles involved in accidents was recorded in 2009. The table also reveals that on the average, 2 vehicles were involved in each accident.

4.2.6 Vehicular Involvement in HGV- Related Accidents

Table 4-12 indicates that there was a steady rise in the number of vehicles involved in accidents over the analysis period.

Table 4-12: Vehicular Involvement in HGV- Related Accidents (2007-2009)

Year	Number	% of Total Vehicles	Number of Accidents	Vehicle/Accidents
2007	60	25	50	1.2
2008	81	34	82	1.0
2009	100	41	106	0.9
Total	241	100	238	1.0

Table 4-12 shows that there was a rise in 2009 figure over that of the previous years. As can be seen from the table, vehicles involvement in accidents within the analysis period increased 1.7 times. The table also indicates that on the average 1 vehicle was involved in each HGV-related accident.

4.2.7 Other Road User in HGV-Related Accidents

Table 4-13 shows the comparison of categories of road user involved in HGV-related accidents within the analysis period of three years.

Table 4-13: Comparison of Road Users in HGV- Related Accidents (2007-2009)

Year	Pedestrians		Bicycles		Motor Cycles		Other Vehicles		Total of Road Users	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2007	12	21	5	16	8	21	26	19	51	19
2008	20	34	10	32	13	33	47	34	90	34
2009	26	45	16	52	18	46	66	47	126	47
Total	58	100	31	100	39	100	139	100	267	100

Observation made from the table indicates that 58 pedestrians were involved in HGV-related accidents and the figure represents 22% of the total road user involvement.

As shown by the table, the involvement of motor cycles and pedestrians in HGV-related accidents more than doubled within the analysis period. The involvement of bicycles riders in HGV-related accidents more than tripled over the period of analysis.

4.2.8 Accidents by Road Locations

Figure 4-2 shows comparison of all accidents to HGV-related accidents by road location that occurred within the period of analysis.

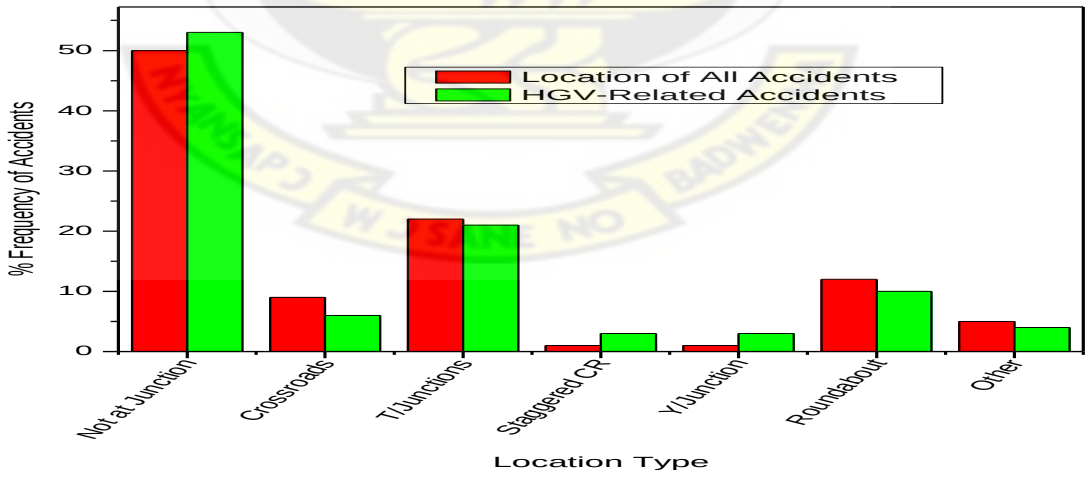

Figure 4-2: Accidents by Road Location

As can be seen from the figure, majority of accidents occurred on link sections other than at intersections. As shown by the figure, accidents by road location from all accidents and HGV-

related accidents more or less occurred by similar percentages. When compared with the pattern of change in accidents, observation made from the figure reveals that 22% of all accidents occurred at T/Junctions, 12% at Roundabout and 9% at Crossroads. Similarly 20% of HGV-related accidents occurred at T/Junction, 11% at roundabout and 8% at Crossroads. Observation made from the figure reveals that HGVs prone to accidents at Y- junctions and staggered crossroads by proportion of involvement relative to all accidents.

4.2.9 Accidents by Collision Type

Figure 4-3 shows the type of collision and their percentages of both all accidents and HGV-related accidents.

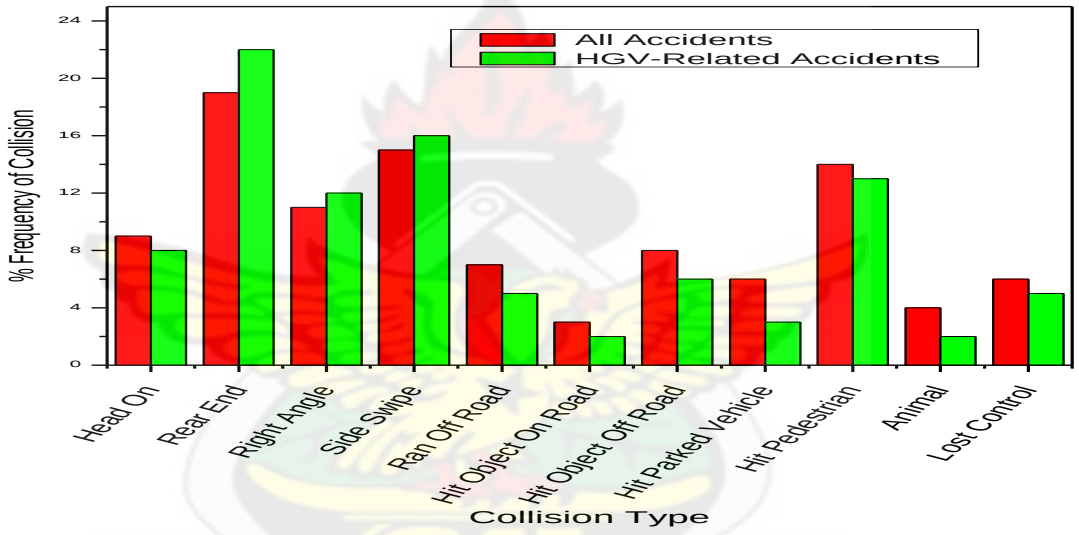

Figure 4-3: Accidents by Collision Type

As shown by the figure, occurrence of Rear End Collisions has been found to be prevalent in both all accidents and HGV-related accidents. Observation from the figure indicates that the pattern of change to both all accidents and HGV-related accidents more or less remains similar in percentages. From the figure, 19% of all accidents involved Rear-End, 15% Side Swipe, and 11% Right Angle collision. Similarly 22% of HGV-related accidents involved Rear-End, 16% Side Swipe, and 12% Right Angle collision. As can be seen from the figure, HGVs prone to Side Swipe, Right Angle and Rear End types of collision by proportion of involvement relative to all accidents.

4.2.10 Hourly Variation in All Accidents and Traffic Distribution

Variation in accident occurrence and traffic distribution by time of day is illustrated in Figure 4-4.

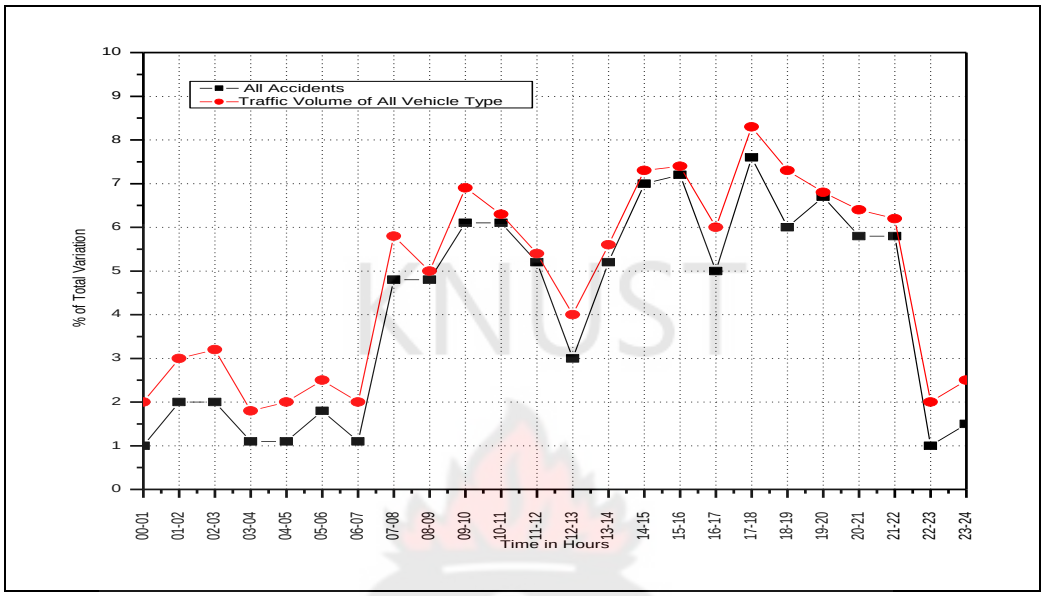

Figure 4-4: Hourly Variation in All Accidents and Traffic Distribution

Figure 4-4 illustrates that both accidents and traffic volume remained stable between the hours of 00.00 and 07.00. From the figure, the highest proportion of accidents and traffic volume was recorded between the hours of 17.00 and 18.00. The high proportion of road accident could be attributed to the high proportion of traffic volume during the daylight time in the Metropolis. Observation from the figure reveals that the pattern of change in accidents more or less remains similar to traffic volume.

4.2.11 Hourly Variation in HGV-Related Accidents and its Traffic Distribution

The percentage variation recorded from HGV-related accidents and its traffic volume is presented in Figure 4-5. The figure reveals that the high proportion of daylight road accident could be attributed to the high proportion of volume of HGVs than in the night and dawn time.

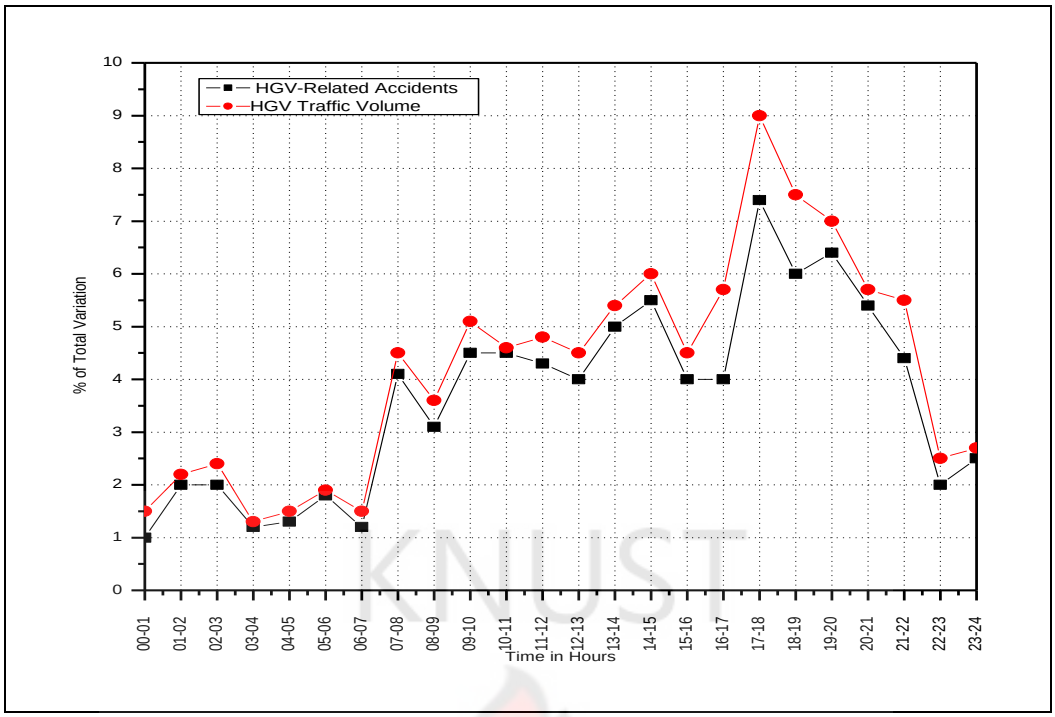

Figure 4-5: Hourly Variation in HGV-Related Accidents and its Traffic Distribution

As shown by the figure, the highest proportion of hourly variation is recorded between the hours of 17.00 and 18.00. The figure reveals that accidents remained more or less stable between the hours of 00.00 and 04.00.

4.3 Assessment of Traffic Congestion

4.3.1 Travel Time and Delay Studies on individual roads within the study area.

The profile of average speeds determined from travel time and delay studies are plotted against distances for individual roads.

4.3.1.1 Harbour Road

Figure 4-6 illustrates speed profile on Harbour Road. The figure shows that the journey speed in the study stretch varied from a maximum of 45km/hr to a minimum of 10km/hr.

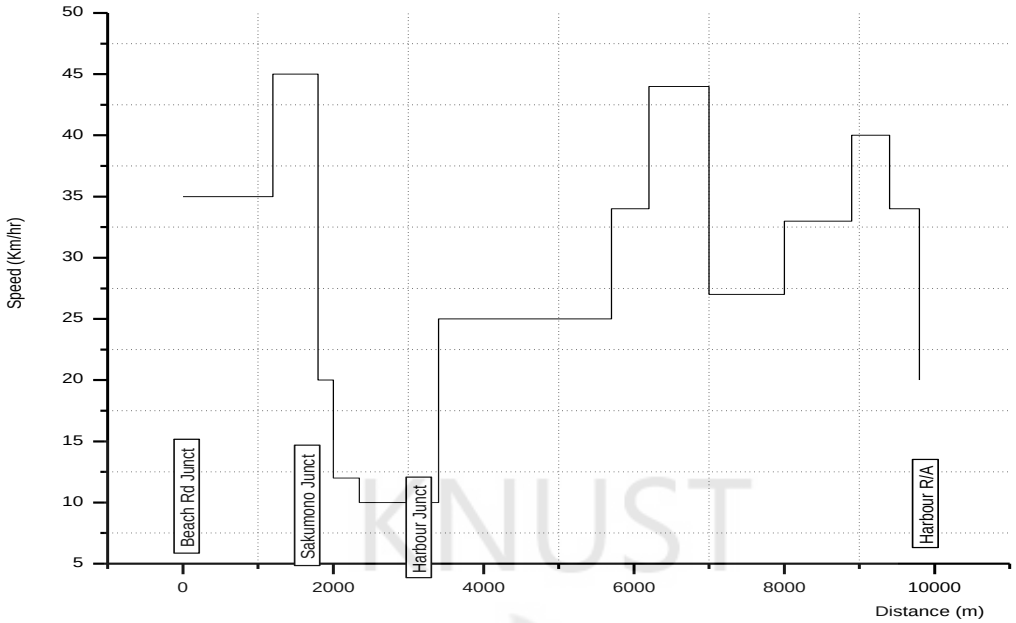

Figure 4-6: Typical Speed Profile on the Harbour Road

The figure reveals that the average journey speed and the average delay for the entire stretch is 16km/hr and 8 minutes respectively in the directions. It can be seen from the figure, the lowest speed was observed between Sakumono Junction and Harbour Junction.

