Chapter 7 Weighbridges and their Operations and Management

7.1 Introduction

7.1.1 Background

The efficient and effective control of overloading in the EAC Partner States requires the adoption of a harmonized approach to a variety of factors related to the operation and management of weighbridges. These factors include:

- Type and characteristics of weighbridges operated;
- Location of weighbridges on the regional road network;
- Management of weighbridges;
- Weighbridge operations and procedures;
- Personnel involved in overload control operations; and
- Weighbridge verification and calibration.

7.1.2 Purpose and Scope

The purpose of this chapter is to recommend a harmonized approach to the operation and management of weighbridges in the EAC region based on regional (SADC/COMESA) and international best practice. The overall goal is to achieve efficient and effective control of overloading in the EAC region as a basis for reducing the accelerated deterioration of road networks and, as a consequence, reducing total transport costs.

7.1.3 Approach and Methodology

In order to adequately address the scope of work implied in addressing the various factors related to weighbridge operations and management listed above, the following tasks were undertaken:

Task 1: A Review of the existing situation in EAC Partner States;

Task 2: A review of relevant background information as a framework for assessing the existing situation; and

Task 3: An analysis of the issues arising from the review of the existing situation, including recommendations for improving weighbridge operations and management in the EAC region.

7.2 Review of the Existing Situation

7.2.1 General

In order to adequately address the factors listed in Section 7.1.1, the following tasks were undertaken:

- Visits were made to all EAC Partner States during which interviews pertaining to various aspects of overload control operations were held with a cross-section of stakeholders. Field visits were also made to a selection of typical weighbridges in each Partner State with a view to seeing first hand the type of weighbridge facilities, manner of carrying out weighbridge operations and personnel involved

- Documents and reports were collected on all matters pertaining to overload control as listed in Section 7.1.1. Related documents were also sourced from the region and internationally on the subject matter.
- A survey questionnaire was prepared in which the relevant stakeholders were requested to reconfirm the information obtained during the country visits.

7.2.2 Findings

(1) Documentation

Informative documentation was obtained from the three EAC Partner States where overload control is carried out (Kenya, Tanzania, and Uganda). Other relevant documentation was also obtained from the SADC/COMESA region as well as from abroad (e.g., UK, Australia, Japan). [1]

(2) Weighbridges – Existing Situation

Tables 7-1 to 7-4 set out the existing situation.

Table 7-1: Type, Number, Location, and Hours of Operation

	Number of Weighbridges Operated for Controlling Axle Load and GCM Limits								
	Fixed					Location of Fixed Weighbridges			
						At border post		Inland	
Country	Single axle Scale (3.2 m × 1 m)	Axle Unit Scale (3.2 m × 4 m)	Multi-Deck Scale (3.2 m × 22 m)	Portable	WIM	No	Op hrs	No	Op hrs
Burundi	0	0	0	0	0	0	0	0	0
Kenya	13	0	0 (1)*	2	0 (2)*	3	24	10	24
Rwanda	0	0	0	0	0	0	0	0	0
Tanzania	3	14	0	14	0	2	16	15	24
Uganda	3	0	0	4	3	1	24	2	24

Notes: Figures in brackets indicate weighbridges to be installed in near future

Table 7-2: Institutional Arrangements for Overload Control Operations

	Responsibility for Overload Control Operations	
Country	Weighing of Vehicles	Enforcement of Regulations
Burundi	N/A	N/A
Kenya	Roads agency (KeNHA)	Police
Rwanda	N/A	N/A
Tanzania	Roads agency (TANROADS)	Traffic Inspectorate
Uganda	Roads agency (UNRA)	Police

[1] The main documents reviewed were: Austroads, *Weigh-in-Motion Technology, AP-R168,* 2006*;* Commonwealth of Australia, National Measurement Institute, *Weighbridge Operators Manual*, 2008*;* East African Community, *The East African Community Standardisation, Quality Assurance, Metrology Testing Act*, 2006*;* Institute of Measurement and Control, *A Guide to the Specification and Procurement of Industrial Weighing Systems*, Publication Reference Number: WGC1099, 2000; Institute of Measurement and Control, *A Code of Practice for the Calibration of Industrial Process Weighing Systems*, Publication Reference Number: WGC0496, 2003; Institute of Measurement and Control, *A Guide to Dynamic Weighing for Industry*, London WC1E 6AF, 2010; Pinard et al, *Overload Control Practices in Eastern and Southern Africa: Main Lessons Learned. SSATP Working Paper No. 91,* The World Bank, Washington, DC., 2010*;* Republic of Botswana, Weights and Measures, Chapter 43:06. Government Printer, Gaborone, 2007; Republic of Kenya, *Technical Report on Axle Load Control*, Inter-Ministerial Technical Committee on Axle Load Control, Nairobi, Kenya, 2009; SADC, *Enabling Legal Reform: Control of Vehicle Loading*, SADC Secretariat, Gaborone, 2009; South African National Department of Transport, *Guidelines for Law Enforcement in Respect of the Overloading of Goods Vehicles*, Pretoria, 2004; Standards Bureau of South Africa, *Verification of Non-Automatic Electronic Self-indicating Road Vehicle Mass Measuring Equipment for Use by Road Traffic Authorities, SANS 10343:2003*, 2003*;* Vehicle Inspectorate and LACOTS, UK, *Enforcement Weighing of Vehicles: Consolidated Code of Practice*, 2002.

Table 7-3: Personnel Involved in Overload Control Operations

	Personnel Aspects			Training Aspects			Annual Budget Amount (USD)
Country	No. of Supervisors	No. of Staff	Job Description?	Training Programme	Training Manual	Frequency of Training	
Burundi	–	–	–	–	–	–	–
Kenya	13	135	No	Yes	Yes	6 months	1,200,000
Rwanda	–	–	–	–	–	–	–
Tanzania	30	+/− 500	Yes	Yes	Yes	12 months	2,000,000
Uganda	3	31	Yes	Yes	No	Intermittent	145,000

Table 7-4: Verification, Calibration, and Weighing Tolerances

	Weighbridge Verification and Calibration Issues						
	Legal	Verification		Calibration		Tolerance	
Country	Instrument	Agency	Frequency	Agency	Frequency	Axles	GCM
Burundi	–	–	–	–	–	–	–
Kenya	W & M Act	W & M	12 months	Private sector	3 months	5%	–
Rwanda	–	–	–	–	–	–	–
Tanzania	W & M Act	W & M	12 months?	TANROADS	3 months	0%	0%
Uganda	W & M Act	None	–	Bureau of Standards	4 months	–	–

7.3 Background Information for Assessing Existing Situation

7.3.1 General

This section presents background information, including best practice approaches, on various aspects of weighbridge operations and management as listed in Section 7.1.1. This provides a good basis for assessing the adequacy of the existing situation by allowing a comparison to be made between these best practice approaches and those currently prevailing in EAC Partner States.

7.3.2 Types and Characteristics of Weighbridges

In principle, any of the following types of vehicle-weighing systems are officially recognized by the International Organisation of Legal Metrology (Organisation Internationale de Métrologie Légal, OIML) for vehicle weighing purposes:

Table 7-5: OIML Approved Types of Weighing Systems

Type of Weighing System	Vehicle Element Weighed
Static– fixed	Total weight (GCM)
Static or dynamic: low speed – fixed	Single, tandem. or tridem axle
Static or dynamic: low speed – mobile	Single, tandem, or tridem axle

OIML-approved weighing material guarantees accurate measurement results and reliability throughout time. Such certification ensures robustness and solidity standards, e.g., the weighing platform must be able to bear the breaking of a 50 tonne axle at 30 km/h without being damaged in any way. This requires that the materials used in the construction of the weighbridge have undergone a series of tests which comply with OIML standards.

Although various types of OIML-approved weighing systems may be used for vehicle weighing purposes, they exhibit varying characteristics and a careful choice must be made in relation to the main purpose of weighing the vehicle. These characteristics are summarized in Table 7-6.

