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

This report presents the results of a study to determine the Impact of Heavy Goods Vehicles on safety and traffic management in the Tamale Metropolis from 2005 to 2007. From 1991 to 2006, a total of 235,559 vehicles were involved in road traffic crashes nationwide, 11.8% of which were HGVs. Within the same period, 21626 people died as a result of their involvement in road traffic crashes throughout the country. 11.2% of these fatalities were HGV-related. On the northern corridor of the national trunk road network, freight transportation continues to grow, largely as a result of trade liberalization in the West African sub region. This appears, in part, to have impacted on safety as the main urban centres in the North have recorded a significant number of HGV-related accident cases. Tamale, the Northern Regional capital has had its fair share of these problems. The objectives of the study were to establish the characteristics of accidents involving 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 in the CBD. Accident data for the study was collected from the files of the Motor Traffic and Transport Unit (MTTU) of the police service in Tamale, and the Building and Road Research Institute (BRRI) accident database in Kumasi. Manual Classified Traffic Counts were also conducted on the Bolga, Daboya, Kumbungu, Dagomba and Gukpegu Roads. Travel Time and Delay Studies were conducted on the roads mentioned to determine the duration, location and causes of delays. Discussions were also held with DUR officials in connection with pertinent traffic management issues on the roads studied. The results of the study show that there was a rapid increase in the number of HGV-related accident cases within the period with 21% out of a total of 76 cases occurring in 2005, 33% in 2006 and 46% in 2007. Fatalities also increased from, 26% in 2005, 29% in 2006 to 45% in 2007 out of a total of 93. The year 2006 recorded the highest proportion (18 out of 45) of people that were hospitalised as a result of their involvement in HGV-related accidents. Sixty-two (62) out of 130 casualties also sustained minor injury during 2006. The number of vehicles involved in HGV-related accidents increased in percentage terms from 20% in 2005, 28% in 2006 to 52% in 2007. It has also been revealed that majority of HGV-related accident cases occurred on link sections rather than at intersections, and that HGVs are prone to Rear-end and Ran-off road types of accidents. The Bolga

and Kumbungu Roads were identified as the most prone to HGV-related accidents. Congestion occurs on the Kumbungu Road between the Bonzali Junction and the Market Circle Road due to a backflow, onto the Kumbungu Road, of vehicles entering the Savelugu Terminal. The situation is compounded by slow-moving light trucks and inadequate NMT facilities which together creates conflicts on this section of the road. It has been recommended that the remaining sections of the second ring road be developed to the required standard to accommodate HGVs so that those HGVs destined for Bolga and beyond would no longer go through the city centre. In addition, the Metropolitan Authorities in collaboration with the Department of Urban Roads, and Goods Supply Companies should set up a bulk-breaking terminal along the Ring Road so that goods destined for Tamale can be delivered to the city centre by smaller vehicles.

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1 INTRODUCTION

1.1 General Background

Heavy Goods Vehicles (HGVs) form an important part of the economic activity of all countries since they account for the bulk of freight transport. Freight transportation in turn forms a vital link with suppliers and customers. It is also a major source of employment in most urban areas.

In industrialised countries, usage of HGVs is carefully controlled. 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.

Despite these controls and regulations, approximately 3,650 people died in road traffic accidents involving HGVs and 700 others also died in road traffic accidents involving buses in 2005 in 14 EU countries (European Road Safety Observatory, 2007).

As shown in Figure 1-1, the situation however appears to be improving in terms of the number of people killed.

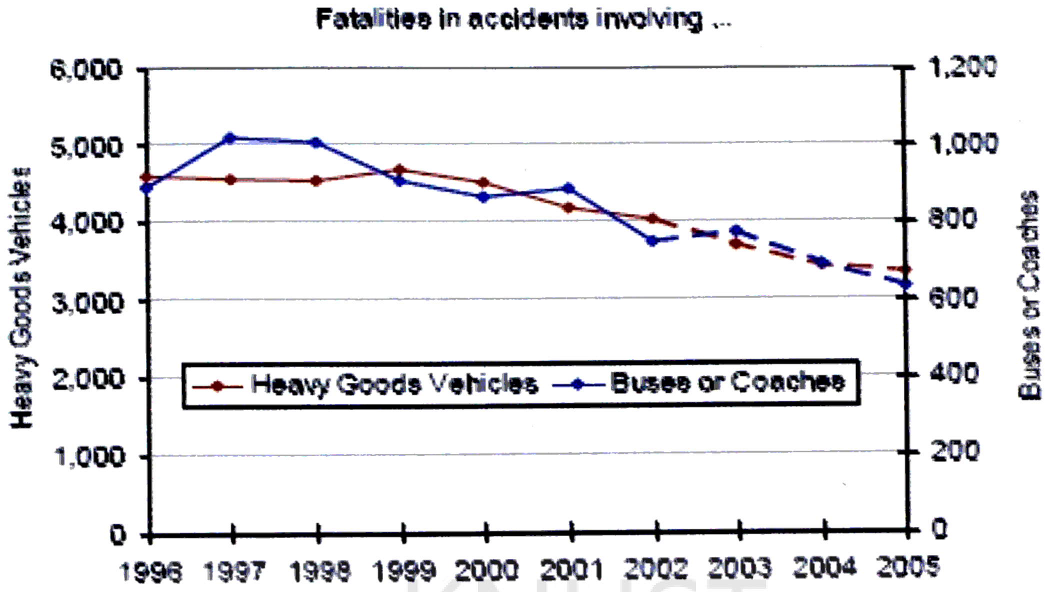

Figure 1-1: The Number of Fatalities in Accidents Involving HGVs and Buses in 14 EU Countries (European Road Safety Observatory, November 2007).

In developing countries however, HGV operations are not adequately regulated. Often anyone can become a goods-vehicle operator, vehicles may be defective and there may be no 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 (Transport Research Laboratory, 1994), whilst the vehicles themselves are frequently grossly overloaded. 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 2006, a total of 235,559 vehicles were involved in road traffic crashes nationwide, 11.8% of which were HGVs. Within the same period, 21626 people died as a result of their involvement in road traffic crashes throughout the country. 11.2% of these fatalities were HGV-related. Urban localities recorded a total of 7172 fatalities, 5.5% of which were HGV-related. Non-urban localities however accounted for a total of 14395 fatalities with 14.4% being HGV-related. Generally, fatalities that resulted from HGV-related accidents nationwide are on the rise within the stated period (National Road Safety Commission, 2007).

On the northern corridor of the national trunk road network, freight transportation continues to grow, largely as a result of trade liberalization in the West African sub region. This appears, in part, to have impacted on safety as the main urban centres in the North have recorded a significant number of HGV-related accident cases. Tamale, the Northern Regional capital has had its fair share of these problems.

Figure 1-3 illustrates typical HGV-related accident cases in the Tamale Metropolis.

Figure 1-2: Typical HGV-Related Accident Cases in the Tamale Metropolis

In order to fully appreciate the scale of the problem and recommend appropriate remedial interventions, this research sought to investigate the involvement of HGVs in accidents, as well as their impact on management of traffic in the Tamale Metropolis.

1.3 Objectives

The objectives of the research were:

- To establish the characteristics of accidents involving 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 CBD.

2 LITERATURE REVIEW

2.1 General

Increasing truck traffic poses many challenges for the transportation organisations that construct, operate, and maintain the transportation infrastructure. As such challenges have increased in importance, public agencies have begun to develop plans and implement strategies to address them. In most cases, these plans and strategies have been developed without the precedents that provide guidance in determining effective strategies.

The rapid increase in truck traffic is influenced by dramatic changes in the global economy, consumer demand, and logistics practices over the past 20 to 30 years (TRB, 2003).

Ever-increasing urban populations demand more and more consumer goods, which are increasingly imported from foreign countries. Goods are delivered to distribution centres and then to retail outlets by truck. Retail outlets increasingly rely on computerised inventory tracking, enabling them to minimise on-hand inventories, but necessitating more truck trips to deliver the needed consumer goods. Distribution of parts, finished goods, and other commodities is done by trucks for virtually all shipments owing to lower shipping costs and greater flexibility (TRB, 2003).

Manufacturers have reduced costs by lowering inventories and relying instead on just-in-time delivery. Such a system not only increases the volume of truck movements but also gives trucking an increasingly critical role in the logistics chain.

These and other trends have led to the rapidly growing volume of trucks using the roadway in most countries worldwide (TRB, 2003).

2.2 Challenges of Increasing Truck Traffic

The types of challenges reported by agencies primarily include those related to the transportation system itself (operations, capacity, safety, and maintenance). However, they include challenges related to broader social categories, including the environment and the economy. Each category of challenges is discussed in the following sections.

Traffic Congestion

Increasing volumes of trucks can cause or exacerbate traffic congestion, especially because trucks use more highway space than automobiles and because they have slower rates of acceleration and deceleration. Truck-related congestion is more likely to occur in areas with heavy truck volumes or where trucks constitute a high percentage of the traffic stream. Congestion can occur in several types of locations.

- Bottleneck locations, especially near areas with concentrated truck activity- such as terminals, ports, and border crossings;
- Urban streets;
- Urban highways; and
- Intercity roads and highways (TRB, 2003)

One measure of congestion could be an additional travel time per Km, while a congestion indicator is dimensionless as it represents a ratio, a measure of congestion in a basic situation to that of an observed. Another measure of congestion is Travel Delay which is the amount of extra time spent travelling due to congestion. Three congestion indicators are:

- The Roadway Congestion Index (RCI): this is based on the number of hours of the day that might be affected by congestion conditions. It is the ratio of daily traffic volume to the roadway demand (with regard to traffic handling capacity).
- Travel Rate Index (TRI): the ratio of additional time required to make a trip in congested conditions over the time required in free flowing traffic. A ratio showing 1.30 would mean that it takes 30% more time to make a trip compared to free flow speeds.
- Travel Time Index: this is similar to TRI, except that it includes both recurring and incident congestion (TRB, 1997).

Transportation System Deficiencies

Increasing volume of trucks can accentuate functional obsolescence and operational changes in the transportation system.

Large trucks have difficulty manoeuvring safely and efficiently on roadways with sub-standard geometrics (such as narrow lanes and small-radius curves) and in work zones where the operational problems of narrow lanes are compounded by the need for weaving manoeuvres. The problems caused by these geometric shortcomings are magnified as traffic or truck volumes increase, when trucks unable to manoeuvre effectively impede other traffic.

In most cases there are no areas specifically designated for parking. Even if parking spaces do exist, they are limited in number.

Truck drivers often drive on roads that are unfamiliar to them, delivering goods to and from locations which they may not visit frequently. These drivers depend on good directional signing to help them reach their destinations easily (TRB, 2003).

Safety

Increasing volume of trucks can be expected to increase the number and severity of crashes, thereby reducing the level of safety on highways and streets.

Infrastructure Deterioration

The sheer size and weight of trucks put a great strain on the highways and bridges that they traverse, resulting in more rapid deterioration of pavement and structures as truck volumes increase.

Multimodal Connections

The rapid increase in the volume of freight moving through the transportation system places particular strains on critical points in the shipping chain where goods are transferred from one mode to another or from one truck to another. Insufficient operations, inadequate size, or ineffective design, often attributable to adapting available facilities instead of designing new ones, cause strains at key transfer points that can delay time-sensitive deliveries, impair the economic chain, or spill excess truck traffic onto the adjacent roadway system (TRB, 2003).

Environmental Impacts

Trucks can create significant impacts on the environment, especially in terms of air pollution and noise, and increasing truck volumes can exacerbate these impacts. Diesel truck engines emit more nitrogen oxides, reactive hydrocarbons, and particulate matter per mile of travel than automobile internal combustion engines. As a result, a substantial increase in truck volumes can affect public health by contributing to degraded air quality either regionally or locally, where trucks pass close to sensitive receptors such as homes or schools. Increasing truck volumes also increase noise levels in adjacent areas, because trucks generate substantially more noise than automobiles. High levels of truck noise are practically undesirable near residential neighbourhoods, schools, parks, and other locations where there are high levels of outdoor activity (TRB, 2003).

Economic Development

Increasing movement of freight brings associated pressures to develop land for freight-related uses. Industrial uses are constructed to manufacture and assemble what is demanded by the public. Warehouses and terminal facilities are developed to store and transfer the goods in the distribution process. Problems may occur if these uses are located adjacent to other types of uses with which they are not compatible. For example, residential areas would not be considered compatible industrial and terminal uses, owing to the noise and other impacts they impose on the neighbouring environment. Another type of challenge may occur if development of freight-related uses discourages other types of uses which the locality and residents consider more beneficial from locating in the area. These challenges are categorised as: (1)

incompatible land uses and (2) truck-related uses that discourage desirable development (TRB, 2003).

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 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 characterised as transport costs and productivity loss (TRB, 2003).

2.3 Planning for Increasing Truck Traffic

Planning for trucks can vary from broad-level state-wide plans, to localised 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 (TRB, 2003).

Freight Planning for the State, Region, or Corridor

One category of planning consists of activities that plan for freight movement over a large area-a state, a metropolitan region, or a major transportation corridor. Planning at this scale may include elements such as goals and policies related to goods movement and how it should be accommodated, a long-term plan of facilities to handle goods movement, or a programme of needed infrastructure improvement to facilitate goods movement. In some cases, this type of goods movement planning occurs as one component of a multimodal system or corridor plan (TRB, 2003).

Freight Planning for Localised Areas

The second category of planning activity involves more detailed planning for a localised area. One type is planning for 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-areas with truck terminals, warehousing, and industrial uses (TRB, 2003).

Goods Movement Forecasting

The third category of planning involves forecasting future flows of goods or future volumes of trucks, to help determine how much freight activity the transportation system will need to accommodate (TRB, 2003).

2.4 Accommodating Truck Traffic on Texas Highways

The Texas Department of Transport (TxDOT) conducted a survey of its various organisational units to (1) determine what actions are being taken at the district level to mitigate the negative impacts associated with increasing levels of truck traffic on the state highway system and (2) identify any processes or procedures that should be changed to better accommodate increasing truck traffic.

Reported actions being undertaken fall into the following categories: pavement type selection, pavement design and construction, pavement management and maintenance, geometric design elements, highway planning, work zone safety, bridges and structures, traffic control devices, intelligent transportation systems (ITS), and truck parking and storage area improvements.

Suggested actions fall into the following categories: finance, truck weight monitoring and enforcement, geometric design standards, operations, truck parking and rest areas, pavement design and construction, and truck routes.

The TxDOT report conclusions are as follows:

- Stronger and more durable pavement structures are needed,
- Attention to preventive maintenance programmes is becoming more important,
- There is an urgent need for shoulder-widening projects,
- Design guidelines for two-lane facilities with intermittent passing lanes are being implemented in several locations where traffic volumes do not justify construction of four-lane facility,
- Dedicated truck lanes were recommended, especially through congested urban areas,
- Truck traffic volume is increasing faster than available levels of funding for transportation system preservation and maintenance.

2.5 Truck Volume Management Strategies

This section discuses a range of management strategies that can be considered in increasing truck volumes, and the types of challenges to which the various strategies apply. The strategies have been grouped into the following categories as follows:

Improved Highway Design

Improvement in highway design includes 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.

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 (automobile). The following roadway facilities can be considered:

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

Operational Standards

Operational strategies address the management and use of the available infrastructure. The following can be considered:

- Lane restriction,
- Time-of-day restriction,
- Roadway restrictions or prohibitions,
- Parking restrictions or prohibitions,
- Improvement in intermodal operations,
- Weight restrictions on bridges,
- Congestion pricing.

Intelligent Transportation Systems (ITS)

ITS are systems that use information, communication, sensor, and control technologies to improve transportation system efficiency and safety. The U.S. Department of Transport has developed a national ITS programme 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).

ITS/CVO elements include information systems, networks, and sensor systems such as weight-in-motion, technologies such as brake testing equipment, border crossing systems, and the components of intelligent commercial vehicles (TRB, 2003)

Signing

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

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

Enforcement and Compliance

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

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

Investments in Alternative Infrastructure

Three types of alternative infrastructure can be used to reduce the amount of trucking: (1) waterborne, (2) air freight, and (3) rail (TRB, 2003).

2.6 Management of HGV Traffic across the Swiss Alps

Responding to the growing HGV traffic on transalpine roads, the Swiss Government has introduced a traffic management system for HGVs following a fire catastrophe in the St. Gottard tunnel in October, 2001. The Alps form a major barrier to transport between central and southern Europe. There are only a limited number of motorways or motorway-standard connections through it.