The Travel Time and Delay Studies reveals that a backflow of vehicles is created on the Harbour Road because of difficulty of getting parking spaces for HGVs at the Cocoa Depot on Meridian road. The Sakumono Junction also reveals bottleneck to flow of traffic. Commercial vehicles find it difficult to park at the Depot for passengers to alight and board vehicles because HGVs park at the designated bus stops or lay bys for long periods. The deplorable state of the road is also among the factors causing the traffic congestion especially between Beach Road Junction and Sakumono Junction. The section of the road between Harbour Roundabout and Harbour Junction has been constructed with well defined facilities such as walkways, lay bys, pedestrian crossings and running lanes with road line markings. On the other hand, the section between Harbour Junction and Beach Road Junction through Sakumono Junction lacks the various traffic management measures. As a result, this section of the road always experiences traffic congestion.

4.3.1.2 Akosombo Road

Figure 4-7 illustrates speed profile on Akosombo Road. As shown by the figure, the journey speed in the study stretch varied from a maximum of 65km/hr to a minimum of 30km/hr.

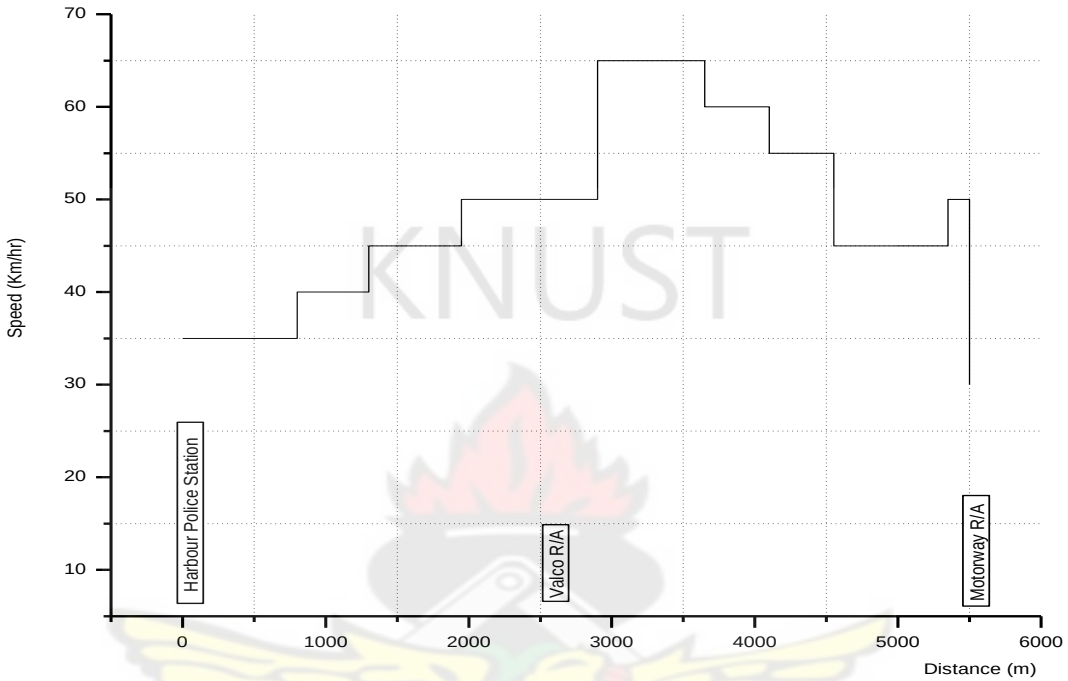

Figure 4-7: Typical Speed Profile on the Akosombo Road

Observation made from the figure indicates that the average journey speed and the average delay for the entire stretch is 47km/hr and 1 minute respectively in the directions. It can be seen from the figure, speeds increase steadily from Harbour Police station to Valco Roundabout. On the other hand speeds decrease from Valco Roundabout to Motorway Roundabout.

The Travel Time and Delay Studies reveals that bottleneck to flow of traffic on the stretch of the road observed to be minimal notwithstanding the percentages of HGVs on it.

In order to reduce fatalities in accidents in which heavy goods vehicles are involved, it is important to look at the potential and effect of different measures on the road. At some sections of the road, HGVs park for long periods in the lay bys or bus stops compelling commercial vehicles to stop on the running lanes for passengers to alight and board vehicles.

Some sections of the road lacks well defined pedestrian crossings and running lanes with road line markings.

4.3.1.3 Meridian Road

Figure 4-8 shows speed profile on Meridian Road. Observation made from the figure indicates that the journey speed in the study stretch varied from a maximum of 45km/hr to a minimum of 10km/hr.

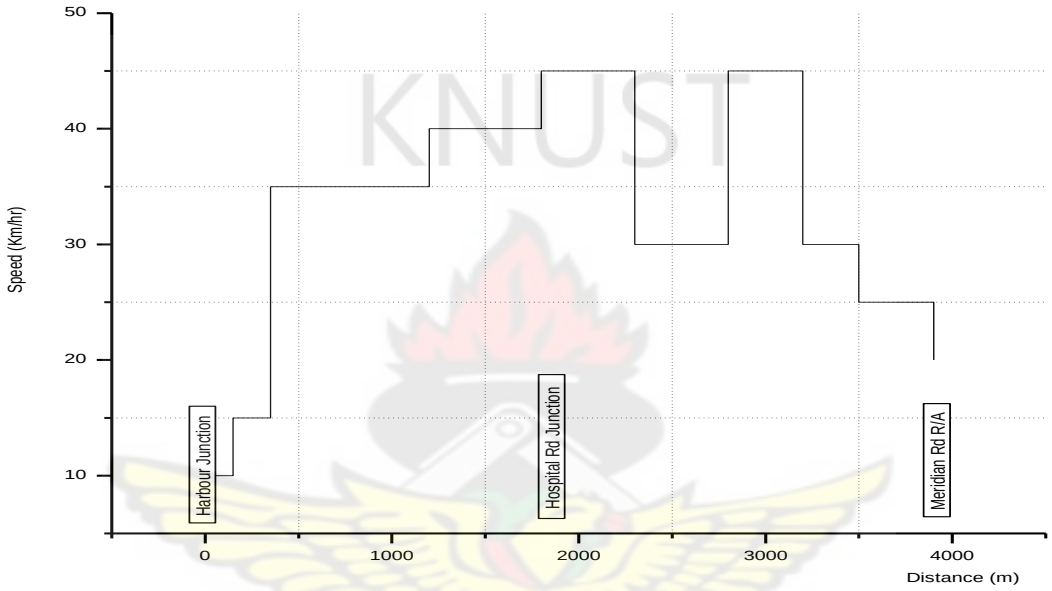

Figure 4-8: Typical Speed Profile on the Meridian Road

As shown by the figure the average journey speed and the average delay for the entire stretch is 28km/hr and 6 minutes respectively in the directions. It can be seen from the figure, the lowest speed was observed between Harbour Junction and Hospital Junction.

The Travel Time and Delay Studies reveals that a backflow of vehicles is created on the Meridian Road because of difficulty of getting parking spaces for HGVs at the Cocoa Depot located on the road. Commercial vehicles find it difficult to park at the Depot for passengers to alight and board vehicles because HGVs park for long period at the designated bus stops or lay bys. The deplorable state of the road is also among the factors causing the traffic congestion on the road. The depot attracts a lot of HGVs from all parts of the country. However, there are no parking spaces for the HGVs. Neither does the road have defined shoulders to accommodate the HGVs. There are no lay-bys or bus stops constructed along the road. The HGVs park on both sides of the road in long queues with part of the vehicles

projecting in the carriageway, thereby reducing the carrying capacity of the road. This situation results conflict between HGVs and other categories of vehicles. The situation as it is needs a designated parking place or well defined shoulders along the road for HGVs in order to avoid the existing vehicular conflict being experienced.

4.3.1.4 Hospital Road

Figure 4-9 shows speed profile on Hospital Road. As can be seen from the figure, the journey speed in the study stretch varied from a maximum of 45km/hr to a minimum of 10km/hr.

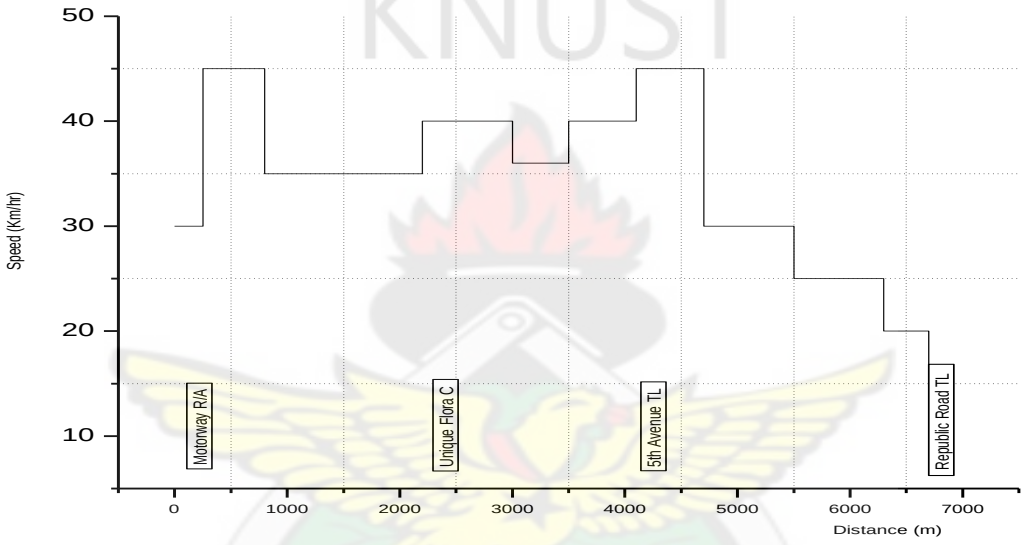

Figure 4-9: Typical Speed Profile on the Hospital Road

Observation made from the figure reveals that congestion at some section of the road is due to intersection delays and side friction involving different categories of vehicles.

The road has no well defined lay bys along some sections of the road as well as shoulders even though there exists enough road reservation to accommodate these facilities. The activities of commercial drivers create a lot of inconveniences as they park on the road for passengers to alight and board vehicles. The road is critical as it leads to the Tema General Hospital. This and other factors require that the road is provided with the necessary traffic management facilities to avoid accidents on the road.

4.3.1.5 Valco Road

Figure 4-10 shows speed profile on Valco Road. As shown by the figure, the journey speed in the study stretch varied from a maximum of 40km/hr to a minimum of 20km/hr.

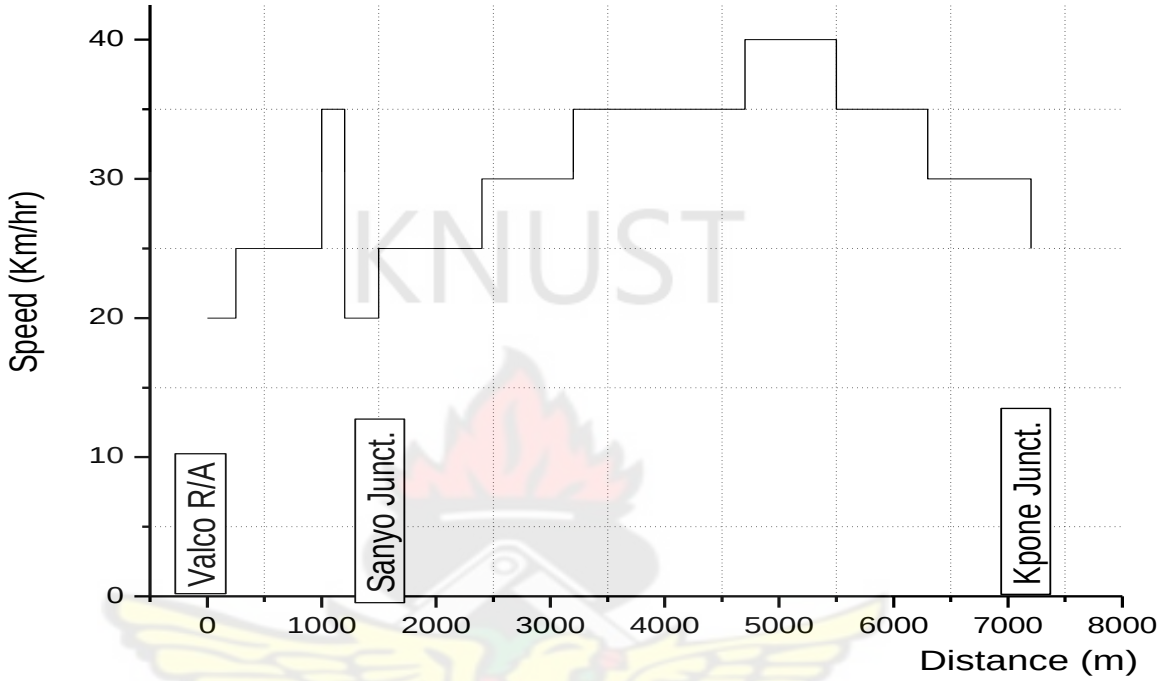

Figure 4-10: Typical Speed Profile on the Valco Road

As can be seen from the figure, congestion at some section of the road is due to intersection delays and side friction involving different categories of vehicles.

The whole section of the road is in a deplorable state. The road has no well defined shoulders, lay bys, road line markings, pedestrians crossing and other facilities that will promote traffic safety. The condition of the road has encouraged commercial drivers to stop on the carriageway for passengers to alight and board vehicles. Some HGVs also park along the road thereby reducing the carrying capacity of the carriageway and sometimes resulting in vehicular conflict.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Characteristics of HGV-Related Accidents

From the accident and traffic analysis, it can be concluded that the highest proportion of HGV-related accidents was recorded between the hours of 17.00 and 18.00. It can also be seen from the analysis that HGVs prone to accidents in Y- intersections and staggered junctions by proportion of involvement relative to all accidents. Additionally, it emerged that the trend in the volume of HGV and HGV-related accident more or less remains similar over the day.

5.1.2 Type of Accidents to which HGVs are prone

It can be seen from the analysis that HGVs are prone to Rear-End, Side Swipe and Right Angle types of collision. The most prone to HGVs-related accidents are the Akosombo and Harbour Roads. This may be attributed to increasing proportion of HGVs in the traffic stream.

5.1.3 Challenges posed to Traffic Management due to the presence of HGVs

This report revealed of difficulty of getting parking spaces for HGVs and inadequate NMT facilities in the Metropolis as HGVs are seen parked for long period at the designated bus stops or lay bye and on the roads. This situation reduces road space and increases conflict among road users. This is also the resultant reduction in sight distance. It is therefore imperative that traffic management issues in the Metropolis must not be seen as parochial but encapsulating enough to be introduced in the planning, design and implementation of road programs aimed at addressing the problem of accidents.