Table 7-6: Weighbridge Characteristics

Type of weighbridge / Method of weighing		Fixed Weighbridges	Mobile Weighbridges
		• Easy to operate • Minimum personnel • Cargo off-loading • High installation costs • Limited placement	• Wide coverage • Difficult site selection • High operating costs • Equipment easily damaged • Police cooperation • Traffic disruption
Static	• More precision • Accepted for legal enforcement • Slower (esp. single axle scales)	• Easiest to operate • Highest level of precision • Can weigh and register axle units	• Lowest investment • Optimal for enforcement
Dynamic (WIM)	• Rapid monitoring • Lower precision • Generally not acceptable for enforcement	• Fast for monitoring • Requires large installation • Requires careful direction of vehicles	• Minimum disruption of commercial traffic • Lowest accuracy • Excellent for statistical monitoring

(1) Fixed/Static Weighing Systems

Multi-deck: Where the traffic volumes warrant it (typically > 500 vpd) a multi-deck weighbridge (also known as split-deck weighbridge) consisting of four individual decks with lengths typically of 3 m, 6 m, 7 m, and 6 m, respectively, giving an overall length of 22 m, with a width of 3.2 m should be provided. Each deck must be capable of weighing a maximum mass of 40,000 kg, giving a total weighing capacity of 160,000 kg. A standard requirement at all weighbridges should be a roof over the scale. This will improve the working conditions and will make it possible to do weighing in all weather conditions. Photograph 7-1 shows a typical 3.2 m x 22 m multi-deck weighbridge.

Photograph 7-1: Typical 3.2 m × 22 m Multi-deck Weighbridge

When configured correctly, multi-deck weighbridges can individually display the weights of all axle groups of both the truck and trailers. Digital weight indicators are assigned to each separate axle group weight to be displayed as illustrated in Photograph 7-2. A summing indicator is used to display the total vehicle mass on the multi-deck weighbridge and then relay all deck weights to a PC if required. External remote displays can also be connected to display the axle group weights back to the truck driver (Photograph 7-3).

Photograph 7-2: Vehicle Control Centre

Photograph 7-3: Digital Display of Actual and Permissible Axle Group and GCM Masses

Some of the benefits of multi-deck scales are as follows:

- static weighing which results in very accurate measurement (<1% error) of individual axles and axle unit configurations as well as GCM;
- level tolerances on the approach slabs are not normally a problem as the whole vehicle is weighed at once;
- it is relatively very quick to weigh a vehicle;
- short verification tests can easily be done without test weights (measure any axle or axle unit on each of the weighbridge decks and the results should be consistent); and
- it is more difficult to "manipulate" the weighing process, as the whole vehicle is weighed in one go (with an axle unit scale it is easy to weigh only part of an axle unit or to weigh one unit twice and skip an overloaded unit).

Axle unit scales: Where commercial traffic volumes (typically < 500 vpd) do not warrant the use of a more expensive multi-deck weighbridge, an axle unit scale can offer a cost-effective choice of weighing system. These scales are typically 3.2 m × 4 m and comprise a single deck (see Photograph 7-4) which can be connected to a digital weight indicator and are capable of weighing a maximum mass of about 40,000 kg. A digital summing indicator can then be used to display the combined weight of the individual axles and axle groups to give the GCM.

Photograph 7-4: Typical 3.2 m × 4 m Axle Unit Scale

Axle unit scales have largely replaced the single axle scales found in many SADC/COMESA countries where the latter are gradually being phased out for various reasons (see next section). Some of the benefits of the axle unit scale are as follows:

- they can weigh any axle unit of a truck (i.e., single, tandem, or tridem unit), not as quickly as a multi-deck scale, but much more quickly than a single axle scale;
- level tolerances on the approach slabs no longer have to be as accurate as for the single axle scale but still need to meet minimum requirements;
- verification testing is relatively simple (limited staking of test weights); and
- it is far quicker to weigh multi-axle vehicles than using a single axle scale but not as quick as using a multi-deck scale.

Single axle scales: These may be described as the "first generation" scales that were used commonly in many countries in East and Southern Africa. They typically comprise a single, 3.2 m × 1 m deck placed centrally within a 40 m concrete slab with a recess to accommodate the scale (see Photograph 7-5). The scale can be connected to a computer linked to a digital reader and printer for producing weighbridge slips indicating the various weights of the axles and axle groups.

Photograph 7-5: 3.2 m × 1 m Single Axle Scale

Although relatively cheaper to install than multi-deck or axle init scales, single axle scales have a number of drawbacks including:

- the sites have to be constructed to very precise level requirements which are not easily met (see section below on accuracy of weighing systems);
- weighing of multi axles is cumbersome and time consuming, especially for articulated or truck-trailer vehicles when up to seven or eight separate axles must be weighed;
- verification of the scales is difficult due to the difficulty of fitting the test weights onto the small deck.

The risk of weight transfer during the weighing will be the determining factor in levels of accuracy, irrespective of the inherent accuracy of the weighbridge.

Due to the pressure from the courts with regard to the accuracy of single axle scales/sites, a number of countries in Southern Africa have dispensed with their use in favour of either axle unit or multi-deck scales, depending on the volumes of commercial traffic to be weighed.

(2) Portable Scales

Static and dynamic

Portable (mobile) scales – either statically or dynamically operated – are normally used for screening purposes. These portable scales can be set up next to any road where there is a suitable surface and an area to pull off and weigh trucks. These scales should not be used for law enforcement purposes, but are sufficiently accurate to identify vehicles that are probably overloaded with a high degree of confidence. Due to the fairly high accuracy of the portable scales, screening can take place at considerable distances from the weighbridge, as the chance of diverting vehicles that are legally loaded to the weighbridge is slim. These portable weighing devices are considerably cheaper than static scales, are relatively light, can be set up very rapidly and measure individual wheels, axles, axle units and vehicle/combination mass.

Examples of a static device (Photograph 7-6) and a dynamic device, a Vehicle Load Monitor weigh-in-motion scale (Photograph 7-7), are shown below.

Photograph 7-6: Portable Static Weighing Device

Photograph 7-7: Portable Dynamic WIM Device

Fixed/dynamic

Weigh-in-motion (WIM): A WIM system is a device that measures the dynamic axle mass of a moving vehicle to estimate the corresponding static axle mass. These systems are designed to capture and record axle weights and gross vehicle weights as vehicles drive over a measurement site at normal traffic speeds. Overhead variable message signs are used to redirect legally loaded vehicles back onto the highway while vehicles suspected of being overloaded are directed to an adjacent lane for accurate weighing on a static scale. Thus, the total number of vehicles to be weighed should be considerably less and a smaller facility may then be adequate.

WIM systems fall into two broad groups as follows:

- High speed (HSWIM) – vehicle travel > 15 km/h
- Low speed (LSWIM) – vehicle speed ≤ 15 km/h

WIMS have traditionally been used for screening rather than enforcement purposes at or near static weighbridges. However, the emergence of a new generation of single-axle weighing fixed WIMS allows vehicles to be weighed at slow speed (typically < 5 km/h) and with sufficient weighing accuracy (< 1%) for enforcement purposes. Although such systems have not yet been used widely in the East and Southern Africa region, they are worthy of consideration and offer an alternative to static devices if a rigorous evaluation confirms their long-term suitability for this type of weighing.

Types of WIMS: The most widely accepted and utilized WIM devices are described below:

- *Piezoelectric sensor:* The sensor is embedded in the pavement and produces a charge that is equivalent to the deformation induced by the tyre loads on the pavement's surface. It is common to install two inductive loops and two piezoelectric sensors in each monitored lane. A properly installed and calibrated Piezoelectric WIM system can provide gross vehicle weights that are within 15% of the actual vehicle weight for 95% of the measured trucks.
- *Bending Plate*. The bending scale consists of two steel platforms that are typically 0.6 × 2 m, adjacently placed to cover a 3.65 m lane. The plates are instrumented with strain gages, which measures tyre load induced plate strains. The measured strains are then analyzed to determine the tyre load. A properly installed and calibrated bending plate WIM system can provide gross vehicle weights that are within 10% of the actual vehicle weight for 95% of the measured trucks. Photograph 7-8 shows a typical bending plate high speed WIM device.
- *Single Load Cell*. This device consists of two 3 × 3 m platforms placed adjacently to cover the 3.65 m monitored lane. A single hydraulic load cell is installed at the centre of each platform to measure the tyre load induced forces that are then transformed into tyre loads. A properly installed and calibrated single load cell WIM system can provide gross vehicle weights that are within 6% of the actual vehicle weight for 95% of the measured trucks.