A HGV capacity management system is part of the measures proposed by the Transport Ministers of the Alpine countries aiming at a more efficient use of the existing road infrastructure, at increased road user safety and at reduced traffic congestion on the bottlenecks that constitute the alpine passes. The components of the capacity management system are:

- Maintaining minimum distance between HGVs,
- Speed reduction for HGVs on access ramps,
- Alternating one-way traffic for HGVs in tunnels,
- Route guidance,
- Section control,
- Traffic information including information on combined transport facilities.

Different from the existing HGV traffic management on the major routes, HGVs will no longer have to queue on the hard shoulder but, HGV Service Centres with waiting areas will be build on either side of two transalpine routes. The HGV Service Centres fulfil the following functions:

1. Reception and dispatching HGVs on tunnel routes within the reservation system,

2. Parking area for HGVs in case of traffic incidents and other adverse weather conditions,
3. HGV parking during a night ban,
4. HGV traffic enforcement centre,
5. Sanitary facilities,
6. Garage and repair shop,
7. Fuel filling station,
8. Shopping,
9. Information centre and Lodging.

During regular service (i.e. no incidents on access ramps or in tunnels) the procedure for HGVs will be as follows:

1. At the HGV Service Centre site, HGVs use a special exit ramp of the motorway and are directed towards the HGV Service Centre,
2. Arrival at the HGV Service Centre and manual sampling by the traffic police of HGVs that are sent for safety check to the enforcement centre within the Traffic Centre. The safety check includes checking for driver condition, driving hours, vehicle condition, loading and others.
3. HGVs that pass the checks are given special tags to enable then 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 wil also give the traffic management centre better information of the HGV traffic demand.

2.7 HGVs and Cyclists on Dublin's Streets

The Dublin City's Roads and Traffic Department has invited proposals from the public regarding HGV Management Strategy on the city's roads. The Dublin Cycling Campaign (DCC) responded to the invitation and submitted proposals on the subject.

DCC believes that a HGV management strategy for the City is long overdue considering the number of cyclists' deaths on the streets, as this should have given those in authority the spur to bring in more drastic road safety measures even as an interim measure. The roads and streets infrastructure in Dublin, mostly following Medieval drovers' and carters' lanes, is a fundamentally unsafe place to mix bicycles with HGVs in traffic, particularly when no limits have been placed on the size of HGV permitted to operate within the City and no strictures placed on delivery or access times.

DCC recognised that HGVs are very efficient 'cyclist killers'. Of course they also kill pedestrians but pedestrians choose where, how and when they cross a street. Between 2000 and 2005, a total of 17 cyclists have been killed on Dublin City's streets, of which 10 have been killed by collision with a goods vehicle. Nationally, a total of 72 cyclists were killed on the roads, 30% of which were killed in accidents involving HGVs.

The main reason for the accidents is that HGVs have been exempted by the EU from all sorts of design safety features that have been forced on car manufacturers over the decades to make cars less lethal in impacting with non-motorised traffic. Public survey has shown that safety, and perception of safety, are the principal factors in the decision to cycle or not to cycle. Public transport policy is aiming to achieve a modal shift away from car commuting to bicycles and buses. The roads must be made safer and cyclists must have the perception that they are safe when using them. The presence of HGVs all over the city shatters this notion.

So, in safety hierarchy terms, the City should be trying to ensure that all trucks should have limited access to the City because they all have been granted a safety-standard derogation and they are mostly oversized in relation to many marked traffic lane dimensions in this City that they have to share with cyclists. The DCC advocates for the following strategies:

- Inner cordon exclusion for all HGVs. All port-related HGV traffic should be required to use other routes no matter what its origin or final destination. Capacity and congestion problems on the other routes should be addressed in other not to create more problems on those routes.
- The issue of effective regulatory agencies' enforcement of any strategy should be addressed. In order for the strategy to be effective, it must be supported by penalties that provide a significant deterrent to non-compliance together with an effective enforcement regime.
- DCC wishes to see the imposition of vehicle type-specific maximum speed limit of 30Kph set for all HGVS using the City's roads. This limit would be indicated by a decal posted on the tailgate of all HGVs with penalties for non-adherence to the maximum speed and for not having the decal displayed. This is required to minimise the lethality of trucks operating under permit in congested streets. The public benefits by being able to visibly see what the maximum speed is for HGVs.

2.8 The Road Transport Management System (RTMS): A Self Regulatory Initiative in HGV Transport in South Africa

HGVs overloading has been a nemesis in South Africa for decades despite efforts at more effective law enforcement. Overloading causes accelerated road deterioration and together with inadequate vehicle maintenance, driver fatigue and poor driver health, contribute significantly to South Africa's poor road safety record. In July 2003, the forestry industry embarked on a project to introduce a self-regulation system, the Load Accreditation Programme (LAP) to address overloading, vehicle maintenance and driver wellness in the timber transport industry. 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 successful implementation of LAP in the forestry industry led to a reduction in overloading by some 40%, and in November 2005, the national steering committee identified the need to revise the LAP strategy document to include vehicle maintenance, driver wellness and productivity. This gave birth to the Road Transport Management System (RTMS). RTMS 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 will offer support for implementation of the following components:

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

The RTMS strategy identifies the following stakeholders:

Value-Chain

- Consignees, consignors and transport operators,
- Organised business and industry associations,
- Organised labour.

Other Stakeholders

- Government (Department of Transport, etc.),
- Public Sector Institutions,
- Travelling Public.

2.9 Urban Transport Planning and Traffic Management Studies for Tamale

Introduction

The Department of Urban Roads (DUR) with assistance from BCEOM French Engineering Consultants and Associated Consultants (ACON) initiated a study, in 2003, on Urban Transport Planning and Traffic Studies for Tamale as part of the Road Sector Development Programme. The Consultants, in conjunction with representatives of the DUR, selected 6 key roads links and 15 intersections to conduct various studies to achieve the objectives of the study. Among other studies, travel time and delay studies were conducted to identify bottlenecks on the roads by virtue of high travel times, low travel speeds and long delays.

Identification of Bottlenecks in the Road Network System

Table 2-1 gives a summary of the congestion levels of the roads, including worst sections and major cause(s) of congestion.

Table 2-1: Comparison of Road Congestion Levels in Tamale's Transport Corridors (BCEOM, 2004)

Rank	Road Name	Functional Class	Study Length (Km)	CI	Worst Section	Length (m)	CI	Major Cause(s) of Congestion
1	Bolga Road	Major Arterial	2.6	1.8	Dagomba Rd. Int.- Rivoli Int.	150	6.2	Intersection Control
2	Salaga Road	Major Arterial	3.8	1.4	Daboya Rd. Int. - Zogbele Rd. Int.	250	8.4	Intersection Control
3	Yapei Road	Major Arterial	3.5	1.2	Daboya Rd. Int. - Zogbele Rd. Int.	250	5.5	Intersection Control/Abuse
4	Dagomba Road	Minor Arterial	2.2	1.1	Bolga Road Int. - Rivoli Link Int.	150	1.5	Intersection Control
5	Daboya Road	Minor Arterial	2.8	1.1	Kumbungu Rd. int. - Salaga Rd. Int.	300	2.9	Intersection Control/Abuse
6	Kumbungu Road	Minor Arterial	3.7	0.9	Mobil Link Int. - ADB Int.	300	3.3	Intersection Control/Abuse

The results of the individual roads are presented in the following subsections:

Bolga Road

The results of the travel time and delay studies are presented in Table 2-2. The operational results are based on the worst of the averages of the peak periods and directions for the entire road.

Table 2-2: Results of Bolga Road Travel Time and Delay Studies (BCEOM, 2004)

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	V/C Ratio	CI	LOS
Bolga Road	Gumbehene Rd. Int. - Baptist Rd. Int.	290	18.6	48	0.2	3.7	F
	Baptist Rd. Int. - New Sakasaka Rd. Int.	1060	33.6	41.5	0.2	1.8	D
	New Sakasaka Rd. Int. - Dagomba Rd. Int.	1050	39.8	28.5	0.2	1.4	D
	Dagomba Rd. Int. - Rivoli Int.	150	12.6	9.5	0.15	6.2	F
	Project road	2550	33.7	204		1.8	D

It can be observed from the table that the worst sections on the Bolga Road are between Gumbehene Link intersection and Baptist Road intersection and Between Dagomba Road intersection and Rivoli Road intersection. The situation was largely due to the performance of the controls at the intersections. The major causes of congestion on the Bolga Road were attributed to intersection controls. The congestion on the bicycle path was due to sharing with pedestrians as well as the two-way operations. The quality of operations of NMT was evaluated at the Bolga Road/Baptist Road intersection. The results of the evaluation indicated a Level of Service D. The results of the survey revealed that most of the control devises were in good condition. A few of them however needed replacement.

Salaga Road

The results of the travel time and delay studies are presented in Table 2-3.

Table 2-3: Results of Salaga Road Travel Time and Delay Studies (BCEOM, 2004)

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	CI	LOS
Bolga Road	Ring Rd. II - Kukuo Rd. Int.	1200	59.2	43	0.8	B
	Kukuo Rd. Int. - Nim Avenue Int.	250	47.3	12	1.1	C
	Nim Avenue Int. - Zogbele Rd. Int.	1750	43.4	96	1.2	C
	Zogbele Rd. Int. - Daboya Rd. Int.	250	8.9	94	8.4	F
	Daboya Rd. Int. - Rivoli Int.	300	14.3	67	5	F
	Project road	3750	41.1	229	1.4	C

It can be observed from the table that the worst section on the Salaga Road is between Daboya Road intersection and Zogbele Road intersection. The situation is largely due to the performance of the controls at the intersections. The major causes of congestion on the Salaga Road can be attributed to intersection controls and road abuse. Link capacities are adequate. Congestion on the bicycle paths was due to sharing with pedestrians as well as the two-way operations.

Yapei Road

The results of the travel time and delay studies are presented in Table 2-4.

Table 2-4: Results of Yapei Road Travel Time and Delay Studies (BCEOM, 2004)

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	CI	LOS
Yapei Road	St. Mary Voc. Inst.-Ring Rd. II Int.	700	42.2	39.7	1.3	C
	Ring Rd. II Int. – Hurlingham Rd. Int.	1350	48.9	61.3	1.0	C
	Hurlingham Rd. Int. – Zogbele Rd. Int.	1150	35.3	85.3	1.6	D
	Zogbele Rd. Int. Daboya Rd. Int.	250	13.1	61.7	5.5	F
	Project road	3450	44.2	189.7	1.2	C

It can be observed from the table that the worst section on the Yapei Road is between Zogbele Road intersection and Daboya Road intersection. The situation was largely due to the performance of the controls at the intersections and road abuse by motorists. The major causes of congestion on the Yapei Road can be attributed to intersection controls and road abuse. The congestion on the bicycle path was due to sharing with pedestrians as well as the two-way operations. The quality of operations of NMT was evaluated at the Yapei Road/Zogbele Road intersection. The results of the evaluation indicate a critical level of service. The results of the survey revealed that most of the control devises were in good condition. There were however, no street lights on the road.

Dagomba Road

The results of the travel time and delay studies are presented in Table 2-5.

Table 2-5: Results of Dagomba Road Travel Time and Delay Studies (BCEOM, 2004)

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	CI	LOS
Dagomba Road	RCC Link Int. – Estate Rd. Int.	390	31.9	29	1.2	D
	Estate Rd. Int. – Nim Avenue Int.	600	33.9	41	1.1	C
	Nim Avenue Int. – New Sakasaka Rd. Int.	550	38.6	30.3	0.9	C
	New Sakasaka Rd. Int. – Rivoli Link Int.	500	30	41	1.4	D
	Rivoli Linkn Int. – Bolga Rd. Int.	150	27.4	13.7	1.5	D
	Project road	2190	36.3	140.7	1.1	C

It can be observed that generally the Dagomba Road has acceptable level of service. Major bottlenecks on the Dagomba Road were at the intersections and the NMT facilities. NMT facilities were also inadequate. The results of the survey revealed that most of the control devises were in good condition. There were however, no street lights on the road.

Daboya Road

The results of the travel time and delay studies are presented in Table 2-6.

Table 2-6: Results of Daboya Road Travel Time and Delay Studies (BCEOM, 2004).

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	CI	LOS
Daboya Road	Nyohene Mosque – Nhohene Link Int.	200	24.4	22.5	1.9	E
	Nyohene Link Int. – Industrial Area R/A	400	25.9	40.5	1.7	E
	Industrial Area R/A –Hurlingham Rd. Int.	1050	53.6	30.5	0.5	B
	Hurlingham Rd. Int. – Kumbungu Rd. Int.	850	36.9	51.0	1.0	C
	Kumbungu Rd. Int. –Salaga Rd. Int.	300	18.3	51.5	2.9	F
	Project road	2800	36.1	177.0	1.1	C

The worst section on the Daboya Road is between Kumbungu Road intersection and Salaga Road intersection. The situation was largely due to the performance of the controls at the intersections and road abuse. Major bottlenecks on the Daboya Road are the intersections and the NMT facilities. NMT facilities are also inadequate. The results of the survey revealed that most of the control devises were in good condition. There were however, no street lights on the road.

Kumbungu Road

The results of the travel time and delay studies are presented in Table 2-7.

Table 2-7: Results of Kumbungu Road Travel Time and Delay Studies

Road Link	Road Section/Segment	Length (m)	Average Travel Speed (Km/h)	Total Delay (Sec.)	CI	LOS
Kumbungu Road	UDS Adm. Jn. – Hill Top R/A	1250	43.3	57.0	0.8	C
	Hill Top R/A – ADB Int.	2000	42.5	94.5	0.8	C
	ADB Int. Mobil Link Int.	300	15.2	60.0	3.3	F
	Mibil Link Int. – Daboya Rd. Int.	150				
	Project road	3700	40.9	192.5	0.9	C

It can be seen from the table that the worst section on the Kumbungu Road is between ADB intersection (Ward I) and Mobil intersection. The situation was largely due to the performance of the controls at the intersections and road abuse by both motorists and pedestrians. A major bottleneck on the Kumbungu Road is the inadequacy of NMT facilities, resulting in unsafe and poor quality of service for NMT operations. The results of the survey revealed that most of the control devises were in good condition. There were however, no street lights on the road.

Tamale Centre Parking

Parking Studies

The Consultant carried out field data collection and analysis in the following areas:

- Inventory of on-street and off-street parking facilities, including transport terminals,
- Accumulation, Duration and Turnover for the parking facilities,
- An assessment of the impact of changing land-use and development of high-rise structures on parking,
- Origin-destination surveys to determine flows and travel desires for the improvement of proposed one-way system,
- Specific studies along major public transport routes for the location of lay-bys.

Recommendations for Parking Management

The recommendations for parking management were informed by the results of the study and review of a report on the subject by MDC, another consultant.

Short Term Measures

1. Install ''No Parking/No Standing'' signs along those street segments where parking, standing or stopping impede smooth traffic flow.
2. Allow on-street parking only on one-way streets.
3. Reserve Lay-bys and designated bus stops for the exclusive use of public transport.
4. Prohibit parking along 20m from any intersection.

Medium/Long Term Measures

1. Sensitise residents, shoppers and shop owners about the introduction of parking fees.
2. Provide additional off-street private car parks.
3. Allow on-street parking on one side of roads.
4. Provide off-street bicycle parking facilities.

Education and Enforcement

The Consultant recommended intensive education and strict enforcement of the traffic rules so as to ensure the full realisation of the proposed traffic management measures. All users of the road and transport facilities should receive continuous relevant training, especially in the areas of safe operations of traffic.

Proposed Traffic Management Improvement Plans

The proposed Traffic Management Plan for all the roads discussed in Section 2.6.1 touched on the following areas:

- Intersection Improvement,

- Crosswalk Improvement,
- Sidewalk Development and Improvement for Pedestrians,
- Bike Path Development and Improvement,
- NMT Timings Requirements at Signalised Intersections,
- Improvement of Traffic Control Devices and Road Furniture,
- Public Transportation Improvement.

2.10 Identification and Analysis of Accident Blackspots on Urban Road Networks

Introduction

In August 1999, the Ministry of Transportation, acting through the DUR, commissioned the BRRI to undertake Consultancy Services for the Identification and Analysis of Accident Blackspots on the Urban Road Networks 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 accident locations with the view of establishing the main causes of accidents and subsequently recommending the appropriate remedial actions to be taken at each identified location.