5.2 Recommendations

The results of the analysis indicate that HGV-related accidents witnessed a rapid increase within the period under review. The observation is an indication of lack of traffic management parameters on the roads in the Metropolis.

It is therefore recommended that the Metropolitan Authorities should ensure the provision of traffic management measures on the roads. Also the DUR should ensure that the provision of traffic management parameters are incorporated into all future road development projects.

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LIST OF APPENDICES

APPENDIX 1: ACCIDENT DATA COLLECTION FORM

ITEM	DATE	TIME OF ACCIDENT OCCURRENCE	NO. OF PEDESTRIANS INVOLVED	NO. OF BICYCLISTS INVOLVED	NO. OF MOTOR CYCLISTS INVOLVED	NO. OF OTHER VEHICLES INVOLVED	ACCIDENT CASUALTIES			DAMAGE ONLY	ACCIDENT CAUSATION FACTOR(S)	TYPE OF ACCIDENT		LOCATION OF ACCIDENT	COLLISION TYPE
							FATAL	SERIOUS	MINOR			HGV-RELATED	OTHERS		

Appendix 2a: Manual Classified Count on Akosombo Road

Location: G.M.G

Station: MS 1 (1)

Date: 15/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/ Up, Jeep etc)**	**Mediu m Trucks**	**Heavy Truck s**	**Other s**	**Total**
(00:00-00:15)	50	27	50	57	2	1	24	25	17	4	**257**
(00:15-00.30)	64	36	36	56	0	0	24	28	19	2	**265**
(00:30-00:45)	57	35	48	79	0	0	99	30	21	3	**372**
(00:45-01:00)	66	57	49	101	0	0	30	31	25	0	**359**
(01:00-01:15)	66	66	55	90	0	0	21	24	16	0	**338**
(01:15-01:30)	79	75	48	101	1	0	34	45	23	0	**406**
(01:30-01:45)	87	57	46	123	0	0	35	49	25	0	**422**
(01:45-02:00)	77	66	38	123	0	0	21	55	21	0	**401**
(02:00-02:15)	75	44	48	123	0	0	15	53	26	0	**384**
(02:15-02:30)	80	56	43	101	0	0	27	44	25	0	**376**
(02:30-02:45)	81	68	43	90	0	0	14	48	20	0	**364**
(02:45-03:00)	76	45	36	101	0	0	33	49	26	0	**366**
(03:00-03:15)	66	55	55	123	0	0	42	43	27	0	**411**
(03:15-03:30)	66	56	58	101	0	0	24	55	36	0	**396**
(03:30-03:45)	62	64	65	101	0	0	34	44	24	0	**394**
(03:45-04:00)	69	65	57	123	0	0	24	35	33	0	**406**
(04:00-04:15)	68	65	68	68	0	0	16	42	43	0	**370**
(04:15-04:30)	77	56	70	90	0	1	24	49	50	0	**417**
(04:30-04:45)	82	67	54	79	0	0	33	56	41	0	**412**
(04:45-05:00)	58	40	68	89	0	0	12	51	52	0	**370**
(05:00-05:15)	67	46	66	77	3	6	33	52	31	0	**381**
(05:15-05:30)	79	68	66	55	2	5	31	45	34	0	**385**
(05:30-05:45)	100	80	88	77	1	3	19	49	27	0	**444**
(05:45-06:00)	99	77	66	77	6	4	20	48	28	0	**425**
(06:00-06:15)	89	65	66	79	1	3	33	50	21	0	**407**
(06:15-06:30)	79	75	80	79	2	3	20	46	21	0	**405**
(06:30-06:45)	68	59	81	57	5	2	18	44	19	0	**353**
(06:45-07:00)	91	86	77	79	4	1	44	50	25	0	**457**
(07:00-07:15)	78	88	77	57	2	0	22	51	35	0	**410**
(07:15-07:30)	86	92	76	46	3	1	32	34	32	0	**402**
(07:30-07:45)	102	89	76	34	2	3	41	60	29	0	**436**
(07:45-08:00)	90	89	66	66	1	2	29	55	22	0	**420**
(08:00-08:15)	88	88	67	86	4	1	14	44	23	0	**415**
(08:15-08:30)	94	79	86	79	3	3	24	48	33	0	**449**
(08:30-08:45)	99	90	78	110	3	4	33	44	25	0	**486**
(08:45-09:00)	101	97	68	100	0	2	24	43	24	0	**459**
(09:00-09:15)	102	78	89	68	2	5	28	47	25	0	**444**
(09:15-09:30)	110	105	77	78	2	3	16	43	22	0	**456**
(09:30-09:45)	110	74	68	78	0	1	31	48	27	2	**439**
(09:45-10:00)	102	67	90	78	0	2	16	47	24	0	**426**
(10:00-10:15)	99	82	111	89	2	5	47	34	28	0	**497**
(10:15-10:30)	106	76	62	90	4	4	56	45	23	0	**466**
(10:30-10:45)	104	90	76	89	2	7	54	45	20	0	**487**
(10:45-11:00)	103	76	67	100	1	2	47	44	19	0	**459**
(11:00-11:15)	100	76	77	112	3	9	41	50	16	0	**484**
(11:15-11:30)	100	87	63	101	0	11	50	33	23	2	**470**
(11:30-11:45)	81	101	76	68	6	14	47	24	24	0	**441**
(11:45-12:00)	64	88	77	79	1	4	61	25	24	0	**423**
Total	**3997**	**3368**	**3152**	**4107**	**68**	**112**	**1517**	**2104**	**1274**	**13**	**19712**

Appendix 2b: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1
(1)

Date:
15/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Mediu m Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	33	35	42	57	3	10	18	14	19	0	**231**
(00:15-00.30)	53	29	34	66	3	3	38	21	27	0	**274**
(12:30-12:45)	44	44	36	57	8	6	44	29	26	2	**296**
(12:45-13:00)	40	56	36	90	7	9	47	31	30	0	**346**
(13:00-13:15)	50	33	39	90	2	5	59	36	28	0	**342**
(13:15-13:30)	35	44	48	67	5	3	50	37	28	0	**317**
(13:30-13:45)	58	41	44	77	3	7	43	32	28	0	**333**
(13:45-14:00)	45	46	35	99	2	24	31	35	30	0	**347**
(14:00-14:15)	58	55	44	99	1	3	41	31	26	0	**358**
(14:15-14:30)	58	70	56	90	0	8	43	35	24	1	**385**
(14:30-14:45)	61	55	61	123	3	6	34	32	7	0	**382**
(14:45-15:00)	35	55	89	112	2	4	64	32	27	1	**421**
(15:00-15:15)	48	61	110	111	1	1	63	28	24	0	**447**
(15:15-15:30)	62	65	101	90	5	5	60	33	22	2	**445**
(15:30-15:45)	67	89	89	89	4	4	66	57	24	2	**491**
(15:45-16:00)	60	79	101	68	4	5	50	69	26	0	**462**
(16:00-16:15)	59	99	101	67	2	5	58	59	26	0	**476**
(16:15-16:30)	58	87	79	79	1	9	49	72	26	1	**461**
(16:30-16:45)	71	108	45	79	1	4	48	60	24	0	**440**
(16:45-17:00)	75	87	66	79	4	6	48	64	30	4	**463**
(17:00-17:15)	74	84	79	57	4	7	51	78	29	1	**464**
(17:15-17:30)	81	75	54	77	4	6	46	73	32	0	**448**
(17:30-17:45)	69	66	90	99	5	3	68	67	20	0	**487**
(17:45-18:00)	43	105	68	99	2	4	42	77	30	1	**471**
(18:00-18:15)	64	91	90	77	9	3	39	58	27	0	**458**
(18:15-18:30)	34	57	99	55	3	2	35	61	18	0	**364**
(18:30-18:45)	66	57	99	78	4	7	53	81	18	0	**463**
(18:45-19:00)	69	55	81	90	3	2	57	49	24	0	**430**
(19:00-19:15)	85	77	100	67	7	5	45	48	24	0	**458**
(19:15-19:30)	73	56	99	79	3	2	28	59	26	0	**425**
(19:30-19:45)	91	57	121	79	5	4	46	62	28	0	**493**
(19:45-20:00)	61	67	101	79	1	2	37	48	23	0	**419**
(20:00-20:15)	73	49	101	44	7	6	38	57	34	0	**409**
(20:15-20:30)	72	72	121	77	2	4	23	53	34	0	**458**
(20:30-20:45)	64	60	121	89	0	1	20	44	24	0	**423**
(20:45-21:00)	81	75	112	79	0	0	21	35	22	0	**425**
(21:00-21:15)	77	80	123	68	2	2	18	25	10	0	**405**
(21:15-21:30)	73	75	101	100	0	6	17	31	15	0	**418**
(21:30-21:45)	81	60	101	121	0	3	22	30	19	0	**437**
(21:45-22:00)	86	43	112	101	0	2	13	28	17	0	**402**
(22:00-22:15)	46	64	101	89	1	3	18	19	21	0	**362**
(22:15-22:30)	19	39	90	67	1	2	16	17	22	0	**273**
(22:30-22:45)	33	48	100	78	0	0	17	15	17	0	**308**
(22:45-23:00)	30	36	35	8	68	0	9	17	17	0	**220**
(23:00-23:15)	27	30	68	3	68	0	16	14	17	0	**243**
(23:15-23:30)	33	25	47	1	67	2	20	17	16	0	**228**
(23:30-23:45)	31	40	68	1	66	1	17	36	17	0	**277**
(23:45-24:00)	23	25	45	1	44	0	11	32	11	0	**192**
Total	**2729**	**2906**	**3783**	**3552**	**437**	**206**	**1797**	**2038**	**1114**	**15**	**18577**

Appendix 3a: Manual Classified Count on Akosombo Road

Location: G.M.G

Station: MS 1 (2)

Date: 16/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	23	15	66	11	0	0	1	15	8	0	**139**
(00:15-00.30)	20	7	57	22	0	0	0	25	8	0	**139**
(00:30-00:45)	25	10	57	17	0	0	19	24	13	0	**165**
(00:45-01:00)	15	7	33	20	0	0	0	13	10	0	**98**
(01:00-01:15)	17	13	88	19	0	0	0	11	13	0	**161**
(01:15-01:30)	13	7	68	20	1	0	23	24	13	0	**169**
(01:30-01:45)	21	5	57	22	0	0	21	18	13	0	**157**
(01:45-02:00)	14	5	45	17	0	0	12	10	23	0	**126**
(02:00-02:15)	12	3	55	19	0	0	16	17	18	0	**140**
(02:15-02:30)	12	3	47	21	0	0	24	24	14	0	**145**
(02:30-02:45)	5	2	88	22	0	0	19	21	24	0	**181**
(02:45-03:00)	10	2	79	20	1	0	16	17	15	0	**160**
(03:00-03:15)	9	4	89	13	0	0	21	19	23	0	**178**
(03:15-03:30)	6	1	121	26	0	0	16	15	26	0	**211**
(03:30-03:45)	11	4	79	39	1	0	17	21	22	0	**194**
(03:45-04:00)	10	3	46	30	0	0	22	20	20	0	**151**
(04:00-04:15)	21	7	44	31	0	1	19	21	16	0	**160**
(04:15-04:30)	20	7	32	33	0	0	10	15	26	0	**143**
(04:30-04:45)	31	8	21	30	0	0	11	15	20	0	**136**
(04:45-05:00)	34	18	30	38	0	0	13	16	21	0	**170**
(05:00-05:15)	36	24	43	30	0	1	16	15	17	0	**182**
(05:15-05:30)	38	19	56	32	1	0	12	14	20	0	**192**
(05:30-05:45)	81	44	91	32	0	4	12	15	30	0	**309**
(05:45-06:00)	92	79	99	31	1	0	14	9	21	1	**347**
(06:00-06:15)	123	95	135	39	4	3	23	13	34	0	**469**
(06:15-06:30)	116	73	108	33	1	3	14	16	27	4	**395**
(06:30-06:45)	139	129	110	32	6	4	16	14	36	1	**487**
(06:45-07:00)	153	145	92	35	7	1	16	16	31	3	**499**
(07:00-07:15)	107	115	80	27	4	2	21	20	15	3	**394**
(07:15-07:30)	119	156	67	29	1	4	14	7	18	2	**417**
(07:30-07:45)	102	127	85	26	3	2	11	14	36	3	**409**
(07:45-08:00)	89	119	60	31	3	2	18	17	21	2	**362**
(08:00-08:15)	99	128	81	34	3	3	15	9	30	0	**402**
(08:15-08:30)	102	127	69	31	2	0	20	13	27	0	**391**
(08:30-08:45)	78	139	68	26	4	2	7	14	20	2	**360**
(08:45-09:00)	102	104	57	20	2	1	15	12	36	4	**353**
(09:00-09:15)	94	109	83	32	33	9	13	9	36	0	**418**
(09:15-09:30)	86	126	63	90	19	1	11	9	21	3	**429**
(09:30-09:45)	125	117	74	89	43	3	17	11	21	1	**501**
(09:45-10:00)	104	109	58	89	34	6	12	18	23	0	**453**
(10:00-10:15)	135	137	90	68	45	5	25	10	21	1	**537**
(10:15-10:30)	100	113	85	98	37	4	22	12	22	0	**493**
(10:30-10:45)	75	122	73	68	32	4	35	20	21	1	**451**
(10:45-11:00)	81	110	76	79	35	2	19	11	24	1	**438**
(11:00-11:15)	71	106	62	79	27	3	19	7	20	0	**394**
(11:15-11:30)	81	90	67	77	35	3	20	11	19	2	**405**
(11:30-11:45)	108	123	75	77	23	1	18	17	13	0	**455**
(11:45-12:00)	56	83	49	55	40	0	22	9	18	0	**332**
Total	**3021**	**3099**	**3358**	**1859**	**448**	**74**	**757**	**723**	**1024**	**34**	**14397**

Appendix 3b: Manual Classified Count on Akosombo Road

Location: G.M.G

Station: MS 1 (2)