Photograph 7-8:
Typical High Speed WIM Device (Bending Plate)

(3) Satellite (Virtual) Weighing Stations

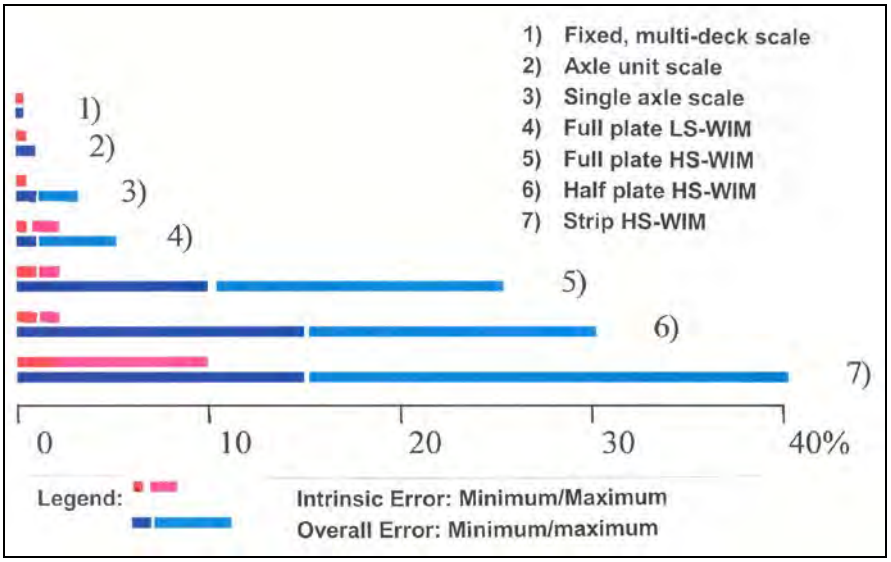
Satellite weighing stations (sometimes referred to as "virtual weigh stations") provide a means of economically and unobtrusively monitoring commercial vehicle traffic at locations where there are a number of alternative, by-pass routes to cover. These stations deploy WIM systems that automatically weigh vehicles as they travel at normal speeds along a road, classifies them based on weight and axle spacings, determines when vehicles are in violation of regulations, and produces a display of these records on a computer with a network connection. Overloaded heavy vehicles cannot be prosecuted or detained at such satellite stations and would have to be sent or escorted to a static weighbridge where they can be weighed accurately for enforcement purposes.

(4) Accuracy of Weighing Systems

The accuracy of weighing systems is primarily influenced by the following factors:

- *The error of the scale*: This is the *difference* between the *indication* and the *load* placed on the platform of the weighing device. It is affected by such factors as temperature, eccentric load, tilted condition, repeatability, creep, and span stability.
- External factors: These are the influences which make a wheel or axle load lower or higher that it would be under perfect conditions. The perfect condition is: absolutely level site, all suspensions of the vehicle in an average, frictionless position, no braking, no vehicle oscillation. These external factors have nothing to do with the scale accuracy.

The accuracy of the weighing system will depend on the type of system used and the weighing method adopted. Figure 7-1 gives a good indication of the accuracy of various types of weighing systems.



Source: HAENNI (2009), *Technical Aspects of Weighing Road Vehicles*. Proc. BSEC Conference, Geneva, 18 June 2009.

Figure 7-1: Accuracy of Various Weighing Systems

As indicated in Figure 7-1, the most accurate method of weighing is by the use of a multi-deck, static scale which is not affected by external factors which are produced by unfavourable characteristics of the vehicle and weighing site. In contrast, the least accurate method of static weighing is by the use of a single axle scale which weighs one axle at a time and for which the difference in height between the approach slab and the weighing platform is a critical factor. Based on a survey carried out to assess the effect of level tolerance on mass accuracy of weighbridges,[2] the proposed specifications, including tolerance limits, are as follows and are illustrated in Figure 7-2:

1) Approach slab: a minimum length of 20 m on either side of the scale
2) Tolerance on coping: Zero to −1 mm
3) Tolerance on deck: Zero to −2 mm
4) Tolerance on approach slab up to 3 m on either side of deck: Zero to +2 mm
5) Tolerance of approach slab from 3 m to 20 m on either side of deck: 30 mm (e.g., +/− 15 mm; 0 to +30 mm; 0 to −30 mm).

[2] Council for Scientific and Industrial Research (CSIR), *Assessing the Effect of Level of Tolerance on Mass Accuracy of Weighbridges*, Pretoria, South Africa, 1994

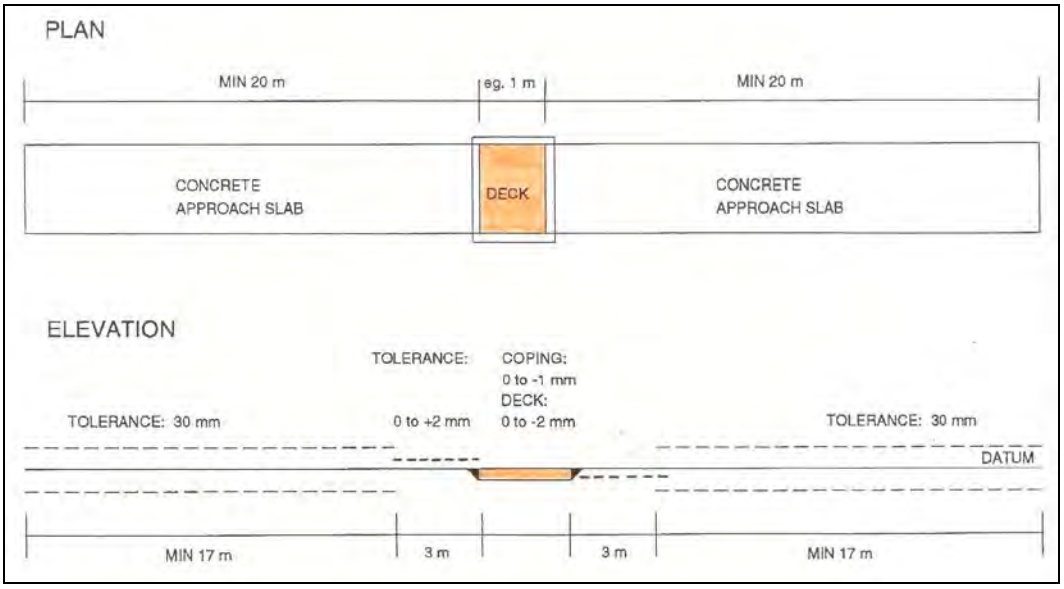


Figure 7-2: Recommended Tolerances for a Single Axle Unit Scale

(5) Weighing Tolerances

Due to scale errors and other external factors contributing to the accuracy of weighing systems, no such systems can be totally accurate all of the time. For this reason, some allowance in the weighing measurement is normally made in the form of a *weighing tolerance.* The magnitude of such an allowance is based on the assumed scale error (scale type dependent) plus that estimated for external factors.

In order to ascertain a reasonable basis for setting a weighing tolerance, a national weighbridge survey was carried out in South Africa in 2002,[3] in which 57 weighbridges were used (single axle scales, axle unit scales and multi-deck scales) to weigh a multi-axled vehicle that had been previously weight-assized. The survey found that:

- *Combination mass:* All readings fell within the range −0.88% to +0.76% of the average combination mass;
- *Axle unit:* All readings fell within the range −2.14% to +2.78% of the average combination mass;
- *Steering axle:* All readings fell within the range −5.12% to +4.96% of the average steering axle mass.

Based on the above findings, it was recommended that the tolerance on GCM should be set at +/−2% and that on axles at +/−5%. However, it was agreed at a tripartite (SADC/ COMESA/EAC) Regional Workshop on Harmonization of Key Elements of Best Practice in Overload that, as an interim measure, a mass tolerance of 5% on axles, axle units, and GCM would be adopted. More recently, at the Extraordinary Task Force Meeting held in Bujumbura on 29–30 June 2011, the Partner States agreed in principle that a 5% tolerance on axle weight be allowed and maximum limits for gross vehicle mass (GVM) or gross combination mass be inclusive of all tolerances.[4]

[3] Council for Scientific and Industrial Research (CSIR), *National Weighbridge Survey 2002: National Department of Transport*, Pretoria, January 2003.
[4] East African Community, *Extraordinary Task Force Meeting for the Study on the Harmonization of Overload Control Regulations in the East African Community, Report of the Meeting*, June 2011, Sections 3.2 and 4.0 (iii) and (iv), pp. 4-5.

7.3.3 Location and Number of Weighbridges on the Regional Road Network

In order to ensure that the available resources for overload control are utilized in a cost-effective manner in EAC Partner States, it is important to adopt an appropriate strategy for deciding on the location and number of weighbridges that should be deployed along the regional road network. At one extreme, a strategy which seeks to eradicate overloading by locating numerous weighbridges along as many routes as possible will be extremely costly and un-cost effective.

In terms of deciding on an optimum number and location of weighbridges, the law of diminishing returns is very important to acknowledge ***(i.e., for every weighbridge added after a certain number, every additional investment has a smaller return until the return on that investment does not warrant any further investment.).*** In this regard, the addition of a new a weighbridge on the regional road network will only be economically viable if the capital, maintenance and operational costs are less than the savings in pavement damage due to overloading. The economic viability analysis should be conducted over the lifetime of the weighbridge network which requires the costs and benefits be converted to Net Present Values (NPVs).