Road Accident and Casualty Distribution for Tamale

Table 2-8 presents Road Accident and Casualty Distribution for the period 1996 to 1998. The table revealed that the number of accident cases increased over the three year period. Out of a total of 210 cases that occurred within the period, 28% occurred in 1996, 36% each in 1997 and 1998. The table also shows that out of a total of 388 casualties recorded within the period, 16% were fatal, 40% sustained serious injuries and 43% sustained slight injuries. The period also witnessed a total of 324 vehicular involvements in accidents.

Table 2-8: Road Accident and Casualty Distribution, 1996-1998 (BRRI, 2001)

Year	Accidents						Casualties					Vehicles Involved
	Fatal	Serious	Slight	Damage Only	Total	% of Total	Killed	Seriously Injured	Slightly Injured	Total	% of Total	
1996	16	12	19	12	59	28	21	48	59	128	33	91
1997	17	23	12	23	75	36	20	62	54	136	35	113
1998	19	12	21	24	76	36	23	46	55	124	32	120
Total	52	47	52	59	210	100	64	156	168	388	100	324

Analysis of Blackspots for Tamale

The analysis identified five top-worst locations in the Tamale Metropolis; three of which are located on the Bolga Road namely; (Forestry Office Junction to Kanvilli Road Junction, Sakasaka Shell Station to Catholic Guest House Junction, Catholic Guest House Junction) and two on the Salaga Road namely; (Waterson Road Junction and Hospital to Nim Avenue Junction). The results of the analysis for Tamale have been summarised and presented in Table 2-9. The table revealed that poor night visibility, excessive speed under prevailing urban conditions, pedestrian sharing the same roadspace with vehicles were the major circumstances under which most accidents occurred.

Table 2-9: Summary Results of Blackspots Analysis (BRRI, 2001)

No.	Accident Location	Accident Type	Accident Circumstances	Remarks	Remedial Measures
1.	Bolga Road (Forestry Office Jn. – Kanvilli)	Rear-end accidents (67%)	-North bound traffic accidents (directional problem) -Excessive speed -close following Fatality at night (poor visibility)	-Fatality associated with south bound traffic -Directional problem -Consequences of accidents are severe	-Provide street lighting -Inform drivers to slow down
2.	Bolga Road (Sakasaka Shell Station – Catholic Guest House Jn.)	Rear-end accidents (100%)	-North bound traffic accidents (directional problem) -Excessive speed -Poor night visibility	-Night accidents are severe -Directional problem	-Provide lay-bys at appropriate locations -Provide street lighting -Inform drivers to slow down
3.	Yendi Road (Waterson Road Jn.	Left turning (25%) Pedestrian accidents (25%)	-North bound traffic accidents -pedestrian crossing problem -Junction (turning vehicles	-Consequences of accidents are severe -Directional problem	-Provide road signs and markings -Provide safe crossing for pedestrians and bicycles -Inform drivers to slow down
4.	Bolga Road (Catholic Guest House Jn.	Left turning (25%) Head-on (25%) Rear-end (50%)	-North bound traffic accidents -Junction (turning vehicles -Poor night visibility	-Directional problem	-Provide traffic signs -Provide street lighting -Inform drivers to slow down
5.	Salaga Road (Hospital – Nim Avenue Jn.	Pedestrian accidents (25%) Rear-end (20%)	-Pedestrian sharing same road space with vehicles -Poor night visibility		-Provide street lighting -Provide traffic signs -Inform drivers to slow down -Provide lay-bys at appropriate locations

3 METHODOLOGY

3.1 Description of Study Area

The Tamale metropolitan area covers an area of 922 sq Km approximately, 13% of the Northern Region area. It is the third most important metropolis after Accra and Kumasi with 293,881 inhabitants (year 2000 census).

The outline of Tamale Road Network and the corridors studied is as shown in Figure 3-1.

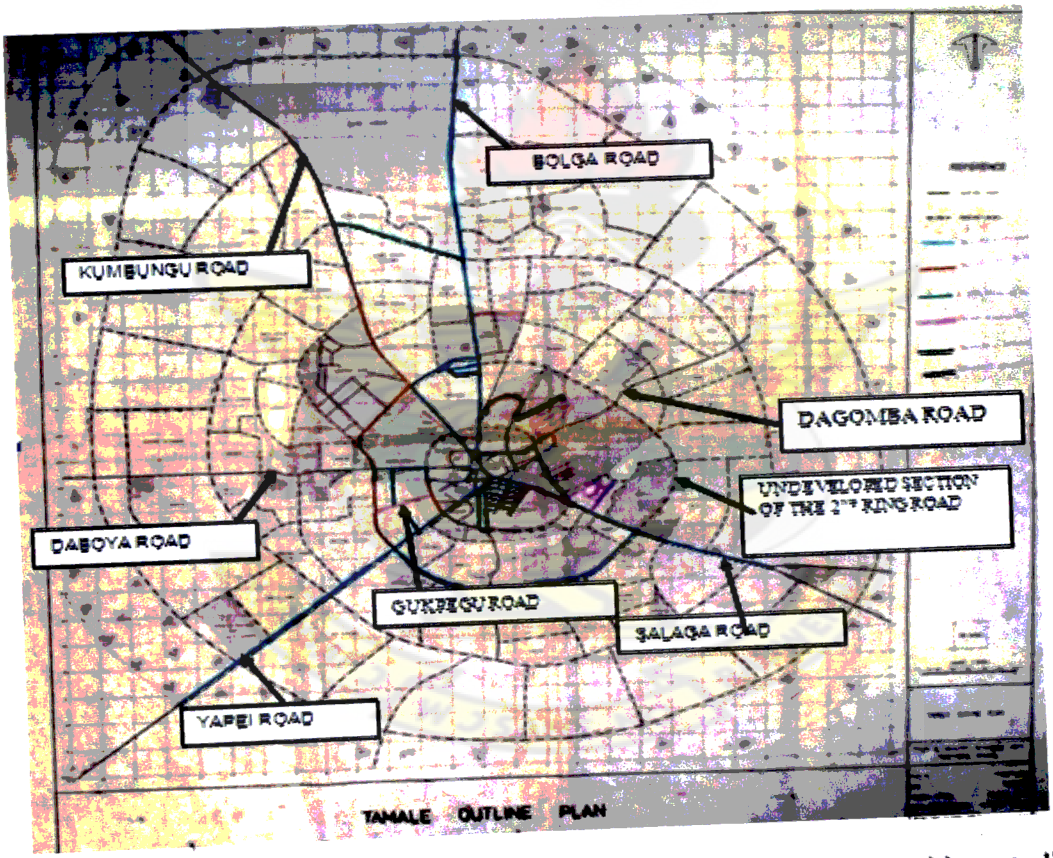

Figure 3-1: Outline of the Road Network in Tamale indicating the corridors studied.

The outline shows four ring-roads, and radial roads that fan out from the city centre. There are also other roads that connect any two ring roads thereby facilitating movement from one immediate locality to the other without necessarily using the main radial roads. Parts of the first, second and third ring roads have been developed. The fourth ring road has not been engineered at all as its development still remains a proposal. Five corridors of the network were selected for the research, and are described in the following subsections.

Bolga Road

This is a North-South major arterial, covering a length of 2.3 Km. The road is a paved two-lane dual carriageway facility. It is the main trunk road to the Upper regions. This makes the road very busy since it also carries international traffic from countries like Mali, Niger and Burkinafaso.

The road has well defined lanes, sidewalks and bicycle paths. The sidewalks/bicycle paths are well constructed shared facilities used by pedestrians and bicycles. Conflicts occur on these facilities due to the interactions between pedestrians and cyclists. Bicycle traffic is quite heavy and their shared operations create inconvenience and unsafe conditions for pedestrians. A typical Bolga Road cross-section is shown in Figure 3-2.

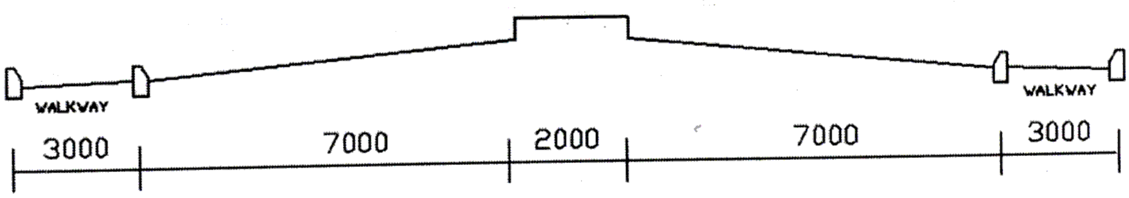

Figure 3-2: Typical Bolga Road Cross-Section

Daboya Road

The Daboya Road is an East-West minor arterial, covering of about 0.7 Km. A section of this road located in the CBD is a two-lane dual carriage road. The road is the main trunk road linking Tamale to Daboya.

The road has well defined lanes, sidewalks and bicycle paths. The sidewalks/bicycle paths are well constructed shared facilities used by pedestrians and bicycles. Conflicts occur on these facilities due to the interactions between pedestrians and cyclists. Bicycle traffic is quite heavy and their shared operations create inconvenience and unsafe conditions for pedestrians. A typical Daboya Road cross-section is shown in Figure 3-3.

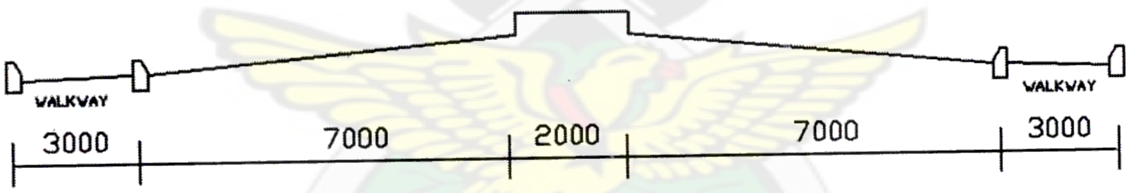

Figure 3-3: Typical Daboya Road Cross-Section

Kumbungu Road

The Kumbungu Road is a minor arterial that runs in a North-West and South-East directions. The road covers a lenght of 3.1 Km. The road is a paved single carriage facility and it is the main trunk road linking Tamale and Kumbungu.

The road has no well defined Non Motorised Traffic (NMT) facilities in most areas. The shoulders, where defined, are used as shared facilities by pedestrians and cyclists. Conflicts occur on these facilities due to the interactions between pedestrians and cyclists, creating inconvenience and unsafe conditions for pedestrians. The section of the road near Daboya Road intersection is used as a parking space by shop owners, creating operational problems. A typical Kumbungu Road cross-section is shown in Figure 3-4.

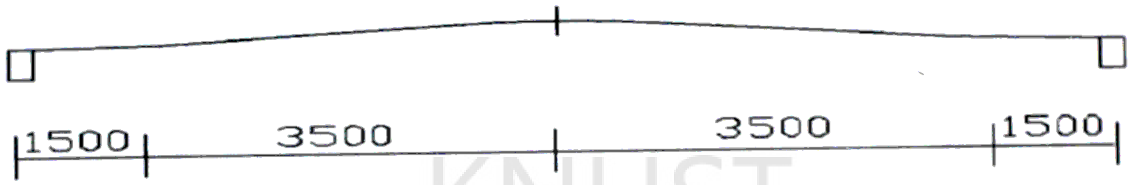

Figure 3-4: Typical Kumbungu Road Cross-Section

Dagomba Road

The Dagomba road is a minor arterial that runs in an East/West and North-East/South-West directions. The road is a paved two-way single carriageway of 0.6 Km. The road has well defined lanes and sidewalks. The sidewalks are well constructed shared facilities used by pedestrians and bicycles. A typical Dagomba Road cross-section is shown in Figure 3-5.

Figure 3-5: Typical Dagomba Road Cross-Section

Gukpegu Road

The Gukpegu Road is an East-West minor arterial, covering an urban (study) area of about 1.3 Km. The road has a pedestrian sidewalk, but is most of the time occupied by hawkers. The roadway space is shared by motorised traffic and cyclists. A typical Gukpegu Road cross-section is shown in Figure 3-6.

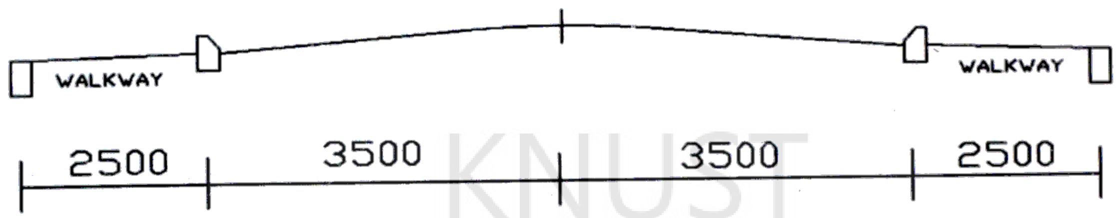

Figure 3-6: Typical Gukpegu Road Cross-Section

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 Tamale, and the BRRI accident database in Kumasi.

Data retrieved from the police covered the year 2007, and was collected by carefully studying all Accident Dockets for that year and recording the data on a form prepared for that purpose. The rest of the data, covering 2005 and 2006, 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,
- Time of accident occurrence,

- Date of accident occurrence,
- Cause or contributing circumstances,
- Location of accident,
- Collision type,
- Accident type (i.e., HGV-related or others).

A sample of the data collection form is attached as Appendix 1.

3.3 Traffic Data

Manual Classified Counts

The survey was conducted on the roads mentioned in Section 3.1 to determine the traffic volume by the type of the various categories of vehicle in the traffic stream. The directional counts were conducted at 5 identified locations on the road links at 15 minutes intervals for 12 hours from 6:00am to 6:00pm. The categories of vehicles that were counted are as shown in Table 3-1.

The Manual Classified Counts Data for the various roads and their summary including the computation of AADTs can be found in Appendces 2 to 7.

Travel Time and Delay Studies

This survey was conducted on the roads mentioned in Section 3.1 using the Floating Car Method. In carrying out the survey, a test vehicle was driven such that it 'floated' in the traffic stream by following the general traffic flow, i.e. the driver of the test vehicle overtook as many vehicles as overtook his vehicle.

The distance driven, the location and time the vehicle passed selected checkpoints were recorded. The survey recorded data on the duration, location and causes of delays. Average speeds on the roads were also computed from the data obtained. A sample of the form used for this survey is attached as Appendix 8.

Table 3-1: Vehicle Categorisation (Source: GHA Road Design Guide)

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 to1 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 constructional machinery.

Stakeholder Consultation

Discussions were held with DUR officials in connection with pertinent traffic management issues on the roads under study. This was done to complement observations made on traffic management issues during the Travel Time and Delays Studies.

4 ANALYSIS AND DISCUSSION OF RESULTS

4.1 Traffic Composition

Traffic volume by the percentages of the various categories of vehicles in the traffic stream was determined from the Manual Classified Traffic Volume Counts. Table 4-1 presents the volume percentages of the various categories of vehicles on the study roads.

Table 4-1: Percentages of Various Categories of Vehicles on the Selected Roads

Vehicle Group	Road Name									
	Bolga Road		Daboya Road		Kumbungu Road		Dagomba Road		Gukpegu Road	
	AADT	% of Total	AADT	% of Total	AADT	% of Total	AADT	% of Total	AADT	% of Total
Light	39664	95.7	25644	91.7	32659	95.9	29149	98.3	24137	98.2
Medium	982	2.4	1436	5.1	1307	3.8	387	1.3	361	1.5
Heavy	817	**2.0**	878	**3.1**	78	**0.2**	131	**0.4**	80	**0.3**
Total	**41463**	**100.0**	**27958**	**100.0**	**34044**	**100.0**	**29667**	**100.0**	**24578**	**100.0**

The Bolga Road recorded the highest AADT of 41463 vehicles per day with 2% of it made up of HGVs. This is understandable considering the fact that it is a major arterial road which connects two regional capitals and also serves other countries like Mali, Niger and Burkinafaso that depend on our sea ports for import and export of goods. The lowest AADT of 24578 vehicles per day was recorded on the Gukpegu Road with 0.3% of it made up of HGVs. It can also be seen from the table that light vehicles are predominant on all the roads.

4.2 Traffic Growth Rates

The only recent past traffic data available for comparison and computation of traffic growth rates are counts undertaken by TDP in July 1996 and by the BRRI in October 2000. From the two reports, it was realised that the only Master Station on the Bolga

Road as stated in those reports was where a 12 hour count, on the Bolga Road, for this research was conducted. Data from those reports were therefore utilised for the estimation of growth rates.

Tables 4-2 and 4-3 respectively show traffic growth rates for the periods 1996 to 2000 and 2000 to 2008.