Date: 16/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	26	21	17	12	1	0	13	10	12	1	**113**
(00:15-00.30)	28	31	28	17	0	4	14	4	9	0	**135**
(12:30-12:45)	44	30	21	19	1	4	15	12	9	0	**155**
(12:45-13:00)	38	34	26	21	4	4	9	11	14	0	**161**
(13:00-13:15)	57	33	21	17	2	4	41	42	13	0	**230**
(13:15-13:30)	35	35	16	18	7	6	63	40	10	2	**232**
(13:30-13:45)	43	44	14	22	4	2	70	37	20	0	**256**
(13:45-14:00)	41	39	27	44	3	3	60	22	20	0	**259**
(14:00-14:15)	59	44	22	57	0	2	41	26	36	2	**289**
(14:15-14:30)	65	54	44	54	4	3	39	24	30	0	**317**
(14:30-14:45)	61	59	20	54	5	0	47	25	25	2	**298**
(14:45-15:00)	66	50	16	79	3	4	44	21	26	3	**312**
(15:00-15:15)	51	58	20	43	8	2	75	24	26	1	**308**
(15:15-15:30)	70	63	17	55	4	13	59	22	27	2	**332**
(15:30-15:45)	70	69	33	101	13	37	31	14	24	0	**392**
(15:45-16:00)	77	78	27	101	14	6	48	27	24	0	**402**
(16:00-16:15)	69	70	35	68	11	4	49	23	29	3	**361**
(16:15-16:30)	83	64	27	57	17	7	43	29	23	1	**351**
(16:30-16:45)	83	71	33	68	17	6	48	23	21	0	**370**
(16:45-17:00)	92	76	75	68	10	5	39	29	35	1	**430**
(17:00-17:15)	88	69	107	78	7	2	38	17	24	2	**432**
(17:15-17:30)	71	60	102	44	15	5	43	22	36	0	**398**
(17:30-17:45)	55	57	76	44	16	4	46	18	30	3	**349**
(17:45-18:00)	64	70	71	38	12	4	39	19	24	1	**342**
(18:00-18:15)	48	55	72	49	15	5	35	20	26	0	**325**
(18:15-18:30)	37	60	35	59	17	8	37	28	24	2	**307**
(18:30-18:45)	53	101	39	53	9	4	23	22	23	1	**328**
(18:45-19:00)	55	124	36	27	10	4	14	16	24	1	**311**
(19:00-19:15)	54	131	51	27	23	1	25	17	29	1	**359**
(19:15-19:30)	46	136	43	30	9	9	28	14	25	0	**340**
(19:30-19:45)	63	110	47	28	6	5	27	19	31	1	**337**
(19:45-20:00)	43	132	44	36	1	3	19	10	24	0	**312**
(20:00-20:15)	46	87	21	32	2	4	22	4	28	2	**248**
(20:15-20:30)	47	91	47	29	0	2	26	12	35	4	**293**
(20:30-20:45)	51	90	59	26	1	0	36	8	25	0	**296**
(20:45-21:00)	60	74	26	18	4	1	17	7	37	1	**245**
(21:00-21:15)	49	80	40	18	1	1	17	6	26	0	**238**
(21:15-21:30)	61	74	35	19	4	1	14	6	28	2	**244**
(21:30-21:45)	60	69	20	11	1	1	19	6	28	3	**218**
(21:45-22:00)	59	56	27	12	0	0	20	10	25	0	**209**
(22:00-22:15)	68	57	19	39	0	1	8	7	24	0	**223**
(22:15-22:30)	43	35	11	14	1	2	5	3	30	1	**145**
(22:30-22:45)	50	34	14	21	2	0	8	6	24	0	**159**
(22:45-23:00)	56	33	15	16	0	0	6	2	25	0	**153**
(23:00-23:15)	24	20	11	8	0	0	8	3	26	0	**100**
(23:15-23:30)	43	18	5	29	0	0	7	3	26	0	**131**
(23:30-23:45)	31	20	6	27	0	1	3	2	27	0	**117**
(23:45-24:00)	36	13	7	28	0	0	5	2	17	0	**108**
Total	**2619**	**2979**	**1625**	**1835**	**284**	**184**	**1443**	**774**	**1184**	**43**	**12970**

Appendix4a: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (3)
Date: 17/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	25	27	15	30	9	12	20	37	19	1	**195**
(00:15-00.30)	20	34	17	57	0	0	15	21	25	0	**189**
(00:30-00:45)	17	28	14	7	0	0	16	29	38	0	**149**
(00:45-01:00)	22	30	15	57	0	0	30	33	25	0	**212**
(01:00-01:15)	28	26	17	56	0	1	42	34	34	0	**238**
(01:15-01:30)	5	54	15	57	0	0	15	14	30	0	**190**
(01:30-01:45)	16	70	14	67	0	0	20	40	43	0	**270**
(01:45-02:00)	34	56	19	57	0	0	31	17	58	0	**272**
(02:00-02:15)	30	74	17	57	0	0	13	15	45	0	**251**
(02:15-02:30)	31	44	22	35	0	0	42	19	54	0	**247**
(02:30-02:45)	42	50	16	57	0	0	10	16	44	0	**235**
(02:45-03:00)	27	54	22	46	0	0	21	24	51	0	**245**
(03:00-03:15)	20	52	24	35	0	0	10	13	46	0	**200**
(03:15-03:30)	44	54	26	44	0	0	18	15	49	0	**250**
(03:30-03:45)	24	56	31	35	5	7	16	16	49	0	**239**
(03:45-04:00)	35	60	19	66	0	0	17	17	52	0	**266**
(04:00-04:15)	48	56	17	56	0	0	28	17	43	0	**265**
(04:15-04:30)	47	76	28	57	0	1	19	20	45	0	**293**
(04:30-04:45)	21	58	44	35	0	0	21	20	47	0	**246**
(04:45-05:00)	33	80	44	35	4	1	25	19	50	1	**292**
(05:00-05:15)	33	70	46	68	6	0	17	15	51	0	**306**
(05:15-05:30)	44	64	46	57	1	2	31	19	50	1	**315**
(05:30-05:45)	32	52	58	46	3	1	20	13	43	0	**268**
(05:45-06:00)	39	58	70	10	9	0	35	33	47	0	**301**
(06:00-06:15)	26	84	61	26	3	1	20	29	49	0	**299**
(06:15-06:30)	38	88	33	30	5	0	45	41	48	2	**330**
(06:30-06:45)	27	82	54	11	8	3	29	30	52	0	**296**
(06:45-07:00)	48	80	52	17	29	1	22	26	24	3	**302**
(07:00-07:15)	37	48	62	33	39	8	31	27	26	0	**311**
(07:15-07:30)	43	96	49	17	10	4	25	35	20	0	**299**
(07:30-07:45)	39	78	57	22	21	3	24	42	19	0	**305**
(07:45-08:00)	37	52	50	13	28	7	49	40	17	1	**294**
(08:00-08:15)	39	71	45	21	23	11	21	33	13	0	**277**
(08:15-08:30)	33	88	45	20	32	10	28	31	23	0	**310**
(08:30-08:45)	47	80	36	23	10	4	26	26	27	0	**279**
(08:45-09:00)	19	88	39	22	13	9	32	25	17	0	**264**
(09:00-09:15)	45	94	64	16	9	3	21	21	20	0	**293**
(09:15-09:30)	27	80	51	22	12	5	30	33	27	0	**287**
(09:30-09:45)	25	74	57	19	13	14	21	29	26	0	**278**
(09:45-10:00)	33	67	52	25	12	4	21	18	23	0	**255**
(10:00-10:15)	44	58	40	15	6	2	31	31	26	0	**253**
(10:15-10:30)	31	54	32	23	1	3	32	24	25	0	**225**
(10:30-10:45)	35	91	30	19	10	7	23	28	21	0	**264**
(10:45-11:00)	32	80	31	10	11	4	18	24	13	0	**223**
(11:00-11:15)	37	82	45	18	6	7	23	22	16	0	**256**
(11:15-11:30)	26	68	35	14	10	5	24	24	27	1	**234**
(11:30-11:45)	36	89	35	18	5	5	23	21	17	0	**249**
(11:45-12:00)	30	90	36	20	6	1	12	16	20	1	**232**
Total	**1551**	**3145**	**1747**	**1601**	**359**	**146**	**1163**	**1192**	**1634**	**11**	**12549**

Appendix 4b: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (3)
Date: 17/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/ Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	17	34	54	45	7	4	30	35	35	0	**261**
(00:15-00.30)	15	30	28	78	8	6	30	44	49	0	**288**
(12:30-12:45)	21	28	32	90	8	2	22	17	46	0	**266**
(12:45-13:00)	27	32	38	79	10	3	30	30	49	2	**300**
(13:00-13:15)	28	34	60	57	7	3	34	26	45	0	**294**
(13:15-13:30)	29	28	74	67	8	3	30	33	50	0	**322**
(13:30-13:45)	35	30	43	68	13	4	22	30	45	0	**290**
(13:45-14:00)	32	50	44	89	3	0	26	33	30	3	**310**
(14:00-14:15)	36	79	54	99	6	2	32	20	35	2	**365**
(14:15-14:30)	43	116	43	66	7	4	23	24	33	0	**359**
(14:30-14:45)	34	96	62	56	3	3	34	27	43	1	**359**
(14:45-15:00)	34	108	65	56	4	0	45	44	45	1	**402**
(15:00-15:15)	34	96	32	56	3	3	27	19	33	1	**304**
(15:15-15:30)	28	140	57	78	5	4	27	34	46	0	**419**
(15:30-15:45)	27	128	63	99	7	0	22	20	22	1	**389**
(15:45-16:00)	32	133	32	99	3	2	16	18	34	2	**371**
(16:00-16:15)	67	131	71	77	7	3	35	35	44	0	**470**
(16:15-16:30)	58	99	52	78	5	2	19	27	45	1	**386**
(16:30-16:45)	32	98	46	90	7	5	17	19	21	0	**335**
(16:45-17:00)	34	54	51	79	10	7	20	37	22	2	**316**
(17:00-17:15)	42	70	41	78	11	8	17	14	11	0	**292**
(17:15-17:30)	46	62	34	90	15	7	30	18	37	0	**339**
(17:30-17:45)	32	70	28	88	12	8	28	23	34	1	**324**
(17:45-18:00)	35	48	63	56	15	8	26	17	27	3	**298**
(18:00-18:15)	22	48	58	67	6	4	47	16	27	0	**295**
(18:15-18:30)	32	42	52	66	4	0	16	18	30	0	**260**
(18:30-18:45)	32	44	99	77	3	5	44	35	35	0	**374**
(18:45-19:00)	33	24	110	77	7	10	23	45	43	0	**372**
(19:00-19:15)	37	68	100	99	1	5	31	28	30	0	**399**
(19:15-19:30)	35	42	144	90	5	12	27	47	53	0	**455**
(19:30-19:45)	32	50	138	89	10	4	42	27	43	0	**435**
(19:45-20:00)	40	56	150	77	9	5	32	23	46	0	**438**
(20:00-20:15)	37	64	125	77	5	9	46	21	25	0	**409**
(20:15-20:30)	33	52	103	77	8	12	50	23	44	0	**402**
(20:30-20:45)	32	32	107	56	4	9	35	24	45	0	**344**
(20:45-21:00)	20	34	67	66	2	13	36	42	46	0	**326**
(21:00-21:15)	23	46	83	77	2	4	29	11	22	0	**297**
(21:15-21:30)	34	54	71	78	6	2	23	30	20	0	**318**
(21:30-21:45)	35	42	48	112	4	9	20	15	33	0	**318**
(21:45-22:00)	26	34	33	122	2	3	27	34	34	0	**315**
(22:00-22:15)	29	40	50	121	0	3	25	7	14	0	**289**
(22:15-22:30)	33	36	45	88	0	4	16	10	12	0	**244**
(22:30-22:45)	19	34	46	66	4	7	20	3	5	0	**204**
(22:45-23:00)	46	40	73	77	1	10	45	37	44	0	**373**
(23:00-23:15)	36	72	53	90	0	5	10	12	30	0	**308**
(23:15-23:30)	43	48	29	90	0	4	23	19	26	0	**282**
(23:30-23:45)	19	49	21	79	0	2	13	12	15	0	**210**
(23:45-24:00)	22	32	35	68	0	5	21	29	34	0	**246**
Total	**1568**	**2877**	**3007**	**3804**	**267**	**237**	**1343**	**1212**	**1637**	**20**	**15972**

Appendix 5a: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (4)
Date: 18/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	25	88	55	44	0	0	31	42	21	0	**306**
(00:15-00.30)	20	85	68	77	0	0	36	45	43	0	**374**
(00:30-00:45)	30	79	66	77	0	0	27	30	43	0	**352**
(00:45-01:00)	41	55	50	66	0	0	27	20	42	0	**301**
(01:00-01:15)	32	68	78	77	0	0	33	14	42	0	**344**
(01:15-01:30)	46	88	48	68	0	0	33	44	34	0	**361**
(01:30-01:45)	28	56	65	79	0	1	21	21	27	0	**298**
(01:45-02:00)	28	66	45	90	0	0	21	39	38	0	**327**
(02:00-02:15)	33	76	70	79	0	0	21	20	35	0	**334**
(02:15-02:30)	44	67	32	57	0	0	20	33	45	0	**298**
(02:30-02:45)	44	67	68	57	0	0	28	34	35	0	**333**
(02:45-03:00)	44	79	64	46	0	0	20	35	35	1	**324**
(03:00-03:15)	40	67	67	45	0	0	16	21	18	0	**274**
(03:15-03:30)	30	62	51	34	0	1	21	10	24	0	**233**
(03:30-03:45)	49	77	60	77	0	0	31	32	16	0	**342**
(03:45-04:00)	50	77	60	99	0	1	18	31	14	0	**350**
(04:00-04:15)	57	56	66	110	0	0	8	35	42	0	**374**
(04:15-04:30)	46	86	39	99	0	0	20	21	24	0	**335**
(04:30-04:45)	53	77	49	88	0	1	9	34	35	0	**346**
(04:45-05:00)	60	77	67	99	0	1	28	24	44	0	**400**
(05:00-05:15)	71	57	67	77	0	0	34	35	33	0	**374**
(05:15-05:30)	57	77	77	55	1	2	29	24	25	0	**347**
(05:30-05:45)	43	68	59	77	2	0	28	28	15	1	**321**
(05:45-06:00)	60	77	70	99	10	5	18	18	22	1	**380**
(06:00-06:15)	50	83	83	133	12	3	17	30	30	0	**441**
(06:15-06:30)	50	111	85	145	6	5	34	19	17	1	**473**
(06:30-06:45)	47	149	86	145	15	3	42	22	12	0	**521**
(06:45-07:00)	71	150	95	133	22	3	40	20	12	0	**546**
(07:00-07:15)	65	151	83	111	16	9	29	19	10	0	**493**
(07:15-07:30)	60	169	82	121	12	8	39	24	4	0	**519**
(07:30-07:45)	39	155	74	133	8	6	38	10	6	0	**469**
(07:45-08:00)	50	173	83	121	18	11	36	15	14	0	**521**
(08:00-08:15)	51	111	65	66	66	1	25	26	11	1	**423**
(08:15-08:30)	44	135	72	77	10	6	30	40	10	0	**424**
(08:30-08:45)	41	162	62	88	10	2	46	32	15	1	**459**
(08:45-09:00)	48	137	64	99	13	5	30	30	15	0	**441**
(09:00-09:15)	51	135	66	110	9	4	35	25	8	0	**443**
(09:15-09:30)	46	112	60	110	5	3	30	16	10	0	**392**
(09:30-09:45)	29	142	58	89	2	6	49	27	15	0	**417**
(09:45-10:00)	39	163	54	89	1	11	54	40	30	2	**483**
(10:00-10:15)	25	147	38	89	7	1	57	35	28	0	**427**
(10:15-10:30)	20	119	162	77	4	34	32	16	22	0	**486**
(10:30-10:45)	30	124	59	79	9	4	50	23	25	0	**403**
(10:45-11:00)	48	117	55	88	12	5	51	17	8	1	**402**
(11:00-11:15)	59	143	67	110	6	2	40	15	7	1	**450**
(11:15-11:30)	60	141	47	110	9	29	63	20	2	0	**481**
(11:30-11:45)	55	130	57	121	9	4	45	47	13	0	**481**
(11:45-12:00)	40	130	47	144	16	4	31	39	17	0	**468**
Total	**2149**	**5021**	**3145**	**4364**	**310**	**181**	**1521**	**1297**	**1093**	**10**	**19091**