Strategic matters that influence the location of a weighbridge include proximity to a port-of-entry (border post or a port) or generators of heavy vehicle traffic, such as industrial areas and whether the location is such that escape routes are minimized and that the greatest impact on reducing overloading can be achieved (i.e., where heavy vehicle traffic volumes are the highest and/or the extent of overloading is the highest. The influence of the strategic matters on the location of a weighbridge should be evaluated after the economic viability of the location has been established.

A methodology has been developed to determine how the location of weighbridges can be optimized within an overload control (OLC) network.[5] This methodology is based on the determination of an overload control index (OLCI) which converts the different NPVs of overload control benefits and costs to a common factor which can be used to rank the options. For an overload control network to be financially viable the OLCI should be equal to or greater than two. Figure 7-3 illustrates the OLCI calculation graphically.

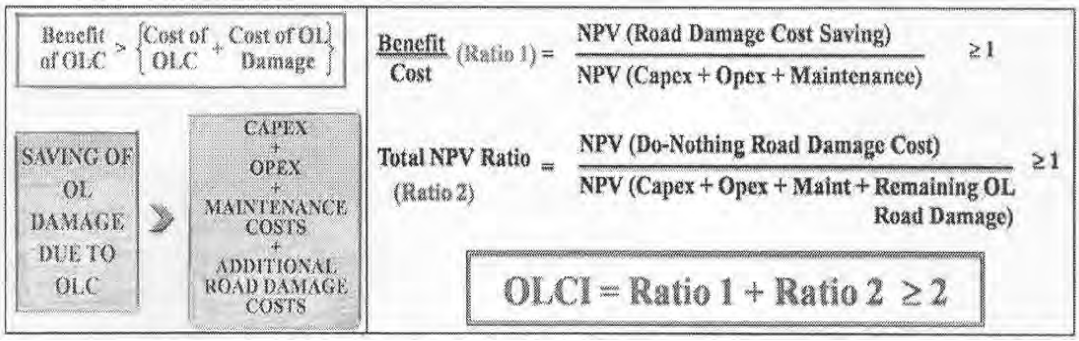


Figure 7-3: Graphical Illustration of the Calculation of the Overload Control Index

[5] Bosman, J and Kapofi, N., *The Optimisation of Weighbridge Location.* 4th SARF/IRF Regional Conference for Africa, 11–13 October 2010, Somerset West, Cape Town, South Africa.

7.3.4 Management of Weighbridges

There are a number of different specialist disciplines required in the area of weighbridge management, operations, and maintenance (MOM) including the following:

- legal issues;
- electronic systems;
- computer systems;
- mechanical systems;
- traffic signalling systems;
- facilities management;
- staff management;
- operations management; and
- maintenance management.

The most common options available for undertaking the above aspects of weighbridge management are:

- **In-house operations:** In this option, the Roads Agency takes full responsibility for the operational management of weighbridge facilities. However, historically, for a variety of reasons, this arrangement has generally not been very effective or efficient in the Southern African region. Moreover, many of the weighbridge facility operations are generally not considered to be core functions of a Roads Agency and, in principle, should be contracted out to the private sector either as a commercialized or privatized operation.

- **Private sector operations:** In this option, the private sector may be appointed by the Roads Agency to carry out some or all of the operational management responsibilities listed above – in essence, a public-private partnership (PPP). Various PPP arrangements may be considered, each with their advantages and disadvantages.

The range and characteristics of the various contract types through which the private sector can become involved in the operational management of weighbridge facilities is summarized in Table 7-7.

Table 7-7: Summary of Private Sector Involvement Options in Overload Control

Item	Service Contract	Management Contract	Lease Contract	Concession Contract	Full Privatization
Ownership	Public Sector	Public Sector	Public Sector	Public Sector	Private Sector
Financing Fixed Assets	Public Sector	Public Sector	Public Sector	Private Sector	Private Sector
Financing Working Capital	Public Sector	Public Sector	Private Sector	Private Sector	Private Sector
Duration	Short (1–3 yrs)	Short (5 yrs)	Medium (6–10 yrs)	Long (20–30 yrs)	Indefinite
Risk	Public Sector	Public Sector	Public Sector	Shared	Private Sector
Remuneration of Private Sector	Operation and management (O&M) costs	O&M costs	O&M costs and working capital	O&M costs, working capital and financing of fixed assets	

The option that could be chosen for a particular overload control operation will, among others, depend on the following:

- financing of fixed assets;
- financing of working capital;
- financing of maintenance;
- extent to which risk is shared between the public and private sector; and
- remuneration of the private sector.

7.3.5 Weighbridge Operations and Procedures

For legal enforcement purposes, it is mandatory that the personnel involved in the weighbridge operations are legally authorized to do so. Typically in the East and Southern African region, such personnel come from the traffic section of the Police or from a Traffic Inspectorate. It is also critical that personnel involved in weighbridge operations are properly trained and are able to carry out the weighing procedures in the prescribed manner, particularly in those countries where overloading is treated as a criminal offence.

Certain of the weighbridge operational procedures depend on the type of weighbridge being used while others are mandatory to all facilities. It would be normal for any weighbridge facility to have a Weighbridge Operators Manual to ensure that all operational procedures are carried out in a proper and consistent manner in accordance with the manufacturer's requirements. Failure to adhere to proper weighbridge operational procedures could result in an overloading violation being thrown out in court.

7.3.6 Personnel Involved in Overload Control Operations

The efficient and effective control of overloading utilizing increasingly sophisticated equipment requires well-trained and experienced staff conversant with a wide range of related disciplines including the following:

- Transport environment;
- Legislation and regulations;
- Weighbridge equipment;
- Weighing operations;
- Software operation;
- Data management;
- Management reporting;
- Staff management;
- Operations management;
- Maintenance management; and
- Safety.

Thus, it should be mandatory for all weighbridge personnel to follow a prescribed training course so that they are able to perform their duties satisfactorily in terms of ensuring that the applicable weighing procedures are followed and overload control regulations are applied correctly. In a regional context, training should be carried out in a coordinated manner in order to endure uniformity across all countries.

7.3.7 Weighbridge Verification and Calibration

The use of any weighing equipment used by the public, such as a weighbridge, is regulated by law. The principal legislation affecting the use of such equipment is normally contained in the

Weights and Measures Acts of most countries. Under that legislation weighing equipment must be individually verified by an authorized Inspector with a stamp of verification and a certificate of verification issued by the inspector.

In essence, the verification process basically involves placing standard weights that are calibrated and traceable to the national standard on the scale(s) and then confirming that the reading given is within the tolerance limits (see Photograph 7-9). The frequency of verification is prescribed in the Act.

Photograph 7-9: Weighbridge Verification

Failure to comply in all respects with the legal requirements of the Weights and Measures Act, including the verification procedures, would render weighbridge operations illegal.

Calibration of a weighbridge is the carrying out of a set of prescribed operations which establish, under reported conditions, the relationship between the weighing system output and corresponding known values of the load applied to the weighbridge. The calibration exercise is normally carried out by an accredited body in accordance with a prescribed procedure such as that contained in *A Code of Practice for the Calibration of Industrial Process Weighing Systems, October 2003* published as – BS EN ISO 9000 series of Quality Management and Quality Assurance Standards as issued by the Institute of Measurement and Control in the UK.

The result of the calibration is normally reported in a formal document – the *certificate of calibration* – which includes a variety of data deemed relevant by the calibrating authority. The data obtained as a result of the calibration operation may be used to estimate the weighing system errors or to adjust the system output to an agreed specified value.

The frequency of calibration is governed by the following factors:

- manufacturer's recommendation;
- frequency and manner of use;
- environmental influence; and
- accuracy sought.

7.4 Issues Arising from Review of Existing Situation and Recommendations

7.4.1 General

Against the background information presented in Section 7.3, this section highlights the issues arising from a review of the existing situation by comparing best practices approaches with those prevailing in EAC Partner States. On that basis, recommendations are made for improving weighbridge operations and management.

As would be apparent from the information presented in Table 7-2, overload control operations in Burundi and Rwanda have not yet started as a result of which the review of the existing situation focuses on Kenya, Tanzania, and Uganda.

7.4.2 Types and Characteristics of Weighbridges Operated

Main findings: As indicated in Table 7-1, single axle scales are used exclusively in Kenya and Uganda while Tanzania uses mostly axle unit scales. Multi-deck scales are not used in any of the countries although there are plans to introduce them in Kenya. Mobile weighbridges are also used in all countries for random policing and screening purposes. Apart from Uganda, WIMs are not used in the other countries although Kenya is planning to introduce them in the near future. All countries operate their weighbridges for 24 hours except Tanzania, which operates those at the border for 16 hours. Weighbridges within Partner States are not electronically linked.