Table 4-2: Traffic Growth Rate on the Bolga Road (1996-2000)

Location	24-hr Volume		% Increase	% Annual Growth Rate
	TDP Data July, 1996	BRRI Data October, 2000		
Bolga Road	23750	24086	1.4	0.35

Table 4-3: Traffic Growth Rate on the Bolga Road (2000-2008)

Location	24-hr Volume		% Increase	% Annual Growth Rate
	BRRI Data October, 2000	Current Data March, 2008		
Bolga Road	24086	30267	25.7	5.88

Annual growth rate of 0.35% was determined for the 1996-2000 period whereas the 2000-2008 period recorded a rate of 5.8%.

4.3 All Accidents Occurrence

Table 4-4 presents the overall number of all accident cases in the metropolis over the study period. The table shows that a total of 284 accidents occurred within the period. The accident cases increased consistently with 26% of all accident cases recorded in 2005, 36% in 2006 and 38% in 2007.

Table 4-4: Number of All Accident Cases in the Tamale Metropolis

YEAR	Fatal Cases		Hospitalised		Minor Injury		Damage Only		All Cases	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2005	20	32	18	19	14	30	21	26	73	26
2006	18	29	36	38	15	32	33	41	102	36
2007	25	**40**	40	**43**	18	**38**	26	**33**	109	**38**
TOTAL	**63**	**100**	**94**	**100**	**47**	**100**	**80**	**100**	**284**	**100**

As can be seen from the table, a total of 63 fatal accidents representing 22% of all accident cases were recorded over the period. Out of the 63 cases, 32% occurred in 2005, 29% in 2006 and 40% in 2007.

A total of 94 cases, representing 33% of all accident cases, resulted in hospitalisation of victims. This category of cases is on the rise with 19% of the total occurring in 2005, 38% in 2006 and 43% in 2007.

Cases that resulted in minor injury and property damage only are also on the rise. Minor injury cases represent the least number of cases, whereas cases resulting in property damage only are the most represented.

4.4 HGV-Related Accident Characteristics

Table 4-5 presents the number of HGV-related accident cases in the Tamale Metropolis for the three year period. The data reveals that a total of 76 HGV-related accident cases were recorded in the metropolis, and this figure represents 26.8% of all accidents that occurred within the period. The table also shows that there has been a rapid increase in the number of cases within the period with 21% of the total cases occurring in 2005, 33% in 2006 and 46% in 2007.

Within the period, a total of 13 cases representing 17% of the total HGV-related cases resulted in fatalities. The number of fatal cases however remained stable over the period.

Table 4-5: HGV-Related Accident Cases in the Tamale Metropolis (2005-2007).

YEAR	Fatal		Hospitalised		Minor Injury		Damage Only		All Cases	
	Total	% of Total	Total	% of Total	Total	% of Total	Total	% of Total	Total	% of Total
2005	4	31	1	7	4	57	7	17	16	21
2006	4	31	5	33	2	29	14	34	25	33
2007	5	38	9	60	1	14	20	49	35	46
TOTAL	**13**	**100**	**15**	**100**	**7**	**100**	**41**	**100**	**76**	**100**

The table also shows that a total of 15 cases, representing 19.7% of the total HGV-related cases resulted in hospitalisation of victims. This category of cases however grew very rapidly from 7% in 2005 to 33% in 2006 and then to 60% in 2007. Cases that resulted in minor injury declined over the period.

Out of a total of 41 cases that resulted in property damage only, 17% was recorded in 2005, 34% in 2006 and 49% in 2007.

HGV-related accidents more than doubled whereas all accidents increased by 49% during the period. By proportion of overall accidents, the share of HGV-related accidents also increased by 45%.

Table 4-6 also shows that HGV-related Kill and Severely Injured (KSI) cases increased 2.8 times, whereas all KSI increased only by 1.7 times over the period. The table also shows that the proportion of HGV-related KSI increased from 13% to 22% over the period.

Table 4-6: Killed and Severely Injured (KSI) Accident Cases

Year	HGV-Related Cases	All Cases	Proportion: HGV-Related to All Cases
2005	5	38	0.13
2006	9	54	0.17
2007	14	65	0.22
Total	28	157	0.51

The rise in the number of HGV-related accidents, relative to all accident cases could be due to the constant growth in the number of HGVs and other categories of vehicles using the northern corridor of the country's highway network as discussed in Section 4.2.

4.5 Casualties from All Accident Cases

The number of casualties recorded from all accident cases over the three year period is presented in Table 4-7. The table reveals that a total of 377 casualties were recorded over the period. 21% of this figure was recorded in 2005, 46% in 2006 and 33% in 2007.

Table 4-7: Number of Casualties from All Accident Cases

YEAR	Fatalities		Hospitalisation		Injury		All Casualties	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2005	24	26	26	17	28	22	78	21
2006	27	29	68	**44**	80	**62**	175	**46**
2007	42	**45**	60	39	22	17	124	33
TOTAL	**93**	**100**	**154**	**100**	**130**	**100**	**377**	**100**

Table 4-7 also reveals that a total of 93 people died from all accidents that occurred within the analysis period, and this figure represents 24.7% of all casualties produced. From 2005 to 2006, fatalities remained more or less stable but witnessed a rapid increase in 2007.

The period also witnessed a total of 154 people being hospitalised as a result of their involvement in accidents, and this figure represents 40.8% of all casualties recorded. As can be seen from Table 4-7, the year 2006 produced the highest proportion of people hospitalised due to their involvement in accidents.

A total of 130 people also sustained various degrees of injury within the analysis period. This figure represents 34.5% of all casualties.

4.6 HGV-Related Accident Casualties

The number of casualties from HGV-related accident cases for the period is presented in Table 4-8. A total of 105 casualties resulted from HGV-related accident cases within the period, and this figure represents 27.9% of all casualties. The year 2006 recorded the highest proportion of casualties of 44%, consistent with what was observed with casualties from all accidents. The figures in 2005 and 2007 are virtually the same.

Table 4-8: Number of Casualties from HGV-Related Accidents

YEAR	Fatalities		Hospitalisation		Injury		All Casualties	
	Total	% of Total	Total	% of Total	Total	% of Total	Total	% of Total
2005	5	21	10	22	15	42	30	29
2006	8	33	18	**40**	20	**56**	46	**44**
2007	11	**46**	17	38	1	3	29	28
TOTAL	**24**	**100**	**45**	**100**	**36**	**100**	**105**	**100**

Table 4-8 also reveals that a total of 24 people died from HGV-related accidents within the period. This figure represents 22.9% of all casualties that resulted from HGV-related accidents. Fatalities recorded in 2005 and 2006 more or less remained stable. The year 2007 however witnessed a rapid rise in fatalities over the previous years. This observation is consistent with what was observed with fatalities that resulted from all accident cases.

Table 4-8 also reveals that a total of 45 people were hospitalised as a result of their involvement in HGV-related accidents. The year 2006 recorded the highest proportion of people that were hospitalised as a result of their involvement in HGV-related accidents, consistent with the observation made on victims that were hospitalised due to their involvement in all accidents.

The period also witnessed a total of 36 people sustaining various degrees of injury as a result of their involvement in HGV-related accidents. The figure represents 34.3% of all casualties that resulted from HGV-related casualties. As can be seen from the table, the year 2006 recorded the highest proportion of people that sustained various degrees of injury. This observation is also consistent with what was observed with people that sustained injuries from all accident cases.

Table 4-9 shows KSI casualties, and the proportion of fatalities to both HGV-related and all casualties

Table 4-9: KSI Casualties, and Proportion of Fatalities to All Casualties

Year	HGV-Related			All Accidents			(KSI) Casualties	
	Fatalities (F)	All Casualties (AC)	Proportion: F to AC	Fatalities (F)	All Casualties (AC)	Proportion: F to AC	HGV-Related	All Accidents
2005	5	30	17%	24	78	31%	15	50
2006	8	46	17%	27	175	15%	26	95
2007	11	29	38%	42	124	34%	28	102
Total	24	105	72%	93	377	80%	69	247

KSI casualties from all accidents and HGV-related cases increased by similar magnitude (almost two-fold). When compared to the pattern of change in accidents, the data would suggest an increased likelihood of KSI with each HGV-related accident. The table also revealed that the proportion of deaths from HGV-related casualties more than doubled over the period.

4.7 Vehicular Involvement in Accident Cases

A total of 525 vehicles were involved in all accidents within the three year period, as shown in Table 4-10.

Table 4-10: Vehicular Involvement in All Accident Cases

Year	Number	% of Total Vehicles	Number of Accidents	Veh/Accident
2005	127	24	73	1.7
2006	174	33	102	1.7
2007	224	43	109	2
Total	525	100	284	1.8

Out of this total, 24% was recorded in 2005, 33% in 2006 and 43% in 2007. The table also shows that on the average, 2 vehicles were involved in each accident case.

4.8 Vehicular Involvement in HGV-Related Accidents

The number of vehicles involved in HGV-related accidents over the analysis period is presented in Table 4-11.

Table 4-11: Vehicular Involvement in HGV-Related Accident Cases

Year	Number	% of Total Vehicles	Number of Accidents	Veh/Accident
2005	12	20	16	0.75
2006	17	28	25	0.68
2007	31	**52**	**35**	**0.88**
Total	**60**	**100**	**76**	**0.79**

Table 4-11 reveals that a total of 60 vehicles were involved in HGV-related accidents over the period, and the figure represents 11.4% of all vehicular involvement in accidents over the period. There was a steady rise in the number of vehicles involved from the year 2005 to 2006. There was however a rapid rise in the 2007 figure over that of the previous years'. The table also revealed that on the average 1 HGV was involved in each HGV-related accident case.

4.9 Other Road-Users in HGV-Related Accidents

Table 4-12 compares the categories of road-users involved in HGV-related accidents over the three year period.

Table 4-12: Comparison of Road Users in HGV-Related Accidents

YEAR	Pedestrians		Bicyclists		Motor Cyclists		Other Vehicles		Total of Road Users	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
2005	1	25	1	13	2	13	10	22	14	19
2006	0	0	1	13	3	**20**	14	31	18	25
2007	3	**75**	6	**75**	10	**67**	21	**47**	40	**56**
TOTAL	**4**	**100**	**8**	**100**	**15**	**100**	**45**	**100**	**72**	**100**

The table reveals that out of a total of 72 road-users involved in HGV-related accidents, 4 of them were pedestrians, and the figure represents 6% of total road user involvement. The table also shows that the year 2005 recorded only 1 pedestrian involvement representing 25% of a total of 4. The figure however tripled in 2007, an indication of a deteriorated situation. Year 2006 did not record any pedestrian accidents involving HGVs.

The involvement of bicycle riders remained stable at 13% from 2005 to 2006 but went up very sharply in 2007 to 75%. In all a total of 8 bicycle riders were involved in HGV-related accidents within the period and this figure represents 11% of total road-user involvement.

Within the period, 15 Motor Cyclists were also involved in HGV-related accidents. The figure represents 21% of total road-user involvement. The number remained more or less stable in 2005 and 2006, but tripled in 2006. This is also an indication of a deteriorated situation.

Bicycles and motorcycles are the most preferred means of transport in the metropolis. This is explained by the fact that they are relatively cheap, and that majority of the people in the metropolis, (who are peasant farmers) find them more convenient for making short distance trips. The terrain is also generally flat, and this makes the use of bicycles convenient. The evidence is shown in the results of the Manual Classified Counts as detailed in Table 7 of the Appendix.

4.10 Hourly Variation in Accident Occurrence

Figure 4-1 shows the variation with time of all accidents recorded in the metropolis over the analysis period.

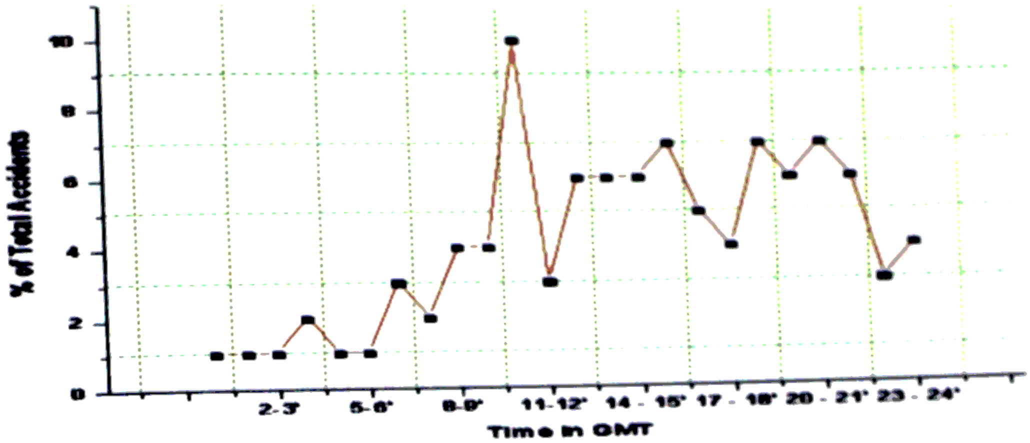

Figure 4-1: Hourly Variation in All Accidents Occurrence

The figure shows that accidents remained stable between midnight and 06 hours, and then increased gradually to a little over 4% at 10 hours. The highest proportion of accidents was recorded between the hours of 10 and 11, and then dropped to a value of 3% between the hours of 11 and 12 hours. From 13 hours to 22 hours, the number of accidents remained more or less stable. A value of 4% was recorded between 23 and 24 hours.

4.11 Hourly Variation in HGV-Related Accidents

The hourly variation in HGV-related accidents is illustrated in Figure 4-2.

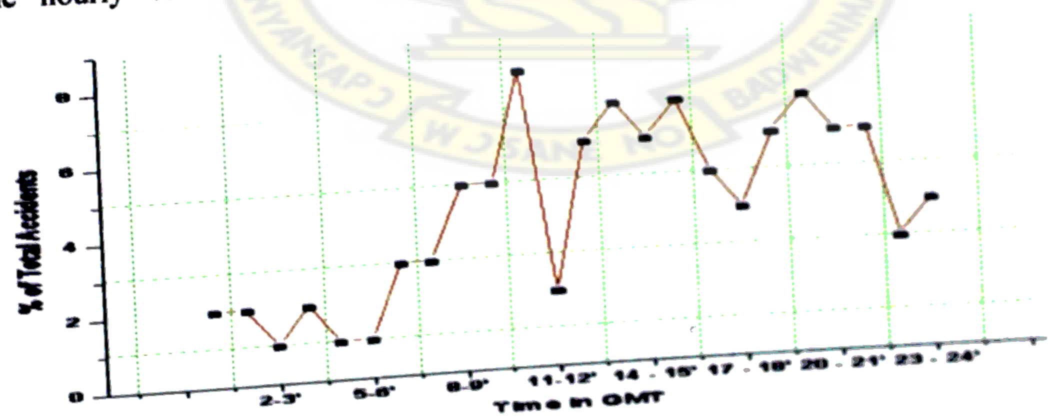

Figure 4-2: Hourly Variation in HGV-Related Accident Occurrence

The figure shows that accidents remained more or less stable between midnight and 06 hours, and then increased rapidly to a peak value of 8% between the hours of 9 and 10 hours. The hours between 11 and 12 however registered a value of 4%, a drop of 4% from the peak value. The number remained more or less stable from 13 hours to 22 hours. A value of 4% was recorded between 23 and 24 hours.

This pattern closely follows that observed with the hourly variation in all accidents in Figure 4-1.

4.12 Location of All Accidents

Table 4-13 shows the location of all accidents that occurred within the period under review.

Table 4-13: Location of All Accident Cases

Location Type	**Total**	**% of Total**
Not at Junction	170	60
Crossroads	30	11
T/Junction	64	23
Roundabout	12	4
Other	8	3
Total	**284**	**100**

The table reveals that majority of the accidents occurred on link sections other than at intersections. Out of the total number of accidents, 60% occurred on link sections.

T-junctions and crossroads recorded 23% and 11% respectively. Roundabouts and other locations recorded 4% and 3% respectively.

4.13 Location of HGV-Related Accidents

As shown in Table 4-14, 46 HGV-related accidents representing 61% of the total occurred on link sections over the period. T-junctions and crossroads recorded 24% and 9% respectively. Roundabouts and other locations recorded 3% each.

These observed characteristics are not so different from the case of All Accidents.

Table 4-14: Location of HGV-Related Accidents

Location Type	Total	% of Total
Not at Junction	46	61
Crossroads	7	9
T/Junction	18	24
Roundabout	2	3
Other	2	3
Total	**76**	**100**

Table 4-15 also shows the distribution of HGV-related accidents on the selected roads mentioned in section 3.2.