Appendix 5b: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (4)
Date: 18/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	102	148	64	55	7	4	49	11	40	0	**480**
(00:15-00.30)	84	135	61	44	13	8	47	14	36	1	**443**
(12:30-12:45)	115	138	68	78	3	10	65	19	38	0	**534**
(12:45-13:00)	112	149	76	88	3	6	45	9	43	0	**531**
(13:00-13:15)	99	143	60	88	10	4	55	12	50	0	**521**
(13:15-13:30)	105	124	53	90	2	1	53	13	41	1	**483**
(13:30-13:45)	110	131	58	100	11	3	42	14	36	0	**505**
(13:45-14:00)	112	119	60	121	7	0	52	12	36	0	**519**
(14:00-14:15)	113	102	47	99	3	0	44	25	36	0	**469**
(14:15-14:30)	73	94	48	121	5	2	49	27	51	0	**470**
(14:30-14:45)	72	121	30	79	3	5	43	20	50	0	**423**
(14:45-15:00)	103	138	30	68	8	5	44	25	49	0	**470**
(15:00-15:15)	80	121	63	78	13	5	61	29	47	0	**497**
(15:15-15:30)	74	123	70	99	11	7	43	26	53	0	**506**
(15:30-15:45)	75	124	68	99	13	5	51	35	61	0	**531**
(15:45-16:00)	66	128	72	132	4	7	43	32	55	0	**539**
(16:00-16:15)	83	148	48	122	10	4	58	28	57	0	**558**
(16:15-16:30)	81	155	54	44	13	4	60	32	66	1	**510**
(16:30-16:45)	107	197	70	68	5	1	62	27	69	1	**607**
(16:45-17:00)	83	167	65	68	14	7	39	37	57	1	**538**
(17:00-17:15)	54	135	50	55	11	8	36	17	52	0	**418**
(17:15-17:30)	55	150	49	55	15	8	39	19	65	0	**455**
(17:30-17:45)	81	183	63	78	21	7	43	20	43	0	**539**
(17:45-18:00)	73	170	53	100	22	10	50	21	47	0	**546**
(18:00-18:15)	116	162	96	132	10	13	68	43	56	0	**696**
(18:15-18:30)	125	159	98	144	4	7	55	40	47	0	**679**
(18:30-18:45)	83	120	98	134	4	9	72	52	26	0	**598**
(18:45-19:00)	89	124	93	144	2	8	63	54	28	0	**605**
(19:00-19:15)	98	133	102	166	1	5	71	64	23	0	**663**
(19:15-19:30)	98	118	107	165	0	2	70	54	26	0	**640**
(19:30-19:45)	108	166	105	733	5	9	46	23	25	0	**1220**
(19:45-20:00)	81	125	55	111	3	9	37	14	27	0	**462**
(20:00-20:15)	73	110	53	112	5	5	24	7	12	0	**401**
(20:15-20:30)	74	102	44	100	3	0	22	14	21	0	**380**
(20:30-20:45)	44	112	40	79	3	1	18	8	24	0	**329**
(20:45-21:00)	63	114	33	89	1	2	17	5	35	0	**359**
(21:00-21:15)	61	91	34	88	2	1	10	5	28	0	**320**
(21:15-21:30)	53	87	37	99	8	2	18	4	28	0	**336**
(21:30-21:45)	54	70	22	143	0	4	16	4	37	0	**350**
(21:45-22:00)	51	79	15	121	1	2	17	7	28	0	**321**
(22:00-22:15)	51	84	18	77	1	1	15	5	29	0	**281**
(22:15-22:30)	37	83	16	77	1	3	21	0	25	0	**263**
(22:30-22:45)	42	72	14	99	4	5	18	5	31	0	**290**
(22:45-23:00)	42	59	14	55	0	1	12	2	30	0	**215**
(23:00-23:15)	24	33	8	77	2	0	2	2	12	0	**160**
(23:15-23:30)	25	33	8	46	1	0	10	2	5	0	**130**
(23:30-23:45)	32	27	4	68	0	0	4	0	1	0	**136**
(23:45-24:00)	33	19	1	68	0	0	6	3	4	0	**134**
Total	**3669**	**5625**	**2495**	**5156**	**288**	**210**	**1885**	**941**	**1786**	**5**	**22060**

Appendix 6a: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (5)
Date: 19/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	58	44	46	35	0	0	28	33	33	0	**277**
(00:15-00.30)	60	57	44	35	0	0	30	34	41	0	**301**
(00:30-00:45)	60	55	45	44	0	0	20	88	18	0	**330**
(00:45-01:00)	56	48	46	44	0	1	33	34	32	0	**294**
(01:00-01:15)	76	67	33	55	0	0	21	46	21	0	**319**
(01:15-01:30)	79	46	68	55	0	0	17	33	46	0	**344**
(01:30-01:45)	89	68	46	57	0	0	33	28	30	0	**351**
(01:45-02:00)	67	37	41	57	0	0	24	33	32	0	**291**
(02:00-02:15)	67	78	56	57	0	0	42	33	31	0	**364**
(02:15-02:30)	76	57	66	66	0	0	16	15	13	0	**309**
(02:30-02:45)	67	76	56	79	0	0	14	19	30	0	**341**
(02:45-03:00)	45	57	57	67	0	0	20	12	16	0	**274**
(03:00-03:15)	68	68	45	68	0	0	34	24	49	0	**356**
(03:15-03:30)	78	46	45	79	0	0	30	14	36	0	**328**
(03:30-03:45)	88	49	46	57	0	0	28	17	17	0	**302**
(03:45-04:00)	51	37	37	57	1	0	12	26	7	2	**230**
(04:00-04:15)	75	68	46	90	1	1	24	34	46	0	**385**
(04:15-04:30)	57	57	44	67	1	0	15	30	24	0	**295**
(04:30-04:45)	89	46	67	67	0	0	12	12	15	0	**308**
(04:45-05:00)	68	55	45	67	2	0	33	24	39	0	**333**
(05:00-05:15)	60	40	39	67	1	1	12	5	12	0	**237**
(05:15-05:30)	62	21	46	57	6	0	5	7	9	0	**213**
(05:30-05:45)	55	36	52	68	6	0	5	7	15	0	**244**
(05:45-06:00)	91	42	60	69	13	1	15	7	23	0	**321**
(06:00-06:15)	90	75	88	57	8	1	17	10	19	0	**365**
(06:15-06:30)	102	103	103	67	8	4	22	11	30	0	**450**
(06:30-06:45)	109	131	105	68	2	4	26	16	28	0	**489**
(06:45-07:00)	139	200	116	78	5	6	13	20	14	0	**591**
(07:00-07:15)	123	179	112	67	4	4	22	21	16	1	**549**
(07:15-07:30)	112	156	108	68	3	7	22	19	18	0	**513**
(07:30-07:45)	114	140	101	57	2	8	20	9	12	0	**463**
(07:45-08:00)	112	120	110	55	7	1	28	9	12	0	**454**
(08:00-08:15)	135	151	123	77	4	7	27	8	7	0	**539**
(08:15-08:30)	104	108	72	56	4	3	31	13	17	2	**410**
(08:30-08:45)	130	152	94	56	4	5	23	13	8	0	**485**
(08:45-09:00)	115	133	80	68	4	4	28	11	15	0	**458**
(09:00-09:15)	96	142	69	45	7	2	23	20	29	1	**434**
(09:15-09:30)	90	134	73	44	5	7	39	30	16	0	**438**
(09:30-09:45)	100	163	81	44	8	9	38	33	26	1	**503**
(09:45-10:00)	94	171	74	23	5	2	38	20	29	1	**457**
(10:00-10:15)	101	150	64	44	2	6	35	33	27	1	**463**
(10:15-10:30)	110	142	48	55	0	7	38	33	27	0	**460**
(10:30-10:45)	92	158	55	67	3	4	29	22	24	0	**454**
(10:45-11:00)	76	130	75	68	5	5	22	20	18	0	**419**
(11:00-11:15)	83	137	64	57	3	6	25	21	24	0	**420**
(11:15-11:30)	70	123	54	56	2	4	24	15	15	1	**364**
(11:30-11:45)	78	132	46	66	2	6	28	16	18	2	**394**
(11:45-12:00)	90	126	76	55	5	5	29	13	19	0	**418**
Total	**4107**	**4611**	**3167**	**2862**	**133**	**121**	**1170**	**1051**	**1103**	**12**	**18337**

Appendix 6b: Manual Classified Count on Akosombo Road

Location: G.M.G
Station: MS 1 (5)
Date: 19/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	50	38	67	24	6	4	24	35	46	1	**295**
(00:15-00.30)	40	32	79	19	3	1	37	40	43	0	**294**
(12:30-12:45)	62	52	86	8	8	7	37	38	33	1	**332**
(12:45-13:00)	82	32	72	7	6	8	24	39	44	0	**314**
(13:00-13:15)	64	50	58	7	7	2	55	27	19	0	**289**
(13:15-13:30)	52	58	62	2	8	6	36	32	15	0	**271**
(13:30-13:45)	70	52	86	8	3	8	26	38	47	0	**338**
(13:45-14:00)	58	58	79	8	5	5	28	46	51	0	**338**
(14:00-14:15)	81	38	69	8	2	9	25	30	38	0	**300**
(14:15-14:30)	66	40	76	12	1	3	32	35	37	0	**302**
(14:30-14:45)	70	66	67	10	1	5	47	29	31	1	**327**
(14:45-15:00)	56	120	73	8	3	8	22	46	38	0	**374**
(15:00-15:15)	70	150	48	1	2	1	11	6	14	0	**303**
(15:15-15:30)	54	170	62	9	0	3	31	10	34	0	**373**
(15:30-15:45)	59	137	57	4	0	4	25	14	41	0	**341**
(15:45-16:00)	84	149	68	6	13	4	16	9	37	0	**386**
(16:00-16:15)	107	204	91	18	7	7	41	10	49	0	**534**
(16:15-16:30)	132	177	64	38	7	3	30	5	67	0	**523**
(16:30-16:45)	119	150	27	5	4	5	16	4	8	0	**338**
(16:45-17:00)	153	138	73	9	12	6	6	39	39	0	**475**
(17:00-17:15)	150	145	93	8	5	5	12	9	15	0	**442**
(17:15-17:30)	173	146	78	6	12	12	22	7	29	0	**485**
(17:30-17:45)	141	150	82	6	9	6	17	12	34	0	**457**
(17:45-18:00)	127	127	84	9	4	7	14	8	31	1	**412**
(18:00-18:15)	103	140	72	21	12	11	52	11	13	0	**435**
(18:15-18:30)	99	126	25	23	8	8	54	19	34	0	**396**
(18:30-18:45)	81	137	38	44	5	9	60	31	52	0	**457**
(18:45-19:00)	70	136	17	45	3	6	64	49	54	0	**444**
(19:00-19:15)	56	79	12	47	4	7	59	41	52	0	**357**
(19:15-19:30)	30	81	20	46	6	5	70	51	47	0	**356**
(19:30-19:45)	62	72	28	49	2	5	439	39	39	0	**735**
(19:45-20:00)	46	60	49	42	0	9	50	34	34	0	**324**
(20:00-20:15)	39	62	30	32	2	5	49	21	39	0	**279**
(20:15-20:30)	58	54	29	26	0	2	38	19	28	0	**254**
(20:30-20:45)	51	60	38	21	2	3	24	15	31	0	**245**
(20:45-21:00)	54	45	45	17	1	2	31	12	13	0	**220**
(21:00-21:15)	49	42	37	10	3	2	16	7	11	0	**177**
(21:15-21:30)	43	40	31	15	0	4	8	6	15	0	**162**
(21:30-21:45)	52	53	30	8	4	0	17	9	8	0	**181**
(21:45-22:00)	48	32	23	7	1	1	10	3	10	0	**135**
(22:00-22:15)	35	41	29	13	1	1	16	7	10	0	**153**
(22:15-22:30)	36	35	20	15	0	1	12	3	5	0	**127**
(22:30-22:45)	37	41	18	10	3	4	16	4	11	0	**144**
(22:45-23:00)	48	39	18	15	0	2	14	5	9	0	**150**
(23:00-23:15)	30	33	8	12	0	1	8	3	6	0	**101**
(23:15-23:30)	34	38	12	6	1	0	6	2	4	0	**103**
(23:30-23:45)	33	40	3	3	0	2	3	2	2	0	**88**
(23:45-24:00)	25	25	5	2	0	2	3	2	4	0	**68**
Total	**3339**	**3990**	**2338**	**769**	**186**	**221**	**1753**	**963**	**1371**	**4**	**14934**