While most countries in the SADC region have largely phased out the use of single axle scales for the variety of reasons listed in Section 7.3, these devices are still used extensively in the EAC countries and, indeed, there are plans in some countries to purchase new ones.

Stakeholders report a number of shortcomings with the types of weighbridges used in the EAC countries with the two most frequently stated being:

- Congestion and delays at some weighbridges due to the length of time taken to weigh multi-axled vehicles on a single axle scale at multiple locations along road networks, including border crossings; and

- Different readings produced by different weighbridges for the same vehicle resulting in acrimonious relations between transporters and weighbridge operators.

The above shortcomings are attributed largely to an injudicious choice of the type of weighbridge (single axle scale) used at locations where large volumes of commercial vehicles need to be weighed, coupled with the inherent problems associated with achieving the necessary levels of accuracy of such scales. These shortcomings (delays to transporters) contribute significantly to the very high transport costs that prevail in the region.

Conclusions: A radical change in approach is required as regards the type of weighbridge infrastructure to be used which would benefit from standardization. The objective should be to facilitate the speedy flow of commercial traffic on the corridors and across the borders of all countries in the region while also ensuring that vehicle overloading is minimized in an efficient and cost effective manner.

The above objective can be achieved by moving away from the traditional concept of a standalone weighbridge with adjacent office, weighbridge operator and ticket printer and, instead, shifting the emphasis to encompass and enhance key areas such as improved overall

system integration – site wide, nationally, and regionally – through the use of modern-day weighbridge technology, including the use of WIMs and data acquisition systems, within a well laid out overload control facility or, better, Traffic Management Centre. Harmonization of such an approach among EAC Partner States is a critical factor.

Recommendations: Based on the approach indicated above, the following recommendations are made:

Recommendation 1*: Standardized categories of Traffic Management Centres should be agreed upon for which the following classes are proposed*:

Category A: Full Traffic Control Centre (FTCC): As the name implies, a FTCC includes a full range of facilities to efficiently and effectively undertake an overload control process at minimum disruption to relatively large volumes of heavy vehicle traffic. Such a facility (see Figure 7-4) would normally operate on both sides of the road and would typically include within its operational system the following:

- a high-speed weigh-in-motion (HSWIM) screening device in the main traffic lane;
- a low-speed weigh-in-motion (LSWIM) screening device to confirm vehicles suspected to be overloaded as indicated by the HSWIM; and
- a static platform scale for accurately weighing axle and axle unit loads and total vehicle or combination mass for prosecution purposes.

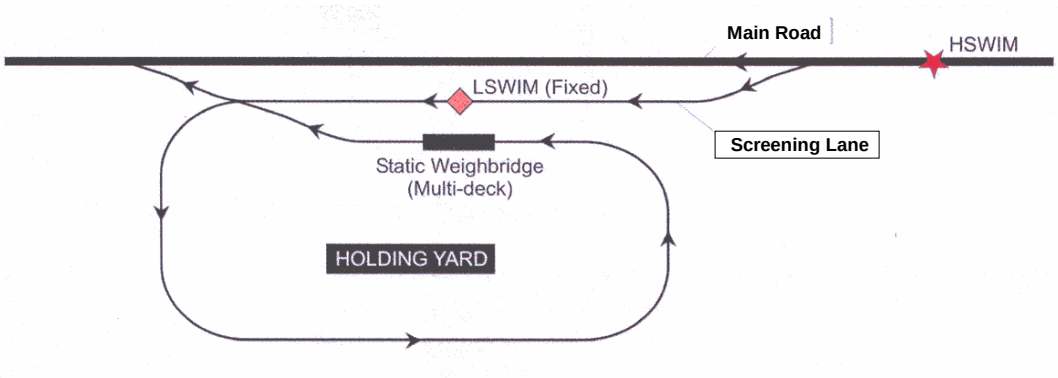


Figure 7-4: Typical Layout of a FTCC Facility (Showing One Side of the Road Only)

The capacity of a FTCC for undertaking various aspects of the overload control process is given in Table 7-8. Such a facility would normally operate 24 hours per day on strategic routes (corridors) which carry relatively high volumes (> 2,000 vpd) of commercial vehicles.

Table 7-8: Capacity Characteristics of a FTCC Facility

Activity	Typical capacity
Screening capacity (veh/h)	200
Weighing capacity (veh/h)	50
Prosecution capacity (veh/h)	10
Maximum system ADTT	2,000

Source: Mikros Systems, South Africa

Category B: Type 1 Traffic Control Centre (TCC 1): A TCC 1 (Figure 7-5) is essentially the same as a FTCC except that it operates on only one side of the road and the HSWIM in the main road is located on an internal screening lane. The drawback of this system is that any vehicles travelling in one direction that are identified as overloaded by the HSWIM must cross over the opposing traffic stream to be weighed. Thus, this type of facility is ideally suited for use where access across the road is provided by an interchange or where traffic flows are not so high as to frustrate the passage of vehicles across the road to the weighbridge.

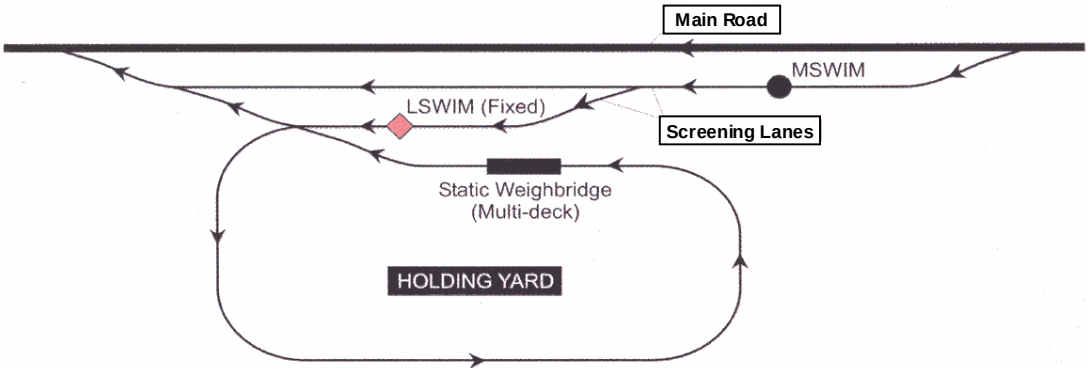


Figure 7-5: Typical Layout of a TCC 1 Facility

The capacity of a TCC 1 is very similar to that of an FTCC (see Table 7-8). This type of facility is less costly to operate than an FTCC as only one team is required to control the station. Such a facility would normally operate 16–24 hours per day on routes which carry medium volumes (500–2000 vpd) of commercial vehicles.

Category C- Type 2 Traffic Control Centre (TCC 2)*:* A type 5 TCC has fewer control facilities than either a FTCC or TCC 1 in that it does not have in-lane traffic screening but requires all heavy vehicles to leave the main carriageway and cross over a LS-WIM. In this layout arrangement (see Figure 7-6) legally loaded vehicles can immediately continue with their journey, but overloaded vehicles must proceed to the static weighbridge for weighing and prosecution.

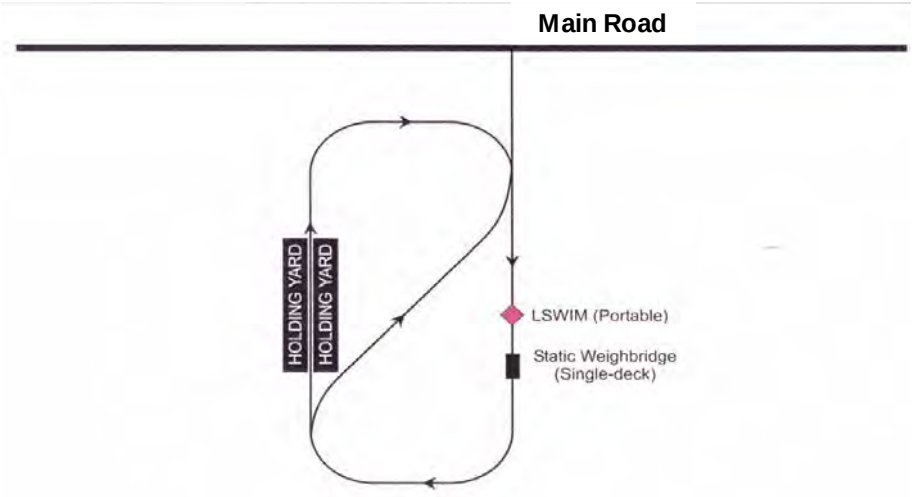


Figure 7-6: Typical Layout of a TCC 2

The capacity of a TCC 5 for undertaking various aspects of the overload control process is given in Table 7-9.