Table 4-15: Distribution of HGV-Related Accidents on Selected Roads

Road Name	Bolga Road	Daboya Road	Kumbungu Road	Dagomba Road	Gukpegu Road	Others	Total
No. of Accidents	30	9	7	4	4	22	76
% of Total (A)	40%	12%	9%	5%	5%	29%	100%
AADT	41463	27958	34044	29667	24578		
% of HGVs (B)	2%	3%	0.20%	0.40%	0.30%		
A÷B	20	4	45	13	18		

The table reveals that majority of HGV-related accidents occurred on the Bolga Road. The table shows that out of the 76 HGV-related accidents that occurred in the

Metropolis over the period, 40% were recorded on the Bolga Road. Other roads not selected for this research accounted for 29% of total accidents. Daboya and Kumbungu Roads accounted for 12% and 9% respectively. Dagomba and Gukpegu Roads recorded 5% each. The ratio of percentage of HGV-related accidents to percentage of HGV traffic indicates that the Kumbungu and the Bolga Roads are most prone to HGV-related accidents. This could be due to the inadequate non-motorised traffic facilities along the roads which forces non-motorised traffic onto the main carriageway thereby creating conflicts between motorised and non-motorised traffic.

4.14 All Accidents Collision Type

Rear End collisions have been found to be prevalent in the Metropolis as illustrated in Table 4-16. A total of 91 cases, representing 32% of total accidents were recorded over the period.

Table 4-16: All Accidents Collision Type

Collision Type	Total	% of Total
Head On	5	2
Rear End	91	32
Right Angle	52	18
Side Swipe	41	14
Ran Off Road	15	5
Hit Object On Road	2	1
Hit Object Off Road	15	5
Hit Parked Vehicle	2	1
Hit Pedestrian	50	18
Animal	2	1
Lost Control	11	4
Total	**284**	**100**

Right Angle collision and Hit Pedestrian accidents also recorded a value of 18% each. The table also shows that Ran Off Road, Hit Object On Road and Hit Object Off Road, together constitute 11% of all collision types.

4.15 HGV-Related Collision Type

The type of collision and their percentages with respect to the total number of accidents are not so different from what was observed with All Accidents as shown in Table 4-17.

Table 4-17: HGV-Related Collision Type

Collision Type	Total	% of Total
Head On	2	3
Rear End	27	36
Right Angle	6	8
Side Swipe	11	14
Ran Off Road	8	11
Hit Object Off Road	7	9
Hit Pedestrian	4	5
Animal	1	1
Lost Control	10	13
Total	**76**	**100**

Rear End collisions are prevalent with a value of 27 cases representing 36% of the total recorded over the period. Ran Off Road and Hit Object Off Road together constitute 20% of all collision types. By comparison, the share of this accident type in all accidents is only 6%.

4.16 Accident Causation Factors

A total of 23 possible accident contributing factors have been provided at the back of the accident record book to guide Police Officers who fill these records. Figure 4-3 illustrates the distribution HGV-related accident causation factors in the Metropolis.

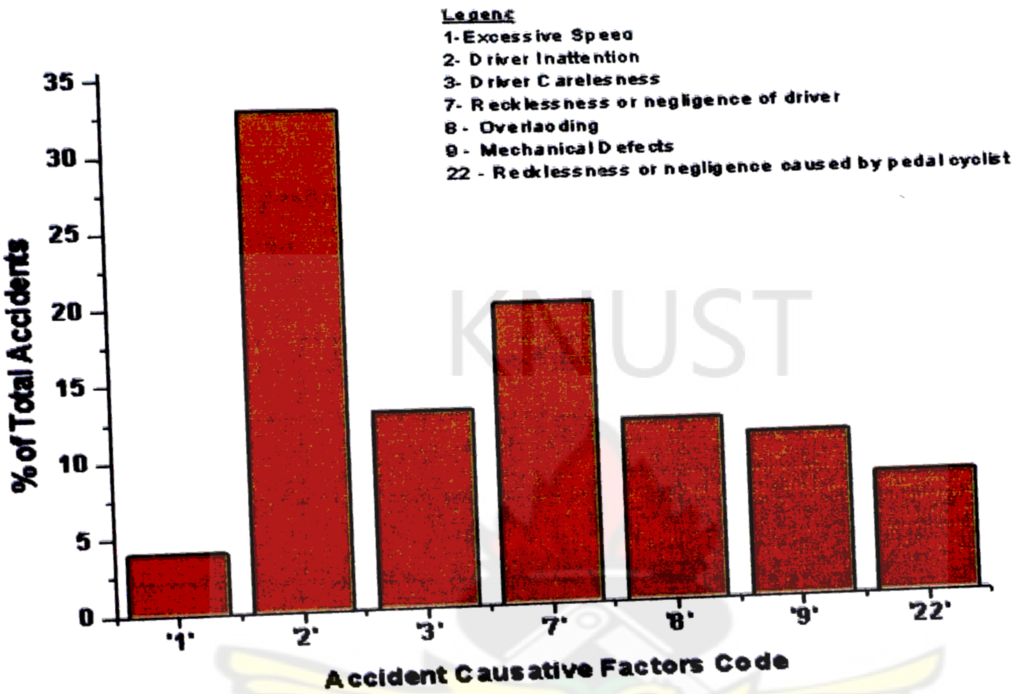

Figure 4-3: HGV-Related Accident Causative Factors.

It is seen from the figure that driver inattention, driver carelessness and recklessness denoted by accident causation factor codes 2, 3 and 7 respectively, were the major causes of HGV-related accidents in the metropolis. The above situation is the same for all accidents.

4.17 Congestion Assessment

Congestion is one of the challenges posed to traffic management as a result of the presence of HGVs. An assessment was therefore carried out to determine if there exists any level of congestion on the roads mentioned in Section 3.1 as a result of the presence of HGVs.

The criteria for the assessment of level-of-service (LOS)/congestion are presented in Table 4-18

Table 4-18: LOS/Congestion Assessment Criteria for Urban Roads (Source: Highway Capacity Manual, 2000)

Speed	LOS
<20 Km/hr	E,F (Congestion Situation)
20-30Km/hr	C,D
>30Km/hr	A,B

Average speeds were determined from the Travel Time and Delay Studies and plotted against distance to produce Speed Profiles along the roads. A typical Speed Profile on the Kumbungu/Market Circle Road is illustrated in Figure 4-4.

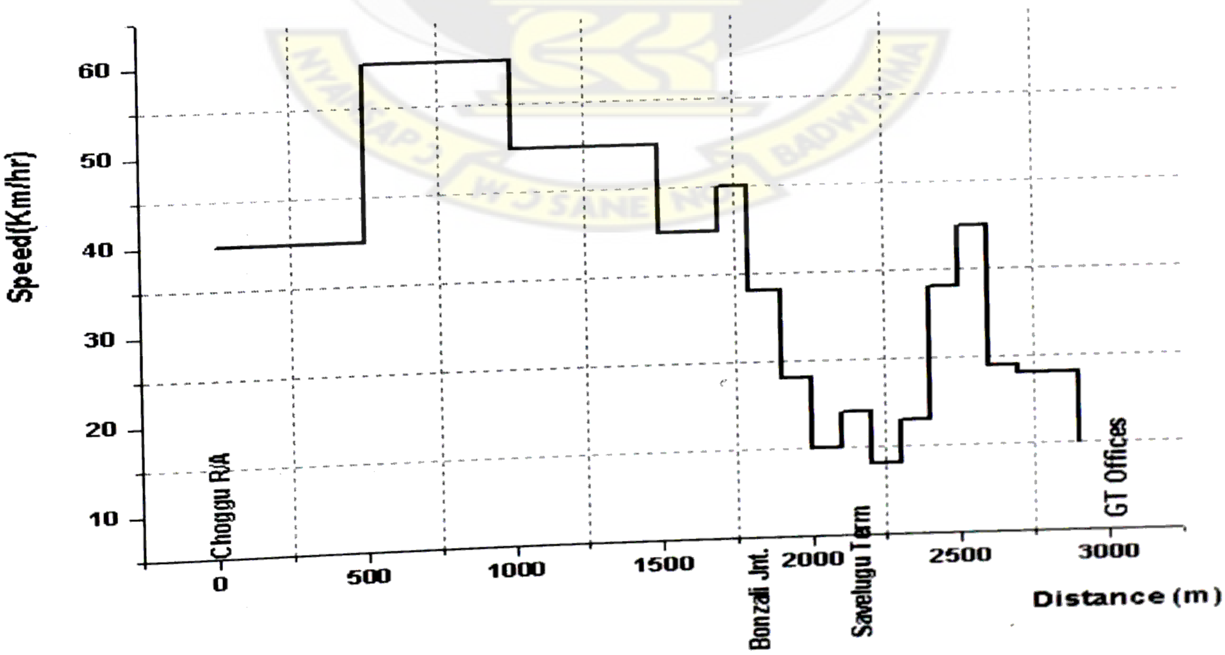

Figure 4-4: Typical Speed Profile on the Kumbungu/Market Circle Road.

It can be seen from Figure 4-4 that LOS E, F prevails on the section of road between Bonzali Junction and Market Circle Road, and on the section along Ghana Telecom offices.

According to the Travel Time and Delay Studies, a back-flow of vehicles is created on the Kumbungu road because of difficulty of getting parking spaces for vehicles entering the Savelugu Terminal. This condition coupled with slow-moving light trucks creates the congestion situation observed on the Bonzali–Market Circle section of the road.

On the stretch of road along GT offices, the situation is due to a bottleneck created by vehicles that occasionally park to offload goods in violation of the Metropolitan Authority's regulation on on-street parking. The remaining sections of the road operate at LOS A,B.

The AADT on the road is 34044 veh/day, with 0.2% of it made up of HGVs.

As illustrated in Figure 4-5 to 4-8, all sections of the rest of the roads operate above LOS E/F, notwithstanding the percentages of HGVs on them.

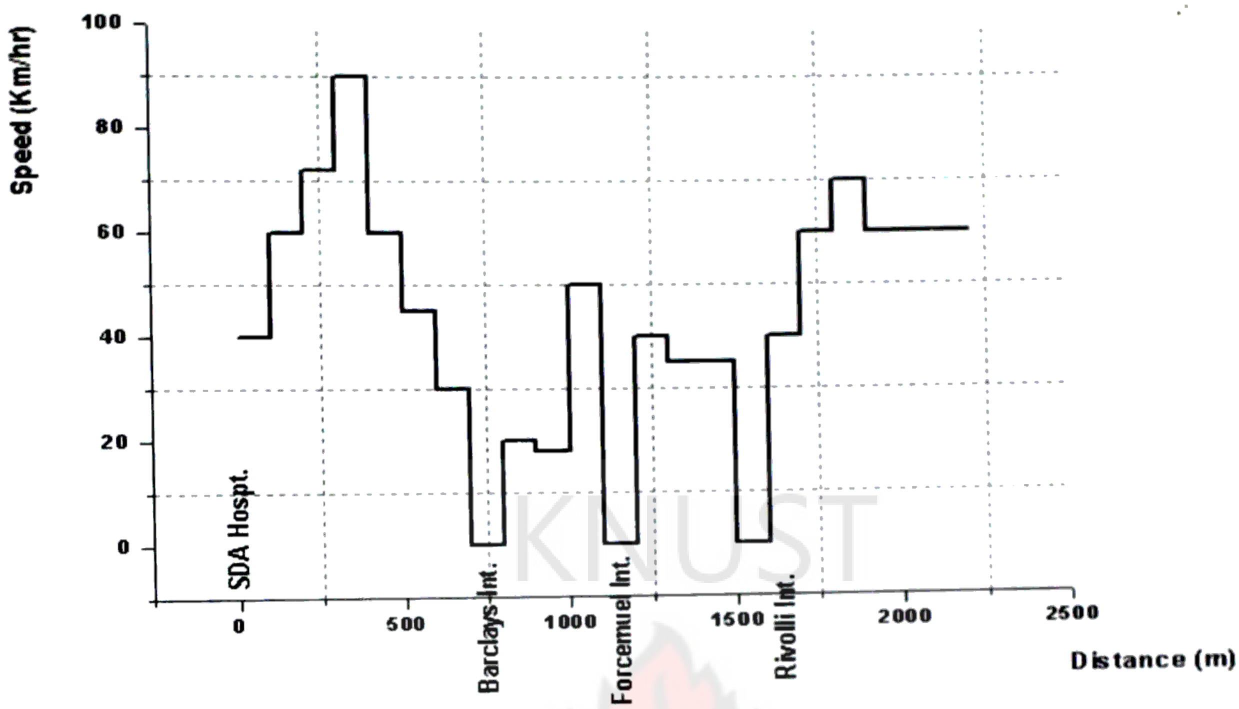

Figure 4-5: Typical Speed Profile on the Bolga-Salaga Road.

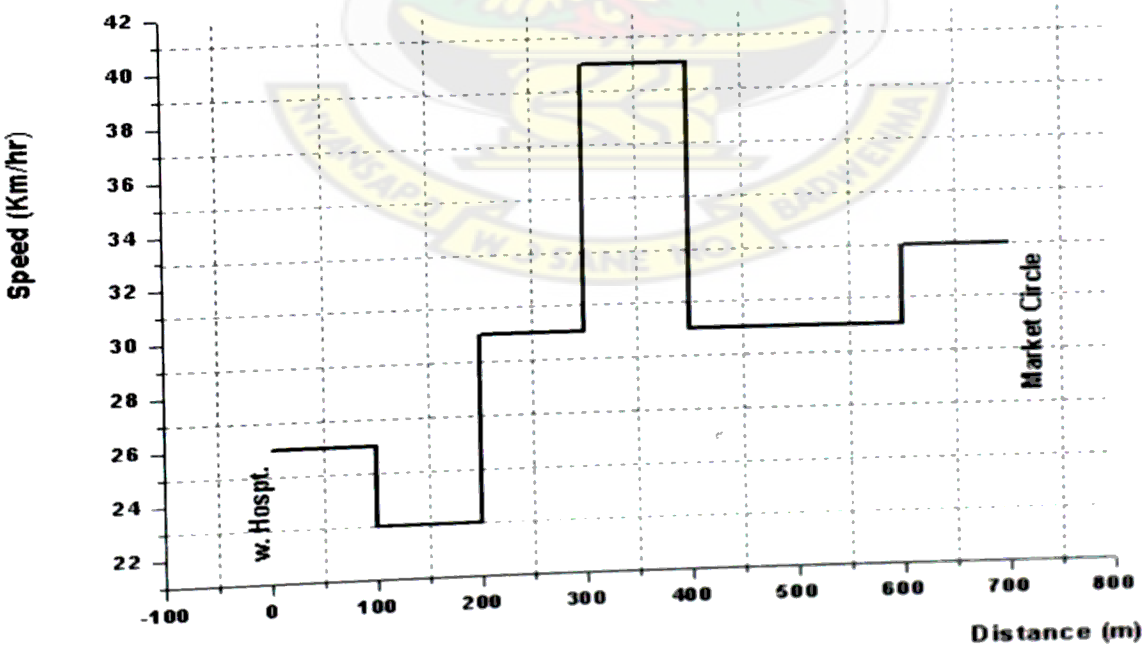

Figure 4-6: Typical Speed Profile on the Daboya Road.