Appendix 7a: Manual Classified Count on Harbour Road

Location: Sakumono Lagoon
Station: MS 2 (1)
Date: 22/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	34	13	13	24	0	0	3	7	5	0	**99**
(00:15-00.30)	36	12	10	35	0	0	1	9	9	0	**112**
(00:30-00:45)	28	17	20	35	0	0	2	7	7	0	**116**
(00:45-01:00)	42	17	16	42	0	0	0	13	13	0	**143**
(01:00-01:15)	44	15	20	46	0	0	0	9	9	0	**143**
(01:15-01:30)	42	31	13	57	0	0	0	14	12	0	**169**
(01:30-01:45)	34	17	30	44	0	0	1	9	11	0	**146**
(01:45-02:00)	36	13	14	56	0	0	0	13	12	0	**144**
(02:00-02:15)	50	33	28	55	0	0	2	12	21	0	**201**
(02:15-02:30)	56	24	17	33	0	0	1	17	20	0	**168**
(02:30-02:45)	50	28	25	34	0	0	0	12	11	0	**160**
(02:45-03:00)	48	17	35	46	0	0	1	22	16	0	**185**
(03:00-03:15)	56	35	31	46	0	0	2	18	23	0	**211**
(03:15-03:30)	52	35	20	57	0	0	5	15	17	0	**201**
(03:30-03:45)	52	51	12	35	0	0	1	9	17	0	**177**
(03:45-04:00)	54	22	34	24	0	0	5	25	17	0	**181**
(04:00-04:15)	58	21	35	24	0	0	3	21	21	0	**183**
(04:15-04:30)	80	32	33	56	0	0	2	16	15	0	**234**
(04:30-04:45)	50	31	44	77	0	0	1	20	24	0	**247**
(04:45-05:00)	44	40	35	55	0	0	1	15	23	0	**213**
(05:00-05:15)	56	50	40	67	0	1	1	13	24	0	**252**
(05:15-05:30)	59	33	48	46	0	0	8	17	30	0	**241**
(05:30-05:45)	75	31	33	48	2	3	6	10	17	0	**225**
(05:45-06:00)	44	57	28	78	3	2	5	9	24	0	**250**
(06:00-06:15)	48	31	37	67	4	5	9	10	23	0	**234**
(06:15-06:30)	55	20	28	77	4	3	12	14	25	0	**238**
(06:30-06:45)	64	66	43	55	2	2	17	9	23	0	**281**
(06:45-07:00)	52	68	37	77	5	3	23	16	24	0	**305**
(07:00-07:15)	44	70	44	56	3	0	23	16	21	0	**277**
(07:15-07:30)	58	40	42	21	1	1	16	18	24	0	**221**
(07:30-07:45)	49	58	56	39	1	7	21	19	20	0	**270**
(07:45-08:00)	59	79	57	29	3	2	31	17	28	0	**305**
(08:00-08:15)	52	62	60	27	2	9	36	25	28	0	**301**
(08:15-08:30)	60	57	79	34	2	3	28	24	20	0	**307**
(08:30-08:45)	63	71	68	30	0	6	42	22	24	0	**326**
(08:45-09:00)	48	63	78	34	0	5	20	23	24	0	**295**
(09:00-09:15)	55	59	101	43	1	3	31	22	24	0	**339**
(09:15-09:30)	48	66	98	38	0	2	35	26	30	0	**343**
(09:30-09:45)	50	61	101	43	2	5	21	24	31	0	**338**
(09:45-10:00)	47	62	90	36	2	3	51	34	26	0	**351**
(10:00-10:15)	48	57	90	43	1	0	23	24	17	0	**303**
(10:15-10:30)	39	37	101	44	4	3	33	25	24	0	**310**
(10:30-10:45)	49	62	78	29	0	6	46	25	20	0	**315**
(10:45-11:00)	65	61	79	29	1	3	34	24	24	0	**320**
(11:00-11:15)	44	67	68	34	3	55	11	27	17	0	**326**
(11:15-11:30)	52	46	79	27	0	11	36	27	21	0	**299**
(11:30-11:45)	48	56	71	23	0	6	36	24	20	0	**284**
(11:45-12:00)	48	35	69	43	0	11	31	24	20	0	**281**
Total	**2425**	**2029**	**2288**	**2098**	**46**	**160**	**717**	**851**	**956**	**0**	**11570**

Appendix7b: Manual Classified Count on Harbour Road

Location: Sakumono Lagoon
Station: MS 2 (1)
Date: 22/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	16	28	45	14	0	2	35	7	4	0	**151**
(00:15-00.30)	19	24	46	7	2	5	42	7	7	0	**159**
(12:30-12:45)	16	34	76	14	1	3	35	14	8	0	**201**
(12:45-13:00)	21	28	30	17	0	2	60	13	7	0	**178**
(13:00-13:15)	25	26	41	14	8	3	35	13	8	0	**173**
(13:15-13:30)	27	34	78	17	4	2	27	8	11	0	**208**
(13:30-13:45)	17	34	83	16	6	5	38	9	11	0	**219**
(13:45-14:00)	36	38	80	32	1	3	52	8	14	0	**264**
(14:00-14:15)	31	83	51	45	5	7	12	11	16	0	**261**
(14:15-14:30)	28	102	82	45	1	2	62	7	14	0	**343**
(14:30-14:45)	31	124	117	56	0	2	61	13	10	0	**414**
(14:45-15:00)	44	144	77	46	1	2	55	11	25	0	**405**
(15:00-15:15)	37	158	62	44	0	4	71	15	29	0	**420**
(15:15-15:30)	47	170	46	57	0	0	49	30	28	0	**427**
(15:30-15:45)	47	155	57	44	0	2	43	52	24	0	**424**
(15:45-16:00)	59	178	65	44	3	5	81	47	24	0	**506**
(16:00-16:15)	70	183	125	44	5	8	66	50	15	0	**566**
(16:15-16:30)	74	159	68	66	2	9	46	43	17	0	**484**
(16:30-16:45)	67	158	73	66	1	8	79	50	17	0	**519**
(16:45-17:00)	84	143	37	66	2	2	62	44	14	0	**454**
(17:00-17:15)	90	156	73	88	3	5	56	41	15	0	**527**
(17:15-17:30)	94	150	63	66	5	16	88	24	24	0	**530**
(17:30-17:45)	69	147	72	89	19	15	62	47	25	0	**545**
(17:45-18:00)	60	136	65	66	5	10	10	45	28	0	**425**
(18:00-18:15)	31	113	24	56	3	3	16	43	21	0	**310**
(18:15-18:30)	31	98	45	46	4	1	14	26	15	0	**280**
(18:30-18:45)	32	94	55	57	2	0	81	35	17	0	**373**
(18:45-19:00)	48	83	72	68	3	1	65	15	18	0	**373**
(19:00-19:15)	38	72	37	68	0	3	32	14	24	0	**288**
(19:15-19:30)	31	69	35	77	0	2	26	13	25	0	**278**
(19:30-19:45)	35	49	29	57	0	0	33	11	14	0	**228**
(19:45-20:00)	19	43	29	61	0	0	34	10	24	0	**220**
(20:00-20:15)	28	48	13	35	2	2	14	13	28	0	**183**
(20:15-20:30)	9	48	12	29	0	2	10	17	29	0	**156**
(20:30-20:45)	10	38	13	34	0	0	8	11	24	0	**138**
(20:45-21:00)	11	30	8	29	0	0	15	21	24	0	**138**
(21:00-21:15)	22	38	14	27	2	2	12	20	24	0	**161**
(21:15-21:30)	14	42	11	32	0	1	9	9	17	0	**135**
(21:30-21:45)	11	27	2	40	0	0	3	15	15	0	**113**
(21:45-22:00)	21	28	6	28	0	0	16	26	21	0	**146**
(22:00-22:15)	11	24	8	17	0	2	4	26	24	0	**116**
(22:15-22:30)	15	17	13	16	0	0	7	24	24	0	**116**
(22:30-22:45)	10	15	12	16	0	0	5	35	24	0	**117**
(22:45-23:00)	6	26	3	18	0	0	3	22	20	0	**98**
(23:00-23:15)	8	22	7	15	0	0	1	0	25	0	**78**
(23:15-23:30)	5	27	2	32	0	0	1	1	25	0	**93**
(23:30-23:45)	6	26	15	18	0	0	4	0	27	0	**96**
(23:45-24:00)	6	25	2	21	0	1	1	0	32	0	**88**
Total	**1567**	**3694**	**2079**	**1960**	**90**	**142**	**1641**	**1016**	**936**	**0**	**13125**

Appendix 8a: Manual Classified Count on Harbour Road

Location: Sakumono Lagoon
Station: MS 2 (2)
Date: 26/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	67	25	56	46	0	0	4	11	7	0	**216**
(00:15-00.30)	46	19	23	66	0	0	3	7	6	0	**170**
(00:30-00:45)	47	25	46	68	0	0	3	11	14	0	**214**
(00:45-01:00)	35	34	35	66	0	0	0	9	10	0	**189**
(01:00-01:15)	35	21	46	46	0	0	1	8	18	0	**175**
(01:15-01:30)	48	32	55	56	0	0	1	10	13	0	**215**
(01:30-01:45)	56	28	45	67	0	0	3	7	12	0	**218**
(01:45-02:00)	47	33	35	88	0	0	1	11	21	0	**236**
(02:00-02:15)	23	37	47	90	0	0	0	13	11	0	**221**
(02:15-02:30)	1	67	57	78	0	0	0	8	17	0	**228**
(02:30-02:45)	0	78	68	77	0	0	1	10	22	0	**256**
(02:45-03:00)	0	89	57	68	0	0	0	18	17	0	**249**
(03:00-03:15)	0	99	44	68	0	0	0	31	20	0	**262**
(03:15-03:30)	0	100	44	66	0	0	0	26	15	0	**251**
(03:30-03:45)	0	88	47	56	0	0	0	20	21	0	**232**
(03:45-04:00)	0	77	48	67	0	0	0	18	22	0	**232**
(04:00-04:15)	2	90	44	78	0	0	1	19	16	0	**250**
(04:15-04:30)	5	111	46	89	0	0	1	22	17	0	**291**
(04:30-04:45)	5	100	78	89	0	0	1	25	23	0	**321**
(04:45-05:00)	1	89	89	99	1	0	0	22	15	0	**316**
(05:00-05:15)	2	78	79	68	0	0	0	37	17	0	**281**
(05:15-05:30)	5	78	68	67	0	0	3	21	24	0	**266**
(05:30-05:45)	8	100	68	77	0	4	4	24	27	0	**312**
(05:45-06:00)	2	90	66	99	1	0	3	26	17	0	**304**
(06:00-06:15)	92	112	48	111	6	2	19	27	25	0	**442**
(06:15-06:30)	64	143	89	88	2	2	11	25	22	0	**446**
(06:30-06:45)	76	197	69	34	2	3	22	27	25	0	**455**
(06:45-07:00)	93	240	79	77	2	2	16	32	17	0	**558**
(07:00-07:15)	131	345	73	89	2	4	33	15	25	0	**717**
(07:15-07:30)	105	285	74	110	0	1	31	16	24	0	**646**
(07:30-07:45)	90	304	112	110	2	1	53	17	29	0	**718**
(07:45-08:00)	116	319	53	133	2	3	54	20	29	0	**729**
(08:00-08:15)	138	318	74	112	0	0	39	24	17	0	**722**
(08:15-08:30)	95	161	85	100	0	3	42	26	25	0	**537**
(08:30-08:45)	113	240	76	68	78	1	23	24	17	0	**640**
(08:45-09:00)	117	189	54	35	120	4	21	27	20	0	**587**
(09:00-09:15)	100	173	53	57	111	7	28	29	17	0	**575**
(09:15-09:30)	72	156	72	57	122	7	19	27	18	0	**550**
(09:30-09:45)	120	225	89	44	121	2	22	23	24	0	**670**
(09:45-10:00)	98	168	77	46	99	2	15	25	25	0	**555**
(10:00-10:15)	110	201	77	57	100	0	35	25	17	0	**622**
(10:15-10:30)	109	192	88	44	112	6	32	25	26	0	**634**
(10:30-10:45)	90	201	68	44	89	5	43	15	24	0	**579**
(10:45-11:00)	81	144	79	59	78	3	42	21	29	0	**536**
(11:00-11:15)	85	187	79	35	78	2	49	15	24	0	**554**
(11:15-11:30)	105	181	94	35	66	2	51	21	24	0	**579**
(11:30-11:45)	113	176	108	57	88	5	37	21	25	0	**630**
(11:45-12:00)	100	195	112	35	89	1	48	17	27	0	**624**
Total	**2848**	**6640**	**3173**	**3376**	**1371**	**72**	**815**	**958**	**957**	**0**	**20210**

Appendix 8b: Manual Classified Count on Harbour Road

Location: Sakumono Lagoon
Station: MS 2 (2)
Date: 26/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	22	44	40	56	0	2	30	17	9	0	**220**
(00:15-00.30)	17	33	68	55	1	0	36	31	11	0	**252**
(12:30-12:45)	17	42	67	46	1	3	30	25	8	0	**239**
(12:45-13:00)	23	46	48	55	0	6	30	30	11	0	**249**
(13:00-13:15)	17	47	75	56	0	3	38	24	16	0	**276**
(13:15-13:30)	19	33	46	46	1	6	41	31	16	0	**239**
(13:30-13:45)	25	26	36	56	0	3	26	25	12	0	**209**
(13:45-14:00)	44	46	35	68	0	3	37	31	11	0	**275**
(14:00-14:15)	50	43	49	54	0	4	45	25	12	0	**282**
(14:15-14:30)	44	40	62	35	0	1	45	35	16	0	**278**
(14:30-14:45)	27	39	28	68	0	2	23	24	17	0	**228**
(14:45-15:00)	35	42	27	78	0	0	33	24	9	0	**248**
(15:00-15:15)	47	112	28	67	0	11	38	26	17	0	**346**
(15:15-15:30)	56	102	56	67	2	5	38	25	10	0	**361**
(15:30-15:45)	71	171	62	68	0	1	43	18	13	0	**447**
(15:45-16:00)	74	162	46	79	0	2	60	24	31	0	**478**
(16:00-16:15)	57	134	64	68	5	9	41	26	26	0	**430**
(16:15-16:30)	57	170	64	57	3	6	30	22	36	0	**445**
(16:30-16:45)	79	207	54	46	1	7	48	25	28	0	**495**
(16:45-17:00)	68	184	63	55	2	4	23	13	44	0	**456**
(17:00-17:15)	72	111	75	77	3	4	32	17	37	0	**428**
(17:15-17:30)	72	138	69	66	2	3	29	31	42	0	**452**
(17:30-17:45)	102	155	55	77	5	9	82	25	33	0	**543**
(17:45-18:00)	57	102	45	66	3	5	48	22	23	0	**371**
(18:00-18:15)	46	71	27	88	0	1	14	23	30	0	**300**
(18:15-18:30)	102	47	32	77	1	2	30	27	22	0	**340**
(18:30-18:45)	35	49	30	45	2	1	24	33	16	0	**235**
(18:45-19:00)	31	28	20	46	0	4	15	24	14	0	**182**
(19:00-19:15)	36	44	19	68	3	5	11	17	16	1	**220**
(19:15-19:30)	29	39	24	68	0	1	6	15	9	0	**191**
(19:30-19:45)	32	47	21	56	0	3	7	25	18	0	**209**
(19:45-20:00)	35	62	19	35	0	1	10	30	16	0	**208**
(20:00-20:15)	33	48	25	68	0	4	18	26	14	0	**236**
(20:15-20:30)	42	55	9	68	0	1	8	26	16	0	**225**
(20:30-20:45)	34	55	25	90	0	1	9	24	17	0	**255**
(20:45-21:00)	30	46	9	110	0	2	6	30	14	0	**247**
(21:00-21:15)	37	42	19	77	0	1	8	30	11	0	**225**
(21:15-21:30)	42	53	12	56	1	0	8	17	13	0	**202**
(21:30-21:45)	24	36	7	77	0	1	11	17	17	0	**190**
(21:45-22:00)	30	49	6	99	0	0	11	17	11	0	**223**
(22:00-22:15)	29	49	8	57	0	0	9	17	9	0	**178**
(22:15-22:30)	38	38	2	45	0	1	2	31	13	0	**170**
(22:30-22:45)	25	25	3	56	0	1	3	20	9	0	**142**
(22:45-23:00)	33	24	2	34	0	0	10	17	14	0	**134**
(23:00-23:15)	30	37	3	44	0	0	6	29	8	0	**157**
(23:15-23:30)	26	26	3	45	0	0	2	17	11	0	**130**
(23:30-23:45)	27	24	3	44	0	0	3	17	15	0	**133**
(23:45-24:00)	25	18	1	55	0	0	3	17	17	0	**136**
Total	**2003**	**3241**	**1591**	**2974**	**36**	**129**	**1160**	**1142**	**838**	**1**	**13115**