Table 7-9: Capacity Characteristics of a TCC 5 Facility

Activity	Typical capacity
Screening capacity (veh/h)	40
Weighing capacity (veh/h)	15
Prosecution capacity (veh/h)	5
Max system ADTT	400

Source: Mikros Systems, South Africa

As indicated in Table 7-9, a TCC 5 facility has the capacity to prosecute approximately 100 overloaded vehicles in an 18 hour day. Thus, from a technical point of view, it is appropriate for locations where the traffic stream carries up to 1,000 heavy vpd in both directions.

Category D - Lay-by Control Centre (LCC): A LCC facility consists essentially of a road lay-by at which either a static or mobile weighbridge is installed (see Figure 7-7). The facility comprises a suitably constructed level concrete platform adjacent to the road where the weighbridge is installed (or in the case of a mobile vehicle scale – with provision for easy installation of such a scale. The installed weighbridge may be operated in conjunction with a HSWIM as a screening device.

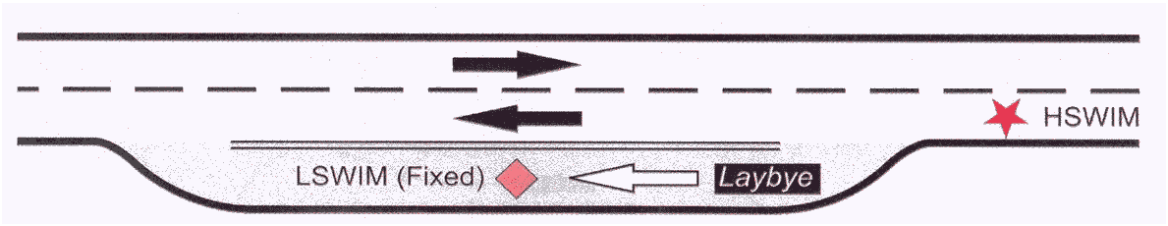


Figure 7-7: Typical Layout of Lay-by with HSWIM Screening Device

Recommendation 2: *The choice of weighbridge facility should be made by carrying out a full lifecycle analysis of the status quo versus the proposed option, which may be either an upgraded or new facility.*

The lifecycle cost analysis would typically include the following:

- Project costs
  - Initial costs
  - Operating costs
  - Maintenance costs

- Project benefits
  - Fees collected for overloading
  - Saving in road damage

Recommendation 3: *Single axle scales should be gradually phased out in favour of either axle unit or multi-deck scales within a TCC facility as illustrated in Figures 7-4, 7-5, and 7-6.*

Recommendation 4: *More extensive use of WIMS is recommended, in conjunction with static weighbridges, to reduce the number of commercial vehicles that need to be weighed.*

Recommendation 5: *An audit of existing weighbridge infrastructure that has been identified as forming part of the regional weighbridge system should be carried out. This should include an evaluation of the existing facilities in terms of weighbridge type (single axle, axle unit, multi-deck), computerization, staff and driver facilities, parking-off areas, etc. in order to determine the required upgrading and estimated cost implications.*

Recommendation 6: *A weighing tolerance of 5% on axles and GCM should be adopted on a regional basis.*

Recommendation 7: *Harmonized accreditation standards for weighbridges and a regional database of accredited weighing stations should be developed.*

7.4.3 Location of Weighbridges along the Regional Road Network

Main findings: Weighbridges are located at relatively frequent intervals along EAC corridors. For example, between Rusumo and Dar es Salaam there are nine weighbridges and between Gatuna and Mombasa there are eight weighbridges. On the basis of an average weighing time of 30 minutes for a multi-axled vehicle on a single axle scale and a queue of ten trucks to be weighed results in a delay time of five hours. If this were replicated at nine weighbridges, then the total delay would be almost two days![6] Clearly such delays are very costly and indeed unacceptable in terms of the additional transport costs incurred. Weighbridges are also located at all main border posts, sometimes on both sides of a common border.

Conclusions: The deployment of numerous weighbridges along the EAC corridors at relatively close intervals is responsible for significant delays to commercial traffic and is contributing to additional transport costs.

There is a need for adopting an appropriate strategy for deciding on the location and number of weighbridges along the regional road network.

There should be stronger cooperation with regard to the sharing of weighbridge facilities in the EAC region. Separate operation of weighbridges on both sides of international borders is unnecessary and results in inefficient use of scare resources.

Recommendations: Based on the main findings highlighted above, the following recommendations are made:

Recommendation 1: *A regionally coordinated strategy should be developed for the control of overloading by the judicious deployment of weighbridges along EAC corridors in accordance with a regionally agreed network of weighing stations.* This strategy needs to be supported by two other strategies which will be the responsibility of individual Partner States, and which focus on national and urban heavy vehicle routes. Obviously, some of the national routes will coincide with the regional corridors.

Recommendation 2: *Key points from which vehicle overloading can be effectively controlled from a regional perspective should be identified on a regional map.* Border posts are obvious strategic points as, with few exceptions, there are limited route choices for a truck driver to

[6] Ministry of Trade and Industry and Private Sector Federation, Rwanda, *Current Status of NTBs Along the Northern and Central Corridors*, 2010.

travel from one EAC country to another. However, the deployment of weighbridges on both sides of international borders should be avoided in favour of greater bilateral cooperation in the operation of a single weighbridge facility, especially where one-stop border posts are operated.

Recommendation 3: *An overload control index should be specified to help determine the optimum number of weighbridges that should be deployed along the EAC network (ref. Section 7.3.3).* This will avoid the tendency to over-police the road network with too many weighbridges.

Recommendation 4: *In locating weighbridge stations, preference should be given to the establishment of such stations in common control areas at border posts as well as to the joint use of weighing stations and related facilities.*

7.4.4 Management of Weighbridges

Main findings: As indicated in Table 7-2, the Roads Agencies in EAC Partner States are responsible for the weighing of vehicles while the enforcement of regulations is carried out either by the police or traffic inspectorate. However, the efforts of these separate bodies are often uncoordinated leading to loopholes that are exploited by unscrupulous transporters.

Although all the roads agencies are required in their Roads Acts to operate in a commercialized manner and to focus on core strategic activities, these agencies still undertake a certain amount of non-core activities, including the deployment of a large number of staff to undertake overload control activities. For example, Tanzania employs more than 500 staff to operate their thirty-one weighbridges (static and potable) at an annual cost of approximately USD 2 million – a very costly undertaking which might well be more cost-effectively carried out with the involvement of the private sector.

Conclusions: Relatively high costs are incurred by roads agencies in carrying out what are essentially non-core activities in-house. The outsourcing of some aspects of weighbridge operations by roads agencies, without relinquishing their strategic management responsibility, might therefore well be a preferable alternative for which there are a number of options to choose from (see Section 7.3.4).

Recommendation: *In principle, the private sector should be involved in some aspect(s) of overload control operations.* Such involvement could range from an ordinary management contract to a full Public-Private Partnership based on the build, operate and transfer (BOT) concept. An assessment of the various options should therefore be carried out to determine the preferred option.

7.4.5 Weighbridge Operations and Procedures

Main findings: A number of shortcomings were identified by stakeholders related to weighbridge operations and procedures in EAC Partner States. These include:

- Weighbridge operation procedures are generally not properly documented and the procedures that are carried out differ from country to country.
- There is no system for maintenance and repair of weighbridges;
- There is no mutual recognition of weighbridge certificates among EAC Partner States;
- Weighbridges are generally not linked to each other and to a central control unit.
- The quality and extent of data that is collected at weighbridges varies enormously among EAC Partner States and what is collected is not shared on a regional basis.

Conclusions: The absence of standardized, documented procedures for carrying out weighbridge operations has led to inconsistency in overload control activities in some EAC countries. Moreover, lack of mutual recognition of weighbridge certificates and sharing of information has diluted the efficiency and effectiveness of overload control operations.