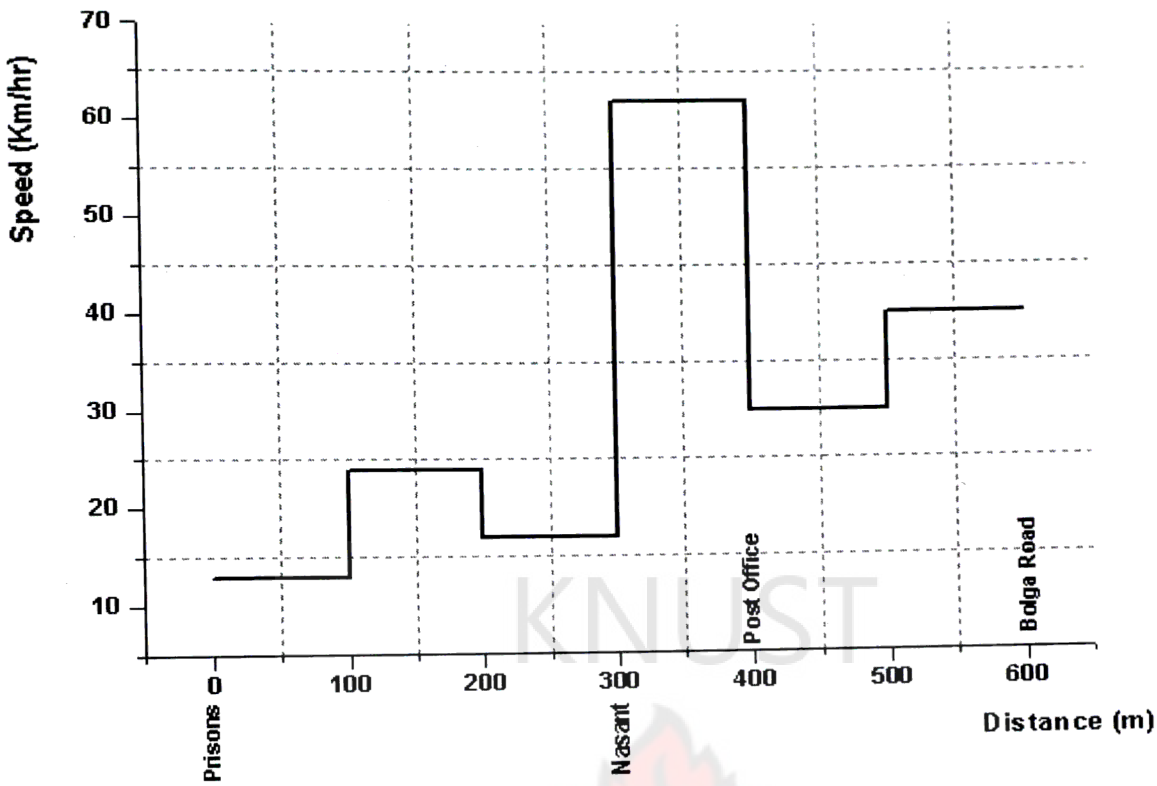

Figure 4-7: Typical Speed Profile on the Dagomba Road.

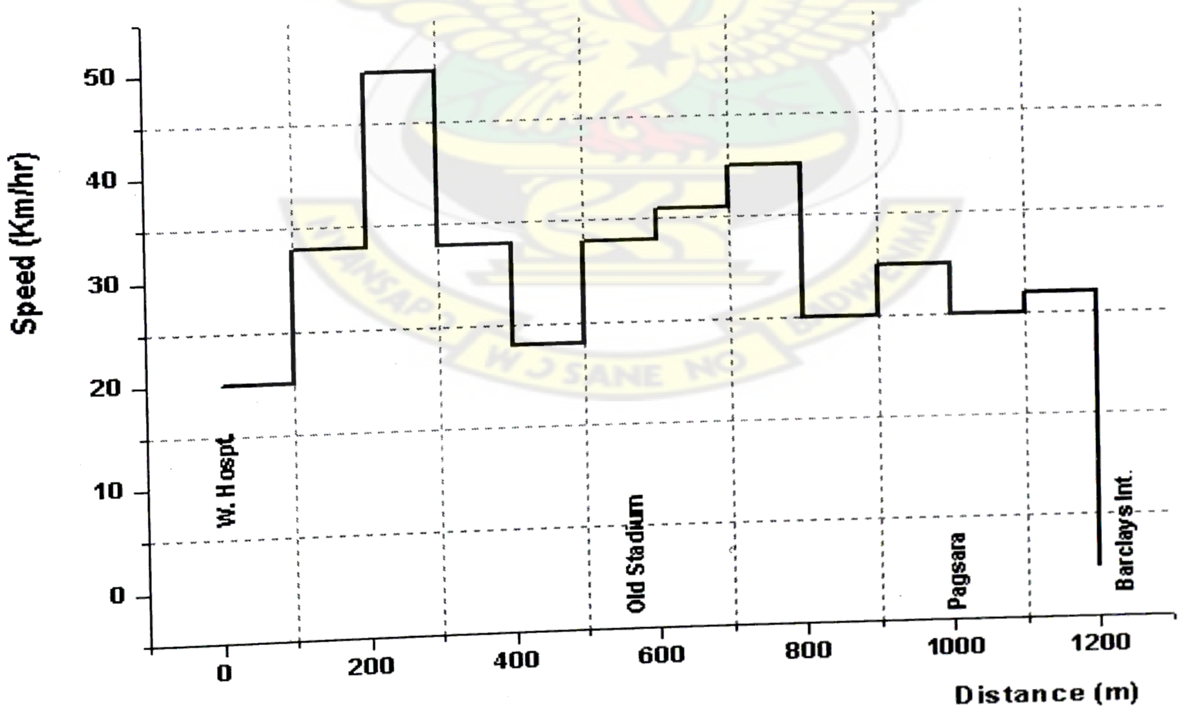

Figure 4-8: Typical Speed Profile on the Gukpegu Road.

4.18 Traffic Management Issues on Selected Roads

The outcome of discussions held with DUR officials, and observations made in connection with pertinent traffic management issues are discussed in the following paragraphs.

Bolga Road

The section of road between Forestry Offices Junction and Kanvilli Road Junction is located at the outskirts of Tamale. There are no street lights along this section of road, and this makes visibility poor at night. Vehicles stop on the road to pick passengers since there are no lay-bys along the road. Broken-down HGVs are left on the road for long periods, and this affects sight distance.

The section of road between Sakasaka Shell Station and Catholic Guest House Junction generally records high speeds. Taxis usually stop on main carriageway to pick or drop passengers. There are no lay-byes on section of road towards Bolga. Any broken-down HGVs on this section are also abandoned for long periods with the resultant reduction in sight distance.

The section between Gumbehini Road and Catholic Guest House Junction also records high speeds. The section has a high median kerb which makes pedestrian crossing somehow difficult.

There are no exclusive left turning lanes on the section between Waterson Road Junction and Liberation Road Junction. Speeds are generally high on the road, and there are also no marked pedestrian crossings. Taxi drivers stop on the main carriageway to pick or drop passengers since there are no lay-bys provided along the road. There is a taxi rank located along the road, and this creates some conflicts between traffic on the main road and those trying to enter it.

Another observation is that conflicts occur on the bicycle paths due to sharing with pedestrians as well as the two-way operations.

Kumbungu Road

Speeds are generally high on the section of road between Choggu Roundabout and Bonzalli Junction. There are no lay-bys along this road, and as a result vehicles (especially light trucks) park on the main carriageway. This behaviour creates bottlenecks at those locations. The NMT facilities are woefully inadequate, resulting in unsafe and poor quality of service for NMT operations.

Daboya Road

There is the Aboabo Market located along this road, and this attracts a lot of pedestrian activities at this location. There is a high median kerb which makes pedestrian crossing difficult. HGVs occasionally park along the road, and this creates some bottlenecks and also reduces sight distance at those locations. The problem is compounded if vehicles from a Filling Station, also located along the road, try to enter the main road. NMT facilities are also inadequate.

Gukpegu Road

Parking by light category of vehicles along this road is common. The existing walkways are occupied by hawkers, so pedestrians have to share the roadway space with vehicles. There are no lay-bys along the road as taxis stop on the main roadway to pick and drop passengers. This behaviour creates bottlenecks temporarily at those locations.

Dagomba Road

Light category of vehicles occasionally park in front of Nasant Ventures to offload goods. This creates bottlenecks at this location. There are also no lay-bys along the road as taxis stop on the main roadway to pick and drop passengers. NMT facilities are also inadequate.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following characteristics of HGV-related accidents have been established:

1. HGV-related accidents have an increased likelihood of producing Kill and Severely Injured casualties.
2. Majority of HGV-related accidents occurred between the hours of 10 and 21
3. HGV-related accidents occurred mostly on link sections of roads rather than at intersections.
4. The Bolga and the Kumbungu Roads are the most prone to HGV-related accidents because of the conflict between motorised and non-motorised traffic.
5. HGV-related accidents are mostly caused by driver inattention, driver carelessness and driver recklessness.

It has also been established that HGVs are prone to Rear-End and Ran-Off Road types of collision.

Another disclosure is that congestion occurs on the Kumbungu Road between the Bonzali Junction and the Market Circle Road due to a backflow, onto the Kumbungu Road, of vehicles entering the Savelugu Terminal. The situation is compounded by slow-moving trucks and inadequate NMT facilities which together creates conflicts on this section of the road. The section of road along GT offices also experiences some level of congestion. Generally along all the study roads, NMT facilities are inadequate.

The study also revealed that any broken-down HGV is left unattended to for long periods, and the situation results in bottlenecks at those locations. There is also the resultant reduction in sight distance.

5.2 Recommendations

The results of the analysis show that HGV-related accidents witnessed a rapid increase within the period under review. The occurrence of all accidents also rose consistently over the period. This observation is an indication of lack of safety on the roads in the metropolis. It is also an indication that the road safety situation for the period was becoming worse for the travelling public.

It is therefore recommended that the remaining sections of the Second Ring Road be developed to the required standard to accommodate HGVs so that HGVs destined for Bolga and beyond would no longer go through the city centre. In addition, the Metropolitan Authorities in collaboration with the Department of Urban Roads, and Goods Supply Companies should set up a bulk-breaking terminal along the Ring Road so that goods destined for Tamale can be delivered to the city centre by smaller vehicles.

The DUR should also ensure that the provision of NMT facilities are incorporated into all future road development projects since NMT are the predominant and the preferred means of transport in the Metropolis. It is also recommended that the MTTU of the Police Service steps up the enforcement of road traffic regulations, and specifically additional truck inspections to prevent accidents on the roads.

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APPENDIX

Appendix 1: Accident Data Collection Form

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

Appendix 2a: Manual Classified Counts Data on the Bolga Road

CENSUS POINT: GOIL FILLING STATION
DIRECTION: BOLGA - TAMALE
STATION NUMBER A
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	7	35	50	68	82	95	100	69	83	42	38	33	69	50	47	44	50	52	37	29	38	40	32	25	1215
MOTOR BIKES	25	23	32	60	71	103	93	93	131	75	93	70	89	78	98	87	50	96	107	95	76	68	75	75	1863
TAXIS/CARS	30	50	73	78	101	148	155	162	151	129	123	121	127	199	199	199	100	117	143	99	114	118	73	77	2886
PICK-UP/VAN	5	3	4	4	10	13	12	11	18	12	18	25	27	21	22	23	24	29	43	39	31	33	17	27	471
SMALL BUS	1	0	0	1	1	5	1	4	3	3	2	1	27	1	0	2	12	19	4	3	2	7	2	1	102
MED BUS/MUMMY WAGONS	0	1	1	5	0	3	12	0	1	5	0	4	2	2	2	0	1	2	0	1	2	0	3	0	47
LARGE BUS	0	0	2	0	0	1	0	0	0	0	0	0	4	1	0	0	1	0	1	1	0	0	0	1	12
LIGHT TRUCK	2	2	2	1	2	1	2	3	0	2	0	0	0	6	3	2	1	3	3	3	7	4	3	1	53
MEDIUM TRUCK	1	0	0	0	2	2	1	2	0	2	1	2	1	2	0	2	2	2	2	2	6	0	2	1	35
HEAVY TRUCK	1	1	1	2	0	1	1	0	0	1	0	0	1	0	1	1	0	2	0	1	2	0	0	1	17
SEMI-TRAILER (LIGHT)	0	0	0	1	1	1	0	1	1	0	0	0	0	1	5	0	1	1	0	0	1	1	1	0	16
SEMI-TRAILER (HEAVY)	1	1	2	0	1	0	1	2	1	1	0	5	1	0	0	1	0	5	1	3	0	0	1	0	27
TRUCK TRAILER	0	0	1	1	0	0	1	0	0	1	1	1	0	1	0	0	1	0	0	0	1	1	1	0	11
EXTRA LARGE TRUCK & OTHERS	1	0	0	0	2	1	2	0	0	1	0	0	0	1	1	1	1	2	1	0	1	0	1	1	17
TOTAL	74	116	168	221	273	374	381	347	389	274	276	262	348	363	378	362	244	330	342	276	281	272	211	210	6772

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2.00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	25	30	40	31	32	35	38	31	44	29	28	42	31	34	49	39	50	47	50	68	51	41	35	38	938
MOTOR BIKES	63	100	110	86	96	90	119	100	125	128	99	122	99	112	92	117	103	122	104	96	93	117	136	97	2526
TAXIS/CARS	83	86	112	70	92	111	18	103	115	119	83	83	82	100	104	122	107	127	122	92	125	152	125	122	2455
PICK-UP/VAN	11	16	24	11	25	27	0	29	28	18	20	38	34	19	29	28	26	43	33	28	42	36	42	41	648
SMALL BUS	0	0	2	3	5	16	0	7	4	0	4	5	0	10	8	3	4	0	4	3	6	3	6	22	115
MED BUS/MUMMY WAGONS	0	1	1	0	0	0	3	2	0	0	1	2	0	4	3	3	4	0	2	0	3	2	2	2	35
LARGE BUS	0	0	0	0	0	0	5	0	0	1	2	0	0	0	3	0	4	1	2	0	1	0	1	0	20
LIGHT TRUCK	3	0	1	1	5	1	0	4	2	1	3	1	1	8	4	4	4	7	3	6	4	4	2	2	71
MEDIUM TRUCK	1	1	2	0	1	1	1	0	1	0	2	3	1	0	1	1	1	0	1	1	4	1	1	0	25
HEAVY TRUCK	0	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	1	1	1	0	1	11
SEMI-TRAILER (LIGHT)	1	0	1	1	1	0	0	0	1	0	1	1	2	0	0	1	1	0	1	0	0	0	1	0	13
SEMI-TRAILER (HEAVY)	0	1	7	0	0	0	0	2	0	2	6	0	4	0	2	6	0	0	0	0	0	1	0	1	32
TRUCK TRAILER	1	0	1	1	1	1	1	0	1	0	0	0	2	0	1	0	1	0	1	0	1	0	0	0	13
EXTRA LARGE TRUCK & OTHERS	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	1	1	1	9
TOTAL	189	236	302	204	259	282	186	279	321	300	249	298	256	288	296	324	306	349	323	295	331	359	352	327	6911

Appendix 2b: Manual Classified Counts Data on the Bolga Road

CENSUS POINT: GOIL FILLING STATION
DIRECTION: TAMALE - BOLGA
STATION NUMBER A
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	28	17	30	24	32	35	32	28	52	24	50	31	47	43	48	46	0	33	53	13	18	18	0	28	730
MOTOR BIKES	40	31	43	51	89	119	126	176	172	129	158	183	153	142	113	143	106	103	72	114	82	138	143	103	2729
TAXIS/CARS	32	36	61	63	79	120	126	126	158	125	138	154	128	146	130	119	119	131	126	115	92	126	112	118	2680
PICK-UP/VAN	7	5	11	16	26	21	18	28	26	18	21	22	38	29	29	23	28	21	19	33	18	33	41	38	569
SMALL BUS	1	2	1	2	1	2	10	2	3	3	1	4	5	4	2	5	8	3	3	8	2	3	2	4	81
MED BUS/MUMMY WAGONS	0	2	1	5	5	3	3	2	2	2	4	3	4	8	5	4	8	8	2	7	2	6	4	2	92
LARGE BUS	1	0	5	0	1	1	0	2	1	0	2	4	2	0	2	1	1	0	4	4	0	2	0	2	35
LIGHT TRUCK	2	2	2	3	1	3	3	1	2	3	2	4	3	1	4	6	2	3	1	5	3	4	5	2	67
MEDIUM TRUCK	3	1	1	3	1	1	1	1	4	1	0	1	0	5	6	1	6	1	3	4	1	0	1	3	49
HEAVY TRUCK	1	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	6	4	1	0	0	2	1	20
SEMI-TRAILER (LIGHT)	0	2	1	2	0	2	3	0	3	8	0	1	2	0	0	1	1	0	0	1	1	1	0	0	29
SEMI-TRAILER (HEAVY)	0	1	1	0	2	0	0	1	1	1	1	5	2	6	0	4	3	1	2	0	2	0	3	1	37
TRUCK TRAILER	0	0	0	0	0	1	0	0	0	3	0	1	4	1	1	0	0	0	1	1	0	1	0	0	14
EXTRA LARGE TRUCK & OTHERS	0	1	1	0	1	0	1	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0	10
TOTAL	115	100	158	169	238	309	323	367	426	318	379	413	389	385	340	354	283	310	291	306	221	332	314	302	7142