Appendix 9a: Manual Classified Count on Hospital Road

Location: TGH
Station: MS 3 (1)
Date: 23/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	30	24	6	5	0	0	2	0	0	0	**67**
(00:15-00.30)	53	24	23	5	0	0	9	3	3	0	**120**
(00:30-00:45)	77	45	34	6	0	0	9	0	3	0	**174**
(00:45-01:00)	76	45	54	5	0	0	20	5	4	0	**209**
(01:00-01:15)	69	46	33	7	0	0	15	3	1	0	**174**
(01:15-01:30)	82	45	56	6	0	0	12	3	4	0	**208**
(01:30-01:45)	68	45	42	7	1	0	10	2	5	0	**180**
(01:45-02:00)	71	43	24	29	0	0	3	3	5	0	**178**
(02:00-02:15)	63	35	34	25	0	0	13	2	1	0	**173**
(02:15-02:30)	75	34	35	24	0	0	12	5	5	0	**190**
(02:30-02:45)	66	33	46	12	0	0	6	3	3	6	**175**
(02:45-03:00)	79	33	24	0	0	0	7	2	4	2	**151**
(03:00-03:15)	72	34	24	34	0	0	5	4	0	6	**179**
(03:15-03:30)	66	46	34	12	0	0	2	4	3	4	**171**
(03:30-03:45)	72	45	34	12	0	0	3	4	3	4	**177**
(03:45-04:00)	68	34	35	8	0	0	5	4	1	0	**155**
(04:00-04:15)	58	44	12	0	0	0	9	3	2	0	**128**
(04:15-04:30)	61	45	34	0	0	0	4	5	4	0	**153**
(04:30-04:45)	47	45	34	1	1	0	6	4	3	0	**141**
(04:45-05:00)	68	33	24	0	0	0	4	2	3	2	**136**
(05:00-05:15)	56	46	34	1	8	0	5	4	0	1	**155**
(05:15-05:30)	68	35	35	1	6	0	12	7	4	0	**168**
(05:30-05:45)	58	44	54	1	14	1	13	4	0	0	**189**
(05:45-06:00)	68	46	32	3	16	6	5	3	2	3	**184**
(06:00-06:15)	68	56	53	3	13	5	3	4	3	3	**211**
(06:15-06:30)	80	56	48	6	12	3	13	5	4	4	**231**
(06:30-06:45)	74	57	44	2	21	10	8	6	4	1	**227**
(06:45-07:00)	79	73	57	2	7	6	16	10	1	1	**252**
(07:00-07:15)	88	87	67	7	10	5	25	3	5	0	**297**
(07:15-07:30)	88	55	46	7	7	3	19	3	3	0	**231**
(07:30-07:45)	88	104	57	6	9	3	18	6	4	0	**295**
(07:45-08:00)	100	90	60	3	14	1	19	6	2	0	**295**
(08:00-08:15)	64	83	55	4	10	5	12	3	4	0	**240**
(08:15-08:30)	69	119	57	1	12	7	10	1	3	0	**279**
(08:30-08:45)	96	136	74	0	17	7	13	0	0	0	**343**
(08:45-09:00)	91	114	64	2	12	5	9	6	1	0	**304**
(09:00-09:15)	91	139	64	1	14	7	22	1	1	0	**340**
(09:15-09:30)	93	142	60	0	18	8	10	2	1	0	**334**
(09:30-09:45)	95	116	61	1	13	5	19	4	0	0	**314**
(09:45-10:00)	74	125	60	0	12	6	9	1	1	0	**288**
(10:00-10:15)	129	154	66	1	14	3	12	2	3	2	**386**
(10:15-10:30)	63	86	40	0	4	2	3	1	3	1	**203**
(10:30-10:45)	87	115	47	3	9	4	18	3	0	0	**286**
(10:45-11:00)	72	123	54	0	14	1	15	2	1	1	**283**
(11:00-11:15)	85	133	61	0	7	7	10	1	2	0	**306**
(11:15-11:30)	72	119	44	0	5	9	13	0	0	1	**263**
(11:30-11:45)	77	123	55	0	14	6	15	10	2	0	**302**
(11:45-12:00)	58	110	44	0	5	9	10	2	1	1	**240**
Total	**3552**	**3464**	**2135**	**253**	**319**	**134**	**512**	**161**	**112**	**43**	**10685**

Appendix 9b: Manual Classified Count on Hospital

Road

Location: TGH
Station: MS 3 (1)
Date: 23/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	64	133	49	0	12	4	33	2	0	0	**297**
(00:15-00.30)	75	113	48	2	11	4	39	0	3	1	**296**
(12:30-12:45)	47	105	50	0	9	6	42	2	1	0	**262**
(12:45-13:00)	51	102	33	2	7	2	33	4	0	0	**234**
(13:00-13:15)	51	101	45	1	0	5	31	1	0	0	**235**
(13:15-13:30)	59	93	52	1	3	2	32	1	2	0	**245**
(13:30-13:45)	67	99	47	1	4	0	33	2	0	2	**255**
(13:45-14:00)	71	127	48	0	3	2	36	2	0	0	**289**
(14:00-14:15)	57	108	57	2	6	1	44	2	4	0	**281**
(14:15-14:30)	52	129	49	2	4	6	50	2	2	0	**296**
(14:30-14:45)	77	115	49	3	4	2	45	5	1	0	**301**
(14:45-15:00)	59	117	54	2	8	3	51	1	1	0	**296**
(15:00-15:15)	84	121	47	1	13	6	54	0	2	2	**330**
(15:15-15:30)	88	147	63	0	8	7	56	2	2	0	**373**
(15:30-15:45)	84	153	55	0	12	4	52	0	0	0	**360**
(15:45-16:00)	68	129	57	0	9	1	54	2	2	0	**322**
(16:00-16:15)	80	143	65	1	11	5	52	4	1	0	**362**
(16:15-16:30)	69	110	57	3	15	6	53	4	0	1	**318**
(16:30-16:45)	104	143	78	3	20	5	49	12	0	0	**414**
(16:45-17:00)	83	155	62	0	19	5	54	6	0	0	**384**
(17:00-17:15)	90	146	64	2	9	6	49	1	0	0	**367**
(17:15-17:30)	87	146	69	1	23	11	53	2	0	0	**392**
(17:30-17:45)	70	156	76	10	6	11	43	1	0	0	**373**
(17:45-18:00)	86	122	79	1	19	7	54	6	2	2	**378**
(18:00-18:15)	86	137	59	0	22	6	49	0	1	0	**360**
(18:15-18:30)	85	147	74	2	23	8	51	1	0	0	**391**
(18:30-18:45)	61	134	64	1	13	8	34	1	0	1	**317**
(18:45-19:00)	69	115	56	2	12	1	26	1	0	0	**282**
(19:00-19:15)	92	121	58	2	6	6	31	1	0	2	**319**
(19:15-19:30)	67	141	60	0	13	5	26	0	1	0	**313**
(19:30-19:45)	75	102	41	0	1	3	27	0	0	0	**249**
(19:45-20:00)	55	111	32	1	2	5	15	1	0	0	**222**
(20:00-20:15)	41	73	23	1	3	1	15	0	0	0	**157**
(20:15-20:30)	60	103	33	1	2	2	16	0	0	0	**217**
(20:30-20:45)	49	87	16	0	4	2	9	0	0	0	**167**
(20:45-21:00)	35	80	18	1	3	2	16	0	1	0	**156**
(21:00-21:15)	46	68	19	1	5	0	16	0	0	0	**155**
(21:15-21:30)	40	66	14	1	1	2	14	0	0	0	**138**
(21:30-21:45)	37	51	20	0	2	2	17	1	0	0	**130**
(21:45-22:00)	34	61	17	0	0	0	11	0	0	0	**123**
(22:00-22:15)	28	52	10	0	0	1	14	0	0	0	**105**
(22:15-22:30)	26	33	6	1	0	0	16	0	0	0	**82**
(22:30-22:45)	17	13	4	1	0	0	11	0	0	0	**46**
(22:45-23:00)	18	18	8	0	0	0	15	0	0	0	**59**
(23:00-23:15)	23	26	7	1	2	0	17	0	0	0	**76**
(23:15-23:30)	12	16	4	0	1	0	18	0	0	0	**51**
(23:30-23:45)	9	16	0	0	0	0	15	0	0	0	**40**
(23:45-24:00)	7	12	3	1	0	0	13	0	0	0	**36**
Total	**2795**	**4796**	**1999**	**55**	**350**	**165**	**1584**	**70**	**26**	**11**	**11851**

Appendix 10a: Manual Classified Count on Meridian Road

Location: Total
Station: MS 4 (1)
Date: 24/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(00:00-00:15)	12	17	13	12	0	0	3	2	0	0	**59**
(00:15-00.30)	18	28	13	12	0	0	4	3	2	0	**80**
(00:30-00:45)	24	48	17	12	0	0	4	2	5	0	**112**
(00:45-01:00)	44	56	21	9	0	0	4	2	3	0	**139**
(01:00-01:15)	42	54	33	9	0	0	5	2	5	0	**150**
(01:15-01:30)	31	43	32	14	0	0	6	4	3	0	**133**
(01:30-01:45)	30	54	45	12	0	0	6	1	5	0	**153**
(01:45-02:00)	37	48	24	13	0	0	7	4	2	0	**135**
(02:00-02:15)	28	52	18	13	0	0	5	4	1	0	**121**
(02:15-02:30)	36	49	35	12	0	0	8	5	4	0	**149**
(02:30-02:45)	32	49	44	13	0	0	11	3	3	1	**156**
(02:45-03:00)	33	52	48	15	0	0	13	2	4	0	**167**
(03:00-03:15)	31	54	34	10	0	0	11	2	4	0	**146**
(03:15-03:30)	35	66	42	15	0	0	7	2	4	0	**171**
(03:30-03:45)	32	64	27	17	0	0	7	2	3	1	**153**
(03:45-04:00)	37	48	28	16	0	0	10	3	5	0	**147**
(04:00-04:15)	31	63	39	13	0	0	6	4	5	0	**161**
(04:15-04:30)	24	62	41	15	0	0	8	2	2	0	**154**
(04:30-04:45)	18	77	43	10	0	0	9	1	4	0	**162**
(04:45-05:00)	27	63	35	15	0	1	11	0	5	0	**157**
(05:00-05:15)	31	67	48	20	0	0	11	4	5	0	**186**
(05:15-05:30)	36	73	43	14	2	1	7	2	7	0	**185**
(05:30-05:45)	32	61	46	17	1	2	7	2	6	1	**175**
(05:45-06:00)	34	62	44	17	0	1	15	3	5	1	**182**
(06:00-06:15)	28	63	40	27	2	1	9	3	4	2	**179**
(06:15-06:30)	36	73	35	15	1	1	9	6	5	0	**181**
(06:30-06:45)	44	70	37	11	1	0	9	4	7	3	**186**
(06:45-07:00)	34	59	41	13	3	0	12	4	5	0	**171**
(07:00-07:15)	22	75	29	12	1	1	10	4	0	0	**154**
(07:15-07:30)	35	70	29	13	0	0	13	5	5	1	**171**
(07:30-07:45)	48	72	35	14	1	0	8	7	2	2	**189**
(07:45-08:00)	38	77	44	15	1	2	6	3	5	1	**192**
(08:00-08:15)	34	87	30	12	2	3	11	2	3	0	**184**
(08:15-08:30)	31	87	35	14	3	1	23	3	5	0	**202**
(08:30-08:45)	28	75	12	16	4	3	17	2	7	1	**165**
(08:45-09:00)	37	85	49	19	1	3	11	3	4	1	**213**
(09:00-09:15)	42	78	21	14	2	3	18	3	5	2	**188**
(09:15-09:30)	35	71	18	13	1	4	20	6	6	0	**174**
(09:30-09:45)	37	61	23	14	1	3	14	3	3	1	**160**
(09:45-10:00)	36	70	17	9	1	3	20	2	2	0	**160**
(10:00-10:15)	16	85	35	16	3	3	11	8	5	1	**183**
(10:15-10:30)	19	90	44	11	0	0	10	3	3	2	**182**
(10:30-10:45)	15	84	47	11	2	1	18	6	0	0	**184**
(10:45-11:00)	31	92	43	12	11	0	7	5	5	0	**206**
(11:00-11:15)	57	61	46	24	3	8	20	0	3	0	**222**
(11:15-11:30)	35	73	47	27	2	5	23	3	3	0	**218**
(11:30-11:45)	16	68	44	27	1	6	7	3	3	0	**175**
(11:45-12:00)	17	64	43	22	0	2	11	2	5	0	**166**
Total	**1506**	**3100**	**1657**	**706**	**50**	**58**	**502**	**151**	**187**	**21**	**7938**

Appendix 10b: Manual Classified Count on Meridian Road

Location: Total
Station: MS 4 (1)
Date: 24/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	25	18	17	10	0	3	8	2	3	0	**86**
(00:15-00.30)	28	15	7	14	1	3	9	3	2	2	**84**
(12:30-12:45)	32	14	3	14	0	1	10	4	2	1	**81**
(12:45-13:00)	29	17	9	12	0	1	10	4	0	1	**83**
(13:00-13:15)	35	11	9	13	0	3	10	2	2	1	**86**
(13:15-13:30)	33	18	7	12	1	1	11	3	3	0	**89**
(13:30-13:45)	37	17	8	11	1	3	19	4	3	1	**104**
(13:45-14:00)	43	18	9	15	1	4	12	4	4	1	**111**
(14:00-14:15)	48	18	22	13	0	1	17	3	3	1	**126**
(14:15-14:30)	67	22	24	17	0	1	36	5	3	1	**176**
(14:30-14:45)	82	47	23	10	0	4	14	5	5	0	**190**
(14:45-15:00)	84	57	22	17	1	2	23	7	3	1	**217**
(15:00-15:15)	85	57	20	23	4	5	41	8	9	1	**253**
(15:15-15:30)	73	58	22	158	2	1	25	8	11	0	**358**
(15:30-15:45)	75	49	35	26	0	5	35	10	11	1	**247**
(15:45-16:00)	69	79	44	33	68	5	24	7	7	0	**336**
(16:00-16:15)	76	134	61	45	1	1	34	8	7	0	**367**
(16:15-16:30)	75	145	56	43	2	8	31	9	9	1	**379**
(16:30-16:45)	91	154	54	51	1	7	24	8	11	1	**402**
(16:45-17:00)	94	143	81	68	0	5	18	8	4	1	**422**
(17:00-17:15)	90	111	51	72	1	4	21	9	7	1	**367**
(17:15-17:30)	68	48	53	54	4	3	31	10	6	1	**278**
(17:30-17:45)	73	53	46	78	1	5	8	9	7	0	**280**
(17:45-18:00)	77	57	35	71	2	5	10	9	5	0	**271**
(18:00-18:15)	82	18	32	61	1	1	12	8	2	0	**217**
(18:15-18:30)	45	26	22	37	8	3	22	8	1	0	**172**
(18:30-18:45)	47	22	15	35	3	2	10	6	2	0	**142**
(18:45-19:00)	48	29	18	30	3	17	15	3	4	0	**167**
(19:00-19:15)	36	29	49	55	0	0	3	5	3	2	**182**
(19:15-19:30)	28	35	18	35	0	0	3	5	4	2	**130**
(19:30-19:45)	26	25	25	27	0	0	8	7	2	1	**121**
(19:45-20:00)	34	32	29	27	0	0	0	5	3	1	**131**
(20:00-20:15)	26	30	27	13	0	0	7	5	4	1	**113**
(20:15-20:30)	26	17	27	17	0	1	10	7	2	1	**108**
(20:30-20:45)	30	17	16	19	1	0	6	7	5	1	**102**
(20:45-21:00)	28	13	13	14	0	0	10	8	4	0	**90**
(21:00-21:15)	28	17	13	13	0	1	10	5	3	2	**92**
(21:15-21:30)	28	13	9	21	0	1	7	5	2	0	**86**
(21:30-21:45)	21	10	12	14	0	0	9	6	3	0	**75**
(21:45-22:00)	15	17	10	17	1	0	8	3	2	1	**74**
(22:00-22:15)	17	19	15	16	0	0	6	3	3	1	**80**
(22:15-22:30)	14	14	12	17	0	0	3	5	3	0	**68**
(22:30-22:45)	17	13	11	16	0	0	4	5	3	1	**70**
(22:45-23:00)	15	12	9	12	0	0	4	3	3	1	**59**
(23:00-23:15)	15	11	9	11	0	0	2	3	2	1	**54**
(23:15-23:30)	16	17	14	10	0	0	5	0	2	0	**64**
(23:30-23:45)	20	7	8	13	0	0	3	5	5	1	**62**
(23:45-24:00)	17	13	9	13	0	0	0	3	5	1	**61**
Total	**2168**	**1816**	**1140**	**1423**	**108**	**107**	**648**	**269**	**199**	**35**	**7913**