Recommendations:

Recommendation 1: *Development of a weighbridge operator's manual to ensure that all weighbridge operations are carried out in a proper, consistent and standardized manner in all EAC Partner States.*

Recommendation 2: *Development of a regional weighbridge certificate and mutual recognition by all EAC Partner States of such a certificate and related documentation issued by an accredited weighing station.*

Recommendation 3: *The linking of weighbridge certificates with customs clearance processes to provide a further filter in the overload control process.*

Recommendation 4: *All weighbridges on the regional road network to be networked and to be linked electronically to a regional data centre to facilitate sharing of information on overload control.*

Recommendation 5: *The conducting of regular regional performance audits* [7] *on the effectiveness of the regional network of weighing stations and the development of regional performance targets and setting of regional performance levels.*

7.4.6 Personnel Involved in Overload Control Operations

Findings: The frequency and standard of training of weighbridge operators varies from country to country with each country following its own syllabus with the result that the calibre of staff involved in weighbridge operations varies considerably.

Conclusions: The quality of training in overload control operations needs to be enhanced to cater for the increased complexity of modern-days weighbridge operations.

Recommendation: *Undertake standardized training of weighbridge staff at a regional training institution following a regionally prescribed syllabus.* The outputs of such training should be certified and accredited with a regional educational body.

7.4.7 Weighbridge Verification and Calibration

Findings: As indicated in Table 7-4, the legal instrument that covers the verification and calibration of weighbridges in EAC Partner States is the Weights and Measures Act. These Acts prescribe the manner in which verification and calibration of weighing instruments, such as weighbridges, must be carried out. Partner States carry out verification of weighbridges on an annual basis and calibration on a quarterly basis. [8]

[7] At the Second Task Force Meeting, the Partner States agreed that weighbridge auditing be undertaken at least every 12 months depending on the traffic flow. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Taskforce Meeting to Review the Interim Report and Initial Study Recommendations*, May 2011 [matrix of outcomes attached].

[8] At the Second Task Force Meeting, the Partner States agreed on weighbridge verification and calibration at least every 12 months depending on traffic flow. See source in previous footnote.

In all EAC countries there is no programme that is strictly adhered to for regular verification and calibration of weighbridges in full conformity with the national Weights and measures Acts as required by law. In principle, this would invalidate the legality of the weighing process and the ability to prosecute offenders.

The EAC Standardisation, Quality Assurance, Metrology and Testing Act, 2006, does not contain any provisions that deal specifically with the verification and calibration of weighbridges. However, it does provide for the establishment of National Standards Bodies to develop and publish national standards in line with internationally recognised procedures.

Conclusion: There is a need for a harmonized verification and calibration standard for weighbridge equipment in the EAC region as a supplement to the EAC Standardisation, Metrology and Testing Act, 2006. Such a standard can be based on the existing Weights and Measures Acts that exist in all the EAC Partner States and other relevant international standards.

Recommendations:

Recommendation 1: *It should be agreed that weighing by any weighing station will only be valid if the weighing station has been accredited on the basis of appropriate verification and calibration carried out in full compliance with a regional standard.*

Recommendation 2: *A regional verification standard should be developed based on the prevailing Weights and Measures Acts in EAC Partner States as well as those adopted internationally.*

Chapter 8 Formulation of a Proposed EAC Regional Legal Instrument

8.1 The Mandate

Legally, the mandate for an EAC legal instrument for the harmonization of vehicle overload control comes from The Treaty for the Establishment of the East African Community (signed by Kenya, Tanzania, and Uganda, on 30 November 1999 and entering into force on 7 June 2000),[1] specifically:

(i) Article 5, on Objectives of the Community, subparagraphs (1) and (2) of which call for the establishment of a Common Market to strengthen and regulate infrastructure relations (among others), and consolidation of cooperation in agreed fields (including transport);

(ii) Article 89, on Common Transport and Communications Policies, subparagraph (a) of which requires the Partner States (among other things) to "develop harmonised standards and regulatory laws, rules, procedures and practices"; and

(iii) Article 90, on Roads and Road Transport, subparagraph (l) of which requires the Partner States to "adopt common rules and regulations governing the dimensions, technical requirements, **gross weight and load per axle** of vehicles used in trunk roads within the Community" [emphasis added].[2]

8.2 Choice of Modality[3]

A number of modalities for legal instruments to control vehicle (over)loading in the EAC are possible, but the two main choices are between:

(i) an EAC Act[4] + EAC Regulations; and
(ii) an EAC Protocol + National Laws and Regulations.[5]

[1] Acceded to by Burundi and Rwanda in June 2007.

[2] Pursuant to this mandate from The Treaty for the Establishment of the East African Community, a number of actions have been taken and meetings held for the harmonization of vehicle overload control standards. See, e.g., EAC Secretariat, *Meeting of a Technical Working Group (TWG) on the Axle Load Harmonization in East Africa*, March 2009. In addition, as was noted during the 2nd Stakeholders Meeting at Nairobi on 30-31 May 2011, Article 38(4) of the Protocol on Establishment of the East African Community Common Market requires the EAC Council to within three years of entry into force (i.e., by 1 July 2013) to issue transport regulations. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 8, item (xiv). Also, there is a tripartite (now five-country) EAC road transport agreement, Article IX (iii) of which calls for "harmonising relevant technical standards on … loads on vehicles".

[3] Much of this discussion draws upon: (i) The Treaty for Establishment of the East African Community [primary source]; and (ii) Corridor Development Consultants (Pty) Ltd., *Final Report, Study on the Legal Framework for Introducing One Stop Border Posts (OSBPs) in East Africa and the Rusumo Border Post*, prepared for the East African Community and the Japan International Cooperation Agency, 29 March 2010, pp. 7–8 and Appendix 1 (unpaginated) [secondary source].

[4] The practice of capitalization here follows that in The Treaty for Establishment of the East African Community ("EAC Treaty"), signed on 30 November 1999 and entered into force on 7 July 2000.

[5] Other modalities mentioned in the report cited in footnote 3 above include the following alternate options: (i) an EAC Act + Protocol; and (ii) an EAC Act + bilateral agreements between pairs of Partner States. Alternate option (i) would use a Protocol instead of Regulation(s) to define operational and administrative parameters and procedures, but Article 151(1) of the EAC Treaty does not seem to envisage Protocols as being sufficiently detailed for this purpose ("Protocols … shall spell out the objectives and scope of, and institutional mechanisms for co-operation and integration"). Also, a Protocol does not override national laws and regulations, which would in effect mean continuation of fragmented approaches to the issue. Bilateral agreements, as envisaged in alternate option (ii), may make sense for the implementation of one-stop border posts (which are between two countries), but make less sense

An **EAC Act + EAC Regulations** would entail the passage of an EAC Act to define the broad principles to be followed by the Partner States in controlling vehicle loading and mandate the EAC Council to promulgate Regulations covering more detailed operational and administrative parameters and procedures. The Act would be passed in accordance with Article 62 of The Treaty for Establishment of the East African Community ("EAC Treaty") on Acts of the Community, which provides for the enactment of EAC legislation "by means of Bills passed by the [East African Legislative] Assembly and assented to by the Heads of State".[6] This modality is preferred because it would provide for an integrated approach to vehicle overload control in the EAC with legal effect in the Partner States. Such a supranational Act and Regulations would override or preempt[7] contrary national laws or regulations,[8] as per subparagraphs (4) and (5) of Article 8 of the EAC Treaty.[9] The modality has been applied effectively in the past (e.g., in the case of the EAC Customs Management Act of 2004 and the EAC Standardisation, Quality Assurance, Metrology and Testing Act of 2006), and it is currently in the process of being applied in the case of the EAC One Stop Border Posts Act. This approach provides a firm legal basis and is reasonably flexible to meet the requirements of changing situations.[10] About one year may be required to pass an Act and adopt Regulations.

An **EAC Protocol + National Laws and Regulations** is the primary alternative to an EAC Act + EAC Regulations. It would entail concluding an EAC Protocol to harmonize the approach to vehicle load control. The Protocol would be pursuant to Article 151(1) of the EAC Treaty, which authorizes the conclusion of Protocols to "spell out the objectives and scope of, and institutional mechanisms for co-operation and integration". While this modality would ensure a degree of uniformity in approach, the steps required for concluding a Protocol are lengthy[11] and

for controlling multi-country transit traffic (although the Ministry of Foreign Affairs of Kenya argued for addressing the issue bilaterally).

[6] The Council of Ministers initiates bills (Article 14(3)(b) of the EAC Treaty), which are then reviewed by the relevant Sectoral Council, after which they are reviewed by the Legal and Judicial Affairs Committee and then put forward for consideration of the Assembly. Once enacted by the Assembly, the Heads of State assent at the Summit. After passage of the Act, Regulations may be considered first by Senior Officials, then Permanent Secretaries, and then the Council of Ministers. Approval by the Council of Ministers gives Regulations legal authority in the Partner States. Corridor Development Consultants (Pty) Ltd., *Final Report, Study on the Legal Framework for Introducing One Stop Border Posts (OSBPs) in East Africa and the Rusumo Border Post*, prepared for the East African Community and the Japan International Cooperation Agency, 29 March 2010, and Appendix 1 (unpaginated). Also see The Laws of the Community (Interpretation) Act, 2004, published in *The East African Community Acts Supplement*, No. 6, 31 January 2004.