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	13	43	22	32	36	28	23	17	10	13	17	17	0	10	26	13	22	13	13	17	8	8	13	0	414
MOTOR BIKES	99	115	147	148	151	139	162	167	59	97	159	119	176	128	148	153	100	126	153	93	102	128	109	40	3018
TAXIS/CARS	106	96	114	93	86	73	113	118	92	103	113	92	116	108	96	76	88	86	86	79	94	88	70	96	2282
PICK-UP/VAN	24	27	27	15	24	22	19	24	38	23	28	24	21	20	17	22	30	22	26	21	21	15	32	28	570
SMALL BUS	3	2	3	2	1	5	1	3	3	3	3	3	0	4	1	3	4	1	5	0	1	0	2	3	56
MED BUS/MUMMY WAGONS	9	2	6	1	5	3	5	4	3	2	3	3	3	1	2	3	2	4	3	4	2	7	3	5	85
LARGE BUS	2	0	2	0	3	0	0	2	3	2	2	0	4	0	1	2	1	1	2	5	4	2	1	0	39
LIGHT TRUCK	4	4	2	5	4	6	3	5	1	2	2	4	4	6	7	4	4	5	5	7	4	2	2	4	96
MEDIUM TRUCK	2	1	1	1	1	4	2	4	2	0	2	1	1	3	6	1	4	3	3	2	2	0	1	1	48
HEAVY TRUCK	0	0	0	1	0	10	1	0	0	1	1	1	2	4	1	1	0	2	1	0	1	2	4	0	33
SEMI-TRAILER (LIGHT)	1	1	0	1	1	0	0	0	5	0	0	0	0	1	4	1	0	0	0	0	1	0	0	1	17
SEMI-TRAILER (HEAVY)	1	1	1	2	0	0	3	1	0	1	0	1	1	0	1	0	5	4	1	1	1	1	1	4	31
TRUCK TRAILER	0	3	0	1	0	2	0	0	1	0	0	0	1	1	0	1	1	2	0	1	0	1	1	0	16
EXTRA LARGE TRUCK & OTHERS	1	0	1	0	4	0	0	0	1	1	0	0	1	0	2	0	0	0	0	0	1	0	0	1	13
TOTAL	265	295	326	302	316	292	332	345	218	248	330	265	330	286	312	280	261	269	298	230	242	254	239	183	6718

Appendix 3a. Manual Classified Counts Data on the Daboya Road

CENSUS POINT: ASHFOAM DEPOT
DIRECTION: DABOYA - TAMALE
STATION NUMBER B
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	23	30	36	45	45	40	40	35	35	40	30	38	52	52	75	44	58	64	2	50	40	13	35	16	938
MOTOR BIKES	19	30	25	51	65	63	111	55	65	80	80	82	50	40	25	50	113	139	95	15	123	68	65	145	1654
TAXIS/CARS	12	30	35	43	40	53	95	68	70	90	40	75	82	103	85	133	134	163	4	80	75	50	50	30	1640
PICK-UP/VAN	0	0	2	3	3	7	1	25	10	21	27	21	18	21	28	37	57	29	28	22	8	14	6	10	398
SMALL BUS	0	0	1	4	1	2	3	16	1	1	0	20	27	21	15	39	20	46	11	5	1	2	5	6	247
MED BUS/MUMMY WAGONS	0	0	0	1	0	0	1	5	5	6	2	18	28	0	22	25	21	18	3	3	0	4	0	0	162
LARGE BUS	0	0	1	1	1	0	0	0	5	0	0	17	16	17	0	32	24	15	0	8	1	1	3	0	142
LIGHT TRUCK	0	0	0	0	2	2	0	10	0	7	15	25	12	18	0	20	25	48	7	3	0	1	0	6	201
MEDIUM TRUCK	0	0	1	1	4	3	11	10	15	20	15	25	19	5	24	20	29	23	1	22	3	2	2	3	258
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	5	17	3	0	4	0	13	19	0	1	0	0	1	0	63
SEMI-TRAILER (LIGHT)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4
SEMI-TRAILER (HEAVY)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	2	6
TRUCK TRAILER	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	5
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	57	91	101	149	161	170	262	224	206	265	214	338	307	277	281	400	496	566	151	209	251	155	167	220	5718

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	18	3	20	62	25	46	23	25	24	20	26	27	21	25	23	51	15	10	23	27	36	65	118	121	854
MOTOR BIKES	95	32	100	67	107	50	50	77	50	53	51	75	25	53	10	86	20	65	73	58	67	81	125	119	1589
TAXIS/CARS	43	10	133	100	86	50	50	81	41	43	40	50	40	45	60	69	70	61	50	50	70	61	95	67	1465
PICK-UP/VAN	16	12	1	28	12	11	19	25	9	11	7	8	17	11	1	28	15	1	18	8	18	23	12	13	324
SMALL BUS	2	0	1	13	3	8	7	7	11	4	1	3	1	3	0	3	20	0	2	1	17	4	3	9	123
MED BUS/MUMMY WAGONS	3	5	25	3	12	2	3	0	0	0	0	1	0	5	0	0	0	3	1	0	16	5	6	4	94
LARGE BUS	2	0	3	8	2	11	6	0	4	0	1	8	0	1	0	4	0	0	0	0	2	0	1	7	60
LIGHT TRUCK	1	0	7	6	13	2	3	14	8	3	1	1	3	2	1	5	1	5	5	1	6	10	5	10	113
MEDIUM TRUCK	2	0	2	1	0	0	2	21	0	0	0	3	0	1	1	5	2	5	6	3	2	0	0	7	63
HEAVY TRUCK	0	0	6	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	9	0	8	0	0	2	28
SEMI-TRAILER (LIGHT)	0	0	0	8	1	0	4	0	0	0	0	0	1	0	0	0	2	1	0	0	0	0	1	0	18
SEMI-TRAILER (HEAVY).	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	1	1	3	3	0	2	0	17
TRUCK TRAILER	0	0	2	0	0	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	9
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	182	62	300	298	261	181	167	250	153	134	128	178	108	146	97	251	145	153	188	151	245	249	368	362	4757

Appendix 3b. Manual Classified Counts Data on the Daboya Road

CENSUS POINT: ASHFOAM DEPOT
DIRECTION: TAMALE - DABOYA
STATION NUMBER B
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	22	22	32	49	38	41	18	32	41	32	32	20	37	40	40	50	30	38	35	48	53	37	58	54	899
MOTOR BIKES	23	25	33	50	40	69	70	90	80	134	90	110	107	124	73	107	100	66	95	82	82	62	57	62	1831
TAXIS/CARS	9	24	30	38	38	37	43	40	65	56	75	80	83	67	42	60	82	77	48	89	108	61	56	54	1362
PICK-UP/VAN	0	4	3	7	6	6	6	16	7	13	9	10	7	13	10	15	4	2	8	3	2	12	12	9	184
SMALL BUS	3	2	1	1	3	4	6	4	3	3	2	6	4	9	1	4	3	3	4	2	1	2	6	2	79
MED BUS/MUMMY WAGONS	0	0	1	0	3	2	2	5	0	1	2	5	6	2	6	3	4	1	0	1	0	0	1	1	46
LARGE BUS	1	0	1	0	1	0	0	2	0	2	1	1	2	2	0	1	1	0	1	2	2	0	1	1	22
LIGHT TRUCK	0	2	1	3	4	3	3	5	3	0	5	0	0	0	3	0	2	2	1	1	0	0	1	1	40
MEDIUM TRUCK	0	0	2	4	2	3	7	3	1	6	3	5	3	6	4	5	1	1	0	2	2	1	1	0	62
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	3
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	1	7
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	58	79	104	153	136	165	155	197	200	247	219	237	252	263	179	245	228	191	192	230	250	175	195	186	4536

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	25	0	25	27	13	38	12	33	31	33	37	20	0	10	20	25	69	92	45	80	45	20	17	28	745
MOTOR BIKES	85	60	48	87	70	43	21	57	35	56	53	65	51	61	39	48	56	55	117	83	50	50	15	70	1375
TAXIS/CARS	80	50	64	57	40	38	27	48	28	65	42	46	37	57	39	41	44	25	80	67	39	41	21	50	1126
PICK-UP/VAN	6	14	12	6	9	8	0	2	3	7	7	3	4	3	4	6	2	3	3	4	10	18	4	5	143
SMALL BUS	3	1	2	0	1	7	1	2	1	2	5	1	1	4	2	2	2	3	0	2	3	8	2	4	59
MED BUS/MUMMY WAGONS	1	5	2	2	0	1	0	0	0	0	1	2	1	3	0	3	1	4	2	0	1	0	1	2	32
LARGE BUS	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1	7
LIGHT TRUCK	1	1	1	2	3	1	1	0	1	2	2	1	0	0	1	2	0	2	3	4	3	1	2	1	35
MEDIUM TRUCK	1	2	0	2	1	0	1	0	0	0	0	0	1	2	0	1	1	1	2	2	0	2	0	2	21
HEAVY TRUCK	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0	6
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	3
TRUCK TRAILER	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	3	0	0	0	0	0	7
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	202	133	155	183	137	136	64	145	99	166	149	141	95	142	106	130	178	186	255	243	151	140	62	163	3561

Appendix 4a: Manual Classified Counts Data on the Kumbungu Road

CENSUS POINT: BONZALI RURAL BANK
DIRECTION: KUMBUNGU - TAMALE
STATION NUMBER C
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	34	43	38	50	52	76	72	76	30	61	47	73	53	69	108	35	44	63	93	53	107	54	45	51	1427
MOTOR BIKES	25	30	42	45	68	98	156	126	230	150	120	163	103	94	148	103	127	102	106	103	118	142	81	85	2565
TAXIS/CARS	21	28	41	61	66	111	191	266	150	170	175	165	166	235	247	243	109	246	213	244	158	153	78	115	3652
PICK-UP/VAN	13	3	4	7	8	28	51	41	15	29	26	15	6	17	17	7	8	13	16	21	23	33	8	8	417
SMALL BUS	1	1	6	13	6	3	6	3	1	1	2	2	2	2	0	1	2	3	4	0	1	1	0	0	61
MED BUS/MUMMY WAGONS	0	0	0	0	6	6	11	7	15	16	8	6	12	8	14	3	3	23	11	2	10	6	1	6	174
LARGE BUS	0	0	0	0	0	0	0	0	0	0	0	1	0	0		0	0	2	0	1	0	0	0	0	4
LIGHT TRUCK	6	2	7	6	2	11	11	15	9	8	15	8	4	23	12	13	8	64	23	26	10	13	3	11	310
MEDIUM TRUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	11
SEMI-TRAILER (LIGHT)	0	0	0	0	3	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TRUCK TRAILER	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
TOTAL	100	107	138	182	212	333	500	536	450	435	393	434	346	448	546	405	301	517	466	450	427	403	219	276	8624

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	37	52	51	54	55	28	103	91	48	45	70	63	36	46	56	57	44	35	39	87	62	52	44	54	1309
MOTOR BIKES	60	58	76	78	106	150	111	133	98	106	116	100	98	95	109	99	104	84	163	191	126	107	153	133	2654
TAXIS/CARS	81	85	175	132	53	65	163	108	61	100	88	84	81	63	104	83	65	77	101	133	53	60	87	155	2257
PICK-UP/VAN	13	8	17	9	3	8	13	6	9	6	11	8	4	5	13	28	12	11	3	7	6	6	9	6	221
SMALL BUS	1	1	0	0	2	1	0	2	1	1	3	0	0	1	1	2	0	0	2	1	7	0	0	0	26
MED BUS/MUMMY WAGONS	2	2	3	0	0	1	8	13	7	2	3	6	2	0	3	0	2	1	4	1	0	2	1	1	64
LARGE BUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2
LIGHT TRUCK	3	3	18	2	7	7	14	23	2	11	3	4	18	4	8	3	18	3	13	4	6	4	3	6	187
MEDIUM TRUCK	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (LIGHT)	1	0	2	0	0	0	0	0	2	3	2	3	3	1	0	0	0	0	2	0	1	0	0	0	20
SEMI-TRAILER (HEAVY)	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3
TRUCK TRAILER	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	198	210	342	276	226	261	412	376	228	274	297	269	242	215	294	273	245	211	327	424	262	231	297	355	6745

Appendix 4b: Manual Classified Counts Data on the Kumbungu Road

CENSUS POINT: BONZALI RURAL BANK
DIRECTION: TAMALE - KUMBUNGU
STATION NUMBER C
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	15	21	27	25	19	22	40	38	20	29	28	26	31	32	36	25	38	17	12	18	36	25	25	28	633
MOTOR BIKES	17	19	38	36	42	44	50	75	82	75	63	68	75	74	74	63	87	42	36	67	95	74	70	58	1424
TAXIS/CARS	8	23	22	25	38	41	44	43	44	40	41	47	47	55	50	41	47	38	35	33	56	31	25	35	909
PICK-UP/VAN	1	3	7	5	3	5	3	3	3	6	11	6	3	6	4	0	5	1	7	4	6	4	4	6	106
SMALL BUS	1	1	0	0	2	1	1	1	3	3	2	1	1	3	2	0	0	2	2	0	3	2	1	2	34
MED BUS/MUMMY WAGONS	0	0	0	0	0	0	0	0	0	1	4	2	0	1	0	0	4	0	0	1	3	2	0	0	18
LARGE BUS	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	4
LIGHT TRUCK	4	5	5	3	1	3	5	0	4	4	1	3	2	2	4	1	5	0	0	6	1	2	0	3	64
MEDIUM TRUCK	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	6
HEAVY TRUCK	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	46	72	99	94	106	116	143	160	159	159	151	153	160	174	170	130	187	101	92	129	201	140	125	132	3199

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	12	20	23	10	24	8	11	20	19	10	12	7	16	35	30	20	25	40	28	40	35	25	48	97	615
MOTOR BIKES	40	55	55	49	41	37	50	36	25	10	58	98	90	85	49	100	65	90	70	90	85	97	140	150	1665
TAXIS/CARS	42	26	33	30	49	26	70	38	25	26	40	90	90	50	45	97	65	100	65	75	85	118	75	245	1605
PICK-UP/VAN	7	1	4	2	7	2	1	3	0	2	0	6	4	1	5	1	0	5	10	3	2	3	3	15	87
SMALL BUS	2	1	2	3	1	1	0	1	0	1	0	1	3	1	1	0	1	0	1	2	0	1	1	4	28
MED BUS/MUMMY WAGONS	0	1	0	1	0	1	0	2	0	0	1	0	1	0	2	0	0	0	0	2	0	1	0	2	14
LARGE BUS	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	3
LIGHT TRUCK	2	1	2	0	0	2	2	1	0	1	1	0	2	0	2	1	3	0	0	1	0	1	0	2	24
MEDIUM TRUCK	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (LIGHT)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHE	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	107	105	120	96	123	77	134	101	69	50	113	202	206	172	135	219	159	235	174	215	207	246	267	515	4047

Appendix 5a: Manual Classified Counts Data on the Dagomba Road

CENSUS POINT: NASANT VENTURES
DIRECTION: ADB - SSNIT FLATS
STATION NUMBER D
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	20	25	35	40	19	38	45	42	85	55	38	36	41	33	38	56	59	56	45	43	35	49	36	36	1005
MOTOR BIKES	12	18	25	36	41	67	68	81	93	65	78	71	70	80	91	82	95	74	88	86	68	61	95	100	1645
TAXIS/CARS	18	23	24	37	35	48	47	63	58	57	54	50	36	28	40	61	52	43	33	46	42	48	51	47	1041
PICK-UP/VAN	3	3	3	7	7	16	11	14	33	24	18	21	15	13	10	24	8	16	10	16	16	15	28	22	353
SMALL BUS	1	1	0	0	1	1	4	2	3	2	0	1	1	1	3	0	1	0	2	6	1	1	2	2	36
MED BUS/MUMMY WAGONS	0	1	0	0	2	1	1	1	3	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	13
LARGE BUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
LIGHT TRUCK	0	1	0	1	0	2	0	2	2	3	0	2	1	1	3	3	2	2	1	1	1	1	3	1	33
MEDIUM TRUCK	0	0	0	0	1	0	0	0	2	1	0	2	0	0	0	1	0	0	0	1	0	0	0	0	8
HEAVY TRUCK	0	1	0	1	1	1	0	1	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	8
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	54	73	87	122	107	174	176	206	279	210	189	183	166	156	186	228	217	191	179	199	163	175	215	209	4144