Appendix 11a: Manual Classified Count on Valco Road

Location: Sanyo Junction
Station: MS 5 (1)
Date: 25/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	Taxi	Private Cars	Light Buses (Trotro)	Medium Heavy Buses	Bicycles	Motor Cycles	Light Del Veh (P/Up, Jeep etc)	Medium Trucks	Heavy Trucks	Others	Total
(00:00-00:15)	6	6	2	0	0	0	4	0	1	0	19
(00:15-00.30)	7	5	2	0	0	0	10	2	3	0	29
(00:30-00:45)	6	5	1	1	0	0	2	0	1	0	16
(00:45-01:00)	4	5	1	0	0	0	2	1	0	0	13
(01:00-01:15)	9	4	2	3	0	0	3	2	2	0	25
(01:15-01:30)	12	9	3	1	0	0	1	1	4	0	31
(01:30-01:45)	4	11	6	0	0	0	1	0	2	0	24
(01:45-02:00)	6	8	13	2	0	0	0	0	0	0	29
(02:00-02:15)	9	10	4	1	0	0	4	0	1	0	29
(02:15-02:30)	6	11	8	0	0	0	0	0	2	0	27
(02:30-02:45)	10	10	3	0	0	0	4	2	1	0	30
(02:45-03:00)	4	3	7	0	0	0	0	1	0	0	15
(03:00-03:15)	8	4	7	1	0	0	2	2	1	0	25
(03:15-03:30)	6	8	4	0	0	0	2	1	2	0	23
(03:30-03:45)	8	11	14	1	0	0	2	1	1	0	38
(03:45-04:00)	15	9	3	0	0	0	4	1	0	0	32
(04:00-04:15)	9	10	6	2	0	0	2	0	0	0	29
(04:15-04:30)	5	4	11	2	0	0	3	2	0	0	27
(04:30-04:45)	9	9	13	1	0	0	2	2	0	0	36
(04:45-05:00)	5	11	20	1	0	0	1	0	0	0	38
(05:00-05:15)	15	12	22	3	0	0	2	2	4	0	60
(05:15-05:30)	17	19	25	4	1	0	16	2	3	0	87
(05:30-05:45)	17	39	65	8	1	3	19	2	4	0	158
(05:45-06:00)	25	32	67	9	0	3	16	2	3	0	157
(06:00-06:15)	24	47	42	16	2	3	22	1	1	0	158
(06:15-06:30)	25	50	59	15	2	3	21	3	2	0	180
(06:30-06:45)	32	49	52	11	4	3	36	1	0	0	188
(06:45-07:00)	20	45	43	11	3	2	36	2	3	0	165
(07:00-07:15)	25	51	45	10	2	1	36	1	0	0	171
(07:15-07:30)	31	60	42	9	3	1	31	1	0	0	178
(07:30-07:45)	25	48	40	12	6	2	27	3	2	0	165
(07:45-08:00)	22	63	93	38	15	4	32	5	0	0	272
(08:00-08:15)	26	52	40	6	4	4	33	4	0	0	169
(08:15-08:30)	33	59	39	4	2	9	27	1	3	0	177
(08:30-08:45)	28	65	53	8	5	8	49	2	4	0	222
(08:45-09:00)	29	58	44	3	2	19	23	2	0	0	180
(09:00-09:15)	29	54	57	6	3	3	35	4	3	0	194
(09:15-09:30)	26	46	42	4	1	0	29	2	5	0	155
(09:30-09:45)	16	50	58	9	0	4	51	2	6	0	196
(09:45-10:00)	11	65	54	9	2	3	33	2	3	0	182
(10:00-10:15)	12	38	37	5	3	4	37	2	4	0	142
(10:15-10:30)	15	43	59	4	2	4	51	3	4	0	185
(10:30-10:45)	12	42	38	3	1	8	50	2	2	0	158
(10:45-11:00)	15	43	58	3	0	9	37	5	2	0	172
(11:00-11:15)	13	38	62	11	0	6	36	2	3	0	171
(11:15-11:30)	19	46	49	5	1	5	51	3	2	0	181
(11:30-11:45)	29	56	50	5	0	10	44	4	4	0	202
(11:45-12:00)	25	31	62	6	1	8	60	4	4	0	201
Total	764	1454	1527	253	66	129	989	87	92	0	5361

Appendix 11b: Manual Classified Count on Valco

Road

Location: Sanyo Junction
Station: MS 5 (1)
Date: 25/02/2010

VEHICLE CLASSIFICATION											
Time (GMT)	**Taxi**	**Private Cars**	**Light Buses (Trotro)**	**Medium Heavy Buses**	**Bicycles**	**Motor Cycles**	**Light Del Veh (P/Up, Jeep etc)**	**Medium Trucks**	**Heavy Trucks**	**Others**	**Total**
(12:00-12:15)	10	11	14	6	0	4	13	0	3	0	**61**
(00:15-00.30)	12	13	18	2	1	7	17	0	3	0	**73**
(12:30-12:45)	7	13	20	6	0	9	16	2	5	0	**78**
(12:45-13:00)	20	9	16	0	1	7	16	1	3	0	**73**
(13:00-13:15)	10	13	18	4	0	2	20	2	6	1	**76**
(13:15-13:30)	22	12	28	5	2	7	17	0	5	1	**99**
(13:30-13:45)	34	13	22	7	0	5	16	2	6	0	**105**
(13:45-14:00)	22	12	30	0	1	5	18	1	5	0	**94**
(14:00-14:15)	22	17	24	4	0	6	15	2	5	0	**95**
(14:15-14:30)	14	27	14	9	0	4	18	2	3	0	**91**
(14:30-14:45)	42	24	20	11	3	5	26	1	4	0	**136**
(14:45-15:00)	60	35	20	8	0	3	32	2	3	0	**163**
(15:00-15:15)	74	47	18	10	0	3	29	0	4	0	**185**
(15:15-15:30)	78	50	24	6	0	5	31	4	7	0	**205**
(15:30-15:45)	92	51	20	12	2	3	43	1	4	0	**228**
(15:45-16:00)	104	51	44	6	0	3	27	2	2	1	**240**
(16:00-16:15)	94	55	70	3	3	5	27	0	9	0	**266**
(16:15-16:30)	107	50	92	11	6	7	31	2	10	1	**317**
(16:30-16:45)	115	66	104	9	0	6	27	3	5	0	**335**
(16:45-17:00)	105	68	106	16	4	2	33	4	6	0	**344**
(17:00-17:15)	125	68	94	8	3	5	29	4	6	0	**342**
(17:15-17:30)	128	76	94	17	3	3	25	2	4	1	**353**
(17:30-17:45)	137	60	86	14	5	2	20	5	7	0	**336**
(17:45-18:00)	124	69	86	13	5	3	25	2	4	0	**331**
(18:00-18:15)	128	40	28	5	3	3	11	1	4	0	**223**
(18:15-18:30)	104	42	42	5	2	2	9	2	6	0	**214**
(18:30-18:45)	51	41	24	3	0	3	9	1	6	0	**138**
(18:45-19:00)	44	44	42	5	2	2	5	2	4	0	**150**
(19:00-19:15)	44	33	30	7	0	4	11	2	6	0	**137**
(19:15-19:30)	34	20	22	2	0	1	5	4	5	0	**93**
(19:30-19:45)	30	48	32	1	0	3	5	3	6	0	**128**
(19:45-20:00)	20	41	26	1	0	8	13	5	2	0	**116**
(20:00-20:15)	29	34	28	3	0	0	11	2	2	1	**110**
(20:15-20:30)	37	37	34	0	0	2	15	0	2	0	**127**
(20:30-20:45)	37	32	24	1	0	7	13	1	2	0	**117**
(20:45-21:00)	17	36	62	6	1	1	9	3	3	0	**138**
(21:00-21:15)	27	22	34	5	0	3	9	3	1	0	**104**
(21:15-21:30)	25	19	40	5	0	4	7	4	3	0	**107**
(21:30-21:45)	17	30	46	9	0	1	13	4	1	0	**121**
(21:45-22:00)	22	36	26	3	0	1	7	1	1	0	**97**
(22:00-22:15)	12	22	10	2	0	2	9	0	1	0	**58**
(22:15-22:30)	5	25	16	3	0	1	3	0	0	0	**53**
(22:30-22:45)	11	19	12	5	0	1	4	2	2	0	**56**
(22:45-23:00)	16	21	8	2	0	0	2	1	0	0	**50**
(23:00-23:15)	7	21	14	3	2	1	5	1	0	0	**54**
(23:15-23:30)	11	17	8	0	0	0	3	0	0	0	**39**
(23:30-23:45)	9	17	14	2	0	0	0	0	1	0	**43**
(23:45-24:00)	3	11	4	0	0	0	0	0	0	0	**18**
Total	**2298**	**1618**	**1708**	**265**	**49**	**161**	**749**	**86**	**177**	**6**	**7117**

Appendix 12: summary of manual classified count

Vehicle Type	Akosombo Road				Harbour Road				Hospital Road				Meridian Road				Valco Road			
	24 Hour Volume	ADT	AADT	% of Total	24 Hour Volume	ADT	AADT	% of Total	24 Hour Volume	ADT	AADT	% of Total	24 Hour Volume	ADT	AADT	% of Total	24 Hour Volume	ADT	AADT	% of Total
Taxi	5,750	5,750	5,865	17.1	4,422	4,377	4,465	15.2	6,347	6,157	6,280	28.2	3,674	3,637	3,710	23.2	3,399	3,331	3,398	24.5
Private Cars	7,524	7,524	7,675	22.3	7,802	7,724	7,878	26.9	8,260	8,012	8,172	36.7	4,916	4,867	4,964	31.0	3,411	3,342	3,409	24.6
Light Buses (Trotro)	5,563	5,563	5,675	16.5	4,566	4,520	4,610	15.7	4,134	4,010	4,090	18.3	2,797	2,769	2,824	17.6	3,591	3,520	3,590	25.9
Medium Heavy Buses	5,982	5,982	6,101	17.7	5,204	5,152	5,255	17.9	308	299	305	1.4	2,129	2,108	2,150	13.4	575	564	575	4.2
Bicycles	556	556	567	1.6	772	764	779	2.7	669	649	662	3.0	158	156	160	1.0	128	125	128	0.9
Motor Cycles	338	338	345	1.0	252	249	254	0.9	299	290	296	1.3	165	163	167	1.0	322	316	322	2.3
Light Del Veh (P/ Up, Jeep etc)	2,870	2,870	2,927	8.5	2,167	2,145	2,188	7.5	2,096	2,033	2,074	9.3	1,150	1,139	1,161	7.3	1,930	1,891	1,929	13.9
Medium Trucks	2,459	2,459	2,508	7.3	1,984	1,964	2,003	6.8	231	224	229	1.0	420	416	424	2.6	192	188	192	1.4
Heavy Trucks	2,644	2,644	2,697	7.8	1,844	1,825	1,862	6.4	138	134	137	0.6	386	382	390	2.4	299	293	299	2.2
Others	33	33	34	0.1	1	0	1	0.0	54	52	53	0.2	56	55	57	0.4	7	7	7	0.0
Total	**33,720**	**33,720**	**34,394**	**100**	**29,010**	**28,720**	**29,294**	**100**	**22,536**	**21,860**	**22,297**	**100**	**15,851**	**15,692**	**16,006**	**100**	**13,853**	**13,576**	**13,847**	**100**
Vehicle Group Analysis																				
Light	22,602	22,602	23,054	67.0	19,979	19,779	20,174	68.9	21,805	21,151	21,574	96.8	12,860	12,731	12,986	81.1	12,781	12,525	12,775	92.3
Medium	5,982	5,982	6,101	17.7	5,204	5,152	5,255	17.9	308	299	305	1.4	2,129	2,108	2,150	13.4	575	564	575	4.2
Heavy	5,136	5,136	5,239	15.2	3,828	3,789	3,865	13.2	423	410	419	1.9	862	853	870	5.4	497	487	497	3.6
Total	**33,720**	**33,720**	**34,394**	**100.0**	**29,010**	**28,720**	**29,294**	**100.0**	**22,536**	**21,860**	**22,297**	**100.0**	**15,851**	**15,692**	**16,006**	**100.0**	**13,853**	**13,576**	**13,847**	**100.0**

$AADT = ADT \times M_f$

Where AADT is the Annual Average Daily Traffic

ADT is the Average Daily Traffic

M_f is the Monthly variation factor for February = 1.02 (Source: Deleuw Cather International Limited Report)

Appendix 13: Travel Time and Delay Studies Form

TRAFFIC STUDIES

JOURNEY TIME SURVEY

Name of City:…… Road Name:……

Enumerator:…… Road Section: From…… To……..

Date:…… Time From……..To……

Weather:…… Direction From……..To……

Location Name	Odometer Reading	Time Lapse			No of stops	Total Stopped Time		Reasons/ Notes
		hr	min	sec		min	sec	

Reasons for delay (with codes where used)		NOTES:
S= Signals	Roadworks - Diversion	
J= Other Junction	Accident- Breakdown	
P= Pedestrian Crossing	Traffic Congestion/Go slow	
B= Bus/Paratransit	Police Intervention	
K= Parked/Loading	Unknwn- Others	
R= Railway Crossing		