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	30	50	43	47	36	45	28	30	38	42	33	46	46	20	30	20	28	50	51	57	80	57	49	80	1036
MOTOR BIKES	75	105	73	94	69	84	69	84	82	80	81	93	93	50	78	75	60	94	99	70	86	75	88	136	1993
TAXIS/CARS	38	50	27	59	35	57	48	50	64	46	51	64	69	62	58	47	60	62	48	43	54	48	83	91	1314
PICK-UP/VAN	27	34	18	24	28	33	19	21	47	20	27	30	46	36	54	33	22	31	17	11	22	20	20	19	659
SMALL BUS	3	7	2	9	2	4	1	4	0	4	5	4	0	5	3	2	4	4	2	2	0	2	0	3	72
MED BUS/MUMMY WAGONS	0	0	0	0	1	1	0	0	0	1	0	2	0	1	2	0	1	1	1	0	2	0	0	1	14
LARGE BUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIGHT TRUCK	1	4	1	4	1	3	2	3	0	2	1	4	3	2	3	4	5	4	0	6	2	3	4	1	63
MEDIUM TRUCK	0	0	1	1	1	1	2	2	0	1	0	1	0	1	1	0	0	1	0	0	1	0	0	0	14
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	1	2	2	1	0	1	1	1	0	1	0	0	1	0	0	11
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	174	250	165	238	173	228	169	194	231	197	200	246	258	177	230	182	181	247	219	189	247	206	244	331	5176

Appendix 5b: Manual Classified Counts Data on the Dagomba Road

CENSUS POINT: NASANT VENTURES
DIRECTION: SSNIT FLATS - ADB
STATION NUMBER D
DATE: 12/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	24	39	34	41	43	49	44	61	37	36	50	45	54	35	41	43	37	50	32	39	53	43	34	35	999
MOTOR BIKES	19	24	32	49	50	80	100	99	100	87	100	62	88	100	112	109	88	87	115	106	115	113	92	96	2023
TAXIS/CARS	14	29	24	50	62	43	67	72	99	69	62	60	60	43	63	42	47	47	49	44	47	64	56	47	1260
PICK-UP/VAN	2	4	5	3	13	13	12	12	19	16	9	17	38	15	19	16	18	14	18	16	22	10	12	12	335
SMALL BUS	1	0	1	2	3	2	2	0	1	2	0	3	7	1	3	4	1	1	1	2	0	1	0	1	39
MED BUS/MUMMY WAGONS	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	7
LARGE BUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
LIGHT TRUCK	2	0	2	0	2	1	2	1	0	3	3	0	7	2	2	0	2	1	0	3	3	1	2	1	40
MEDIUM TRUCK	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	1	1	1	2	0	2	1	1	13
HEAVY TRUCK	0	0	0	0	1	0	1	0	1	0	2	2	0	0	1	1	0	1	0	0	0	0	2	1	13
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	62	97	98	145	175	188	229	245	258	214	226	190	254	197	244	216	196	202	216	212	240	234	199	194	4731

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	40	75	59	78	29	50	38	69	50	23	64	56	65	68	79	74	72	57	41	39	58	47	45	64	1340
MOTOR BIKES	87	93	91	100	89	100	100	100	83	90	88	116	82	95	99	90	78	99	100	100	137	115	100	100	2332
TAXIS/CARS	54	58	50	53	59	49	58	73	43	68	44	64	61	43	57	63	49	39	59	50	60	53	53	52	1312
PICK-UP/VAN	25	37	23	33	14	20	18	38	17	19	18	35	23	19	27	23	27	17	17	14	16	13	12	10	515
SMALL BUS	3	2	3	3	1	0	0	5	1	0	2	7	3	9	3	1	3	1	2	0	1	2	1	1	54
MED BUS/MUMMY WAGONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3
LARGE BUS	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
LIGHT TRUCK	1	3	3	6	1	1	2	4	2	0	2	4	6	15	7	3	8	0	4	1	1	3	1	2	80
MEDIUM TRUCK	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1	0	8
HEAVY TRUCK	0	0	0	2	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	5
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
SEMI-TRAILER (HEAVY)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	210	271	229	276	193	220	216	290	196	200	223	282	240	249	273	255	237	215	223	205	275	234	213	231	5656

Appendix 6a: Manual Classified Counts Data on the Gukpegu Road

CENSUS POINT:
DIRECTION: CENTRAL MOSQUE - PICORNA
STATION NUMBER E
DATE: 18/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	65	64	45	37	74	92	78	57	74	61	49	80	28	45	93	78	52	33	36	38	54	54	41	50	1378
MOTOR BIKES	137	110	87	25	116	101	102	130	109	64	89	110	54	106	94	115	125	92	98	83	105	100	113	110	2375
TAXIS/CARS	53	45	21	18	46	44	43	31	44	24	34	32	12	53	24	31	41	40	41	48	46	51	52	44	918
PICK-UP/VAN	16	16	7	3	19	19	12	17	20	8	25	20	12	18	16	12	20	9	10	23	9	12	18	25	366
SMALL BUS	3	2	0	1	0	1	0	4	1	1	0	4	1	3	2	1	1	3	1	2	0	2	3	5	41
MED BUS/MUMMY WAGONS	1	0	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	7
LARGE BUS	1	1	3	2	1	1	1	3	0	0	1	0	0	0	0	1	1	0	1	3	0	0	0	1	21
LIGHT TRUCK	5	5	1	3	1	2	2	1	1	4	4	5	0	3	1	3	3	4	2	4	4	2	2	4	66
MEDIUM TRUCK	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	5
HEAVY TRUCK	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	1	1	1	0	0	7
SEMI-TRAILER (LIGHT)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	282	243	166	89	259	260	239	243	250	163	203	252	107	228	231	242	245	182	190	202	220	222	229	239	5186

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	38	61	56	61	62	32	58	56	42	50	43	40	78	48	44	61	59	50	37	54	45	71	26	9	1181
MOTOR BIKES	86	105	110	75	123	41	62	90	72	101	114	121	126	111	104	110	89	90	85	114	68	90	13	13	2113
TAXIS/CARS	50	42	44	40	30	13	17	31	32	45	65	46	52	53	55	44	40	60	29	33	24	26	7	1	879
PICK-UP/VAN	12	19	15	10	13	4	10	10	10	10	4	17	14	11	15	21	18	15	15	22	12	17	1	0	295
SMALL BUS	3	3	1	2	1	1	0	1	2	1	0	2	0	0	0	4	2	0	2	1	1	2	0	0	29
MED BUS/MUMMY WAGONS	0	0	2	0	1	1	0	1	1	0	0	0	2	3	0	0	0	1	3	1	0	0	0	0	16
LARGE BUS	0	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	1	0	0	1	0	0	0	8
LIGHT TRUCK	3	6	4	3	3	3	5	0	1	0	0	1	0	4	2	0	0	2	6	4	2	2	3	2	56
MEDIUM TRUCK	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	1	1	0	0	0	0	6
HEAVY TRUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	2	0	0	0	0	5
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	192	237	232	191	233	95	152	189	161	210	229	227	273	232	221	240	209	220	178	232	153	208	50	25	4589

Appendix 6b: Manual Classified Counts Data on the Gukpegu Road

CENSUS POINT:
DIRECTION: PICORNA - CENTRAL MOSQUE
STATION NUMBER E
DATE: 18/03/08

VEHICLE TYPE	6.00-6.15am	6.15-6.30am	6.30-6.45am	6.45-7.00am	7.00-7.15am	7.15-7.30am	7.30-7.45am	7.45-8:00am	8.00-8.15am	8.15-8.30pm	8.30-8.45am	8.45-9.00am	9.00-9.15am	9.15-9.30am	9.30-9.45am	9.45-10.00am	10.00-10.15am	10.15-10.30am	10.30-10.45am	10.45-11.00am	11.00-11.15am	11.15-11.30am	11.30-11.45am	11.45-12.00pm	TOTAL
CYCLES	35	73	89	90	108	76	90	75	49	58	44	39	40	53	47	38	40	40	46	47	18	26	33	38	1292
MOTOR BIKES	7	14	22	32	33	61	47	80	64	64	83	75	68	67	58	50	71	56	80	82	39	78	57	69	1357
TAXIS/CARS	6	2	2	3	5	6	19	9	9	17	9	7	11	9	12	7	9	3	18	13	6	15	15	19	231
PICK-UP/VAN	0	2	1	2	0	5	3	10	3	4	7	16	10	10	14	9	7	7	8	9	6	12	5	10	160
SMALL BUS	0	0	0	1	0	1	1	1	0	1	0	0	0	1	1	2	0	0	0	0	0	0	0	0	9
MED BUS/MUMMY WAGONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LARGE BUS	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
LIGHT TRUCK	2	2	1	3	0	0	1	0	1	3	0	1	1	0	3	0	1	2	3	2	0	0	1	1	28
MEDIUM TRUCK	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	3
HEAVY TRUCK	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	4
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	3
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50	93	115	131	147	149	161	177	126	147	143	138	132	140	137	106	128	108	155	153	72	132	111	138	3089

VEHICLE TYPE	12.00-12.15am	12.15-12.30am	12.30-12.45am	12.45-1.00pm	1.00-1.15pm	1.15-1.30Pm	1.30-1.45pm	1.45-2:00Pm	2.00-2.15pm	2.15-2.30pm	2.30-2.45pm	2.45-3.00pm	3.00-3.15pm	3.15-3.30pm	3.30-3.45pm	3.45-4.00pm	4.00-4.15pm	4.15-4.30pm	4.30-4.45am	4.45-5.00pm	5.00-5.15am	5.15-5.30am	5.30-5.45am	5.45-6.00pm	TOTAL
CYCLES	25	42	26	27	29	37	36	27	51	36	38	31	34	41	54	32	50	47	64	44	47	42	33	52	945
MOTOR BIKES	70	75	63	83	80	94	41	95	79	100	78	67	55	90	87	88	71	75	79	86	80	53	81	92	1862
TAXIS/CARS	18	12	10	14	10	16	15	12	10	11	17	10	15	12	11	9	8	8	12	13	12	5	15	11	286
PICK-UP/VAN	12	11	9	13	7	17	20	15	12	11	8	15	11	12	9	15	11	8	17	15	18	9	14	12	301
SMALL BUS	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	2	4	1	3	0	16
MED BUS/MUMMY WAGONS	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
LARGE BUS	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
LIGHT TRUCK	3	2	0	0	2	2	0	2	1	2	1	1	1	2	0	0	1	1	1	0	2	3	2	4	33
MEDIUM TRUCK	0	0	0	0	0	0	1	1	0	1	0	1	1	2	1	0	0	0	0	0	0	1	0	0	9
HEAVY TRUCK	0	0	0	0	1	0	0	0	0	0	0	2	1	0	1	0	0	0	1	0	0	0	0	0	6
SEMI-TRAILER (LIGHT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
SEMI-TRAILER (HEAVY)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRUCK TRAILER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXTRA LARGE TRUCK & OTHERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	128	142	108	138	129	166	114	154	154	161	142	127	118	159	164	145	143	140	174	161	163	114	148	171	3463

Appendix 7: Summary of Manual Classified Counts

VEHICLE TYPE	BOLGA ROAD					DABOYA ROAD					KUMBUNGU ROAD				
	12-HOUR VOLUME	24-HOUR VOLUME	ADT	AADT	% OF TOTAL	12-HOUR VOLUME	24-HOUR VOLUME	ADT	AADT	% OF TOTAL	12-HOUR VOLUME	24-HOUR VOLUME	ADT	AADT	% OF TOTAL
CYCLES	3297	3623	4819	4963	12.0	3436	3776	5022	5173	18.50	3984	4378	5823	5997	17.62
MOTOR BIKES	10136	11138	14814	15259	36.8	6449	7087	9425	9708	34.72	8308	9130	12142	12507	36.74
TAXIS/CARS	10303	11322	15058	15510	37.4	5593	6146	8174	8420	30.12	8423	9256	12311	12680	37.25
PICK-UP/VAN	2258	2481	3300	3399	8.2	1049	1153	1533	1579	5.65	831	913	1215	1251	3.67
SMALL BUS	354	389	517	533	1.3	508	558	742	765	2.74	149	164	218	224	0.66
MED BUS/MUMMY WAGON	259	285	379	390	0.9	334	367	488	503	1.80	270	297	395	406	1.19
LARGE BUS	106	116	155	160	0.4	231	254	338	348	1.24	13	14	19	20	0.06
LIGHT TRUCK	287	315	419	432	1.0	389	427	569	586	2.09	585	643	855	881	2.59
MEDIUM TRUCK	157	173	229	236	0.6	404	444	590	608	2.18	11	12	16	17	0.05
HEAVY TRUCK	81	89	118	122	0.3	98	108	143	148	0.53	2	2	3	3	0.01
SEMI-TRAILER (LIGHT)	75	82	110	113	0.3	27	30	39	41	0.15	32	35	47	48	0.14
SEMI-TRAILER (HEAVY)	127	140	186	191	0.5	26	29	38	39	0.14	3	3	4	5	0.01
TRUCK TRAILER	54	59	79	81	0.2	28	31	41	42	0.15	2	2	3	3	0.01
EXTRA LARGE TRUCK & O	49	54	72	74	0.2	0	0	0	0	0.00	2	2	3	3	0.01
TOTAL	**27543**	**30267**	**40255**	**41463**	**100.0**	**18572**	**20408.7912**	**27144**	**27958.0031**	**100**	**22615**	**24852**	**33053**	**34044**	**100**
VEHICLE GROUP ANALYSIS															
LIGHT	26348	28954	38509	39664	95.7	17035	18719.7802	24897	25644	91.7	21695	23841	31708	32659	95.9
MEDIUM	652	716	953	982	2.4	954	1048	1394	1436	5.1	868	954	1269	1307	3.8
HEAVY	543	597	794	817	2.0	583	641	852	878	3.1	52	57	76	78	0.2
TOTAL	**27543**	**30267**	**40255**	**41463**	**100.0**	**18572**	**20408.7912**	**27144**	**27958**	**100.0**	**22615**	**24852**	**33053**	**34044**	**100.0**

VEHICLE TYPE	DAGOMBA ROAD					GUKPEGU ROAD				
	12-HOUR VOLUME	24-HOUR VOLUME	ADT	AADT	% OF TOTAL	12-HOUR VOLUME	24-HOUR VOLUME	ADT	AADT	% OF TOTAL
CYCLES	4380	4813	6402	6594	22.23	4796	5270	7010	7220	29.37
MOTOR BIKES	7993	8784	11682	12033	40.56	7707	8469	11264	11602	47.20
TAXIS/CARS	4927	5414	7201	7417	25.00	2314	2543	3382	3483	14.17
PICK-UP/VAN	1862	2046	2721	2803	9.45	1122	1233	1640	1689	6.87
SMALL BUS	201	221	294	303	1.02	95	104	139	143	0.58
MED BUS/MUMMY WAGON	37	41	54	56	0.19	25	27	37	38	0.15
LARGE BUS	4	4	6	6	0.02	32	35	47	48	0.20
LIGHT TRUCK	216	237	316	325	1.10	183	201	267	275	1.12
MEDIUM TRUCK	43	47	63	65	0.22	23	25	34	35	0.14
HEAVY TRUCK	37	41	54	56	0.19	22	24	32	33	0.13
SEMI-TRAILER (LIGHT)	5	5	7	8	0.03	6	7	9	9	0.04
SEMI-TRAILER (HEAVY)	1	1	1	2	0.01	1	1	1	2	0.01
TRUCK TRAILER	0	0	0	0	0.00	1	1	1	2	0.01
EXTRA LARGE TRUCK & O	1	1	1	2	0.01	0	0	0	0	0.00
TOTAL	**19707**	**21656**	**28803**	**29667**	**100.00**	**16327**	**17942**	**23863**	**24578**	**100.00**
VEHICLE GROUP ANALYSIS										
LIGHT	19363	21278	28300	29149	98.3	16034	17620	23434	24137	98.2
MEDIUM	257	282	376	387	1.3	240	264	351	361	1.5
HEAVY	87	96	127	131	0.4	53	58	77	80	0.3
TOTAL	**19707**	**21656**	**28803**	**29667**	**100.0**	**16327**	**17942**	**23863**	**24578**	**100.0**

AADT = $V_{24\text{-hour}}$ * D.F * M.F

$\frac{V_{12\text{-hour}} \text{ (automatic count)}}{V24_{\text{-hour}} \text{ (automatic count)}}$ = 0.91 (This factor used to adjust 12-hour volumes to 24-hour volumes)

D.F(Daily Variation Factor) = 1.33 (Source, GHA)

M.F(Monthly Variation Factor) = 1.01

N.B: Automatic Counts Undertaken by the BRRI in October, 2000

Appendix 8: Travel Time and Delay Studies Form

Date			City	Region Code	Metro Code	Sub Metro	Road Class	Road No.	Link No.	Veh Type	Sheet No.	Enumerator	Approved By		
Day	Month	Year													

Origin/Destination	Length (Km)	Direction (To & From)	Start Time	End Time	Peak Operating Speed	Stopped Time Delays	Highest Delay (Sec.)	Comments