[7] This is analogous to the doctrine or concept of preemption in the law of the United States (i.e., the displacement of state law by federal law) or the European Union (the displacement of national law by the law of the European Union). See, e.g., J.H.H. Walker, *The Doctrine of Union Preemption in the EU Single Market*, New York University of Law, Jean Monnet Working Paper 03/10, 2010.

[8] At the same time, national laws that are existing or proposed in EAC Partner States will remain in force and be unaffected by the proposed EAC Act to the extent that they are consistent with the Act. And, in accordance with the subsidiarity principle, measures provided for in EAC Acts should only be enacted if their objects can better be achieved at the EAC level. Corridor Development Consultants (Pty) Ltd., *Final Report, Study on the Legal Framework for Introducing One Stop Border Posts (OSBPs) in East Africa and the Rusumo Border Post*, prepared for the East African Community and the Japan International Cooperation Agency, 29 March 2010, Appendix 11 (One Stop Border Posts Policy Paper for the East African Community), Sections 9.1–9.2 (unpaginated).

[9] "4. Community organs, institutions and laws shall take precedence over similar national ones on matters pertaining to implementation of the Treaty. 5. In pursuance of the provisions of paragraph 4 of this Article, the Partner States undertake to make the necessary legal instruments to confer precedence of Community organs, institutions and laws over national ones."

[10] However, it has been argued that this approach may be more difficult to refine through practical experiences during implementation. Corridor Development Consultants (Pty) Ltd., *Final Report, Study on the Legal Framework for Introducing One Stop Border Posts (OSBPs) in East Africa and the Rusumo Border Post*, prepared for the East African Community and the Japan International Cooperation Agency, 29 March 2010, p. 7.

[11] The steps include: (i) submission of a draft Protocol to the sectoral council and then to workshops in the Partner States for review and comment; (ii) preparation of a final report with a revised draft Protocol as an official document; (iii) submission of the final report to the Council of Ministers for approval; (iv) article-by-article review by the Attorneys Generals of the Partner State and the Legal Department of the Secretariat; and (v) submission of the

a Protocol does not override national laws and regulations. Indeed, the process of adopting the required laws and regulations in the Partner States would likely be cumbersome and result in a fragmented approach.

Accordingly, the modality of an EAC Act + EAC Regulations was recommended.[12] Appendix K presents addresses this recommendation in more detail. **The recommendation is consistent with the position reached at the Extraordinary Task Force Meeting held in Bujumbura on 29-30 June 2011, during which the Partner States agreed that an EAC Act supported by harmonized regulations is the appropriate legal instrument for vehicle overload control in the region.**[13]

8.3 A Recommended Model

The structure of a recommended draft EAC Act is set out in Box 8-1. Draft annotated text for the EAC Act follows in Section 8.4, with the draft text in italics and comments in (unnumbered) boxes. Section titles and text in "square" brackets (i.e., "[…]") present options to be considered by the Partner States.

Key points follow:

(i) The draft EAC Act includes 10 parts: Preliminary Provisions, Legal Load Limits and Overloading Fees; Management of Vehicle Loading, Enforcement; Authorized Officers; Voluntary Compliance; Network Development; Weighing Stations, Weighing Equipment, and Weighing Operations; Institutional Arrangements; and Miscellaneous Provisions. In addition, a series of Schedules are to be attached.

(ii) The draft EAC Act was prepared with reference to the SADC Model Legislative Provisions on the Management of Vehicle Load Control, as well as with reference to other good-practice models, including the Zambia Public Roads (Maximum Weight of Vehicles) Regulations (2007) and the Botswana Road Traffic (Vehicle Loads) Regulations (2008), as well as the SADC Memorandum of Understanding on Vehicle Loading.

(iii) The structure of the draft Act most closely follows the SADC Model Legislative Provisions, as this was a draft act (albeit intended for an individual country, not for a group of partner states comprising a regional economic community) as opposed to draft

resulting draft to the Council of Ministers for signing. Corridor Development Consultants (Pty) Ltd., *Final Report, Study on the Legal Framework for Introducing One Stop Border Posts (OSBPs) in East Africa and the Rusumo Border Post*, prepared for the East African Community and the Japan International Cooperation Agency, 29 March 2010, and Appendix 1 (unpaginated)[interview with Mr. Stephen Agaba, Principal Legal Officer, EAC Secretariat].

[12] At the 2nd Stakeholders Meeting, three of the EAC Partner States (Burundi, Rwanda, and Uganda) expressed agreement with this recommendation, Kenya and Tanzania stated that they prefer a Protocol. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 13, first item (iv). Tanzania mentioned that the Partner States have different levels of axle load control and suggested that the issue of an Act or Protocol be left pending for now. Previous source, pp. 10-11, item (xiii), and p. 12, items (xxii) and (xxii). However, the EAC Secretariat clarified that a Protocol is just a general framework. Also, the one-stop border post example is instructive, since the subject matter is similarly cross-cutting and requires a binding legal framework for effective implementation; there are no convincing reasons to abandon this approach. Precedence over national laws is important to avoid differences. If a Partner State is not ready, the entry into force of the Act may be delayed, but it is desirable to proceed now with preparation of the Act. Previous source, p. 11, item (xv). Also, the SADC Secretariat recalled that in 1998 SADC had already developed a legal instrument and discussed the issues. They asked if some countries are ready, why cannot they proceed, with others to follow within five years. Previous source, pp. 11-12, items (xvii) and (xviii).

[13] East African Community, *Extraordinary Task Force Meeting for the Study on the Harmonization of Overload Control Regulations in the East African Community, Report of the Meeting*, June 2011, Sections 3.4 and 4.0 (viii) and (iv) pp. 4-5.

regulations or a draft regional agreement, but the recommended draft Act deviates from the SADC Model Legislative Provisions where appropriate. For example, while the SADC Model Legislative Provisions merely call for establishment of a national committee to set vehicle loading standards, the EAC Act would include specific standards, to be determined based on economic and engineering (as opposed to legal) technical inputs, as well as discussion between and among the experts from the respective EAC Partner States. Or, to take another example, the chapter from the SADC Model Legislative Provisions on Weighing Stations was generally not adopted as it would provide for a laissez-faire approach that may lead to a proliferation of weighbridges or certainly a supply of weighbridges greater than what is economically optimal. The comments accompanying the draft legal text indicate the source(s) of specific sections.

(iv) The preparation of the draft EAC Act also took in to account the analysis of the laws and regulations of each of the Partner States, as set out in Chapter 2 of this report, as well as the comments made at the various task force meetings and workshops for this study.[14]

(v) Other sources, especially for the Preliminary and Miscellaneous Provisions, and general issues of style, included the EAC Treaty and previous examples of EAC Acts, e.g., East African Community Customs Management Act (2004) and the One Stop Border Posts Act (in process).

(vi) Standard EAC practice of structuring Acts with parts, sections, and subsections was followed. Chapters were therefore not included under parts and over sections in the structural hierarchy of the Act.[15]

(vii) Regulation(s), which would come later, may cover detailed operational parameters, e.g., measures relating to live, dangerous, and hazardous cargo; imposition of administrative sanctions; the details of a demerit points systems; the establishment of a regional network of weighing stations; specification of different standards for different types of weighing stations; and sample forms (e.g., vehicle weighing report, weighing certificate). At this stage, however, what is important is for the Partner States to agree on an EAC framework, an EAC Act, for harmonization of vehicle overload control.[16]

(viii) The EAC Secretariat has clarified that this is a work in progress and will be taken up in the study by the Bureau for Industrial Cooperation (BICO).[17]

(ix) At the 3rd Stakeholders Meeting it was suggested that matrices be prepared showing changes required in the respective Partner State laws and regulations to meet the

[14] While at the 2nd Stakeholders Workshop Kenya suggested that only existing regulations should be harmonized, the JICA Study Team considers, as noted in paragraph (ii) above, that reference should also be made to existing good-practice models, to avoid a "lowest common denominator approach". See East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 9, item (xix).

[15] In its final form, the EAC Act will be presented with the section titles in the margins, as is standard for EAC Acts.

[16] There may be a gray area in terms of what can be included as part of the Act and what can be included in Regulations, but more detailed aspects were put off to Regulations (and not drafted in this study) so that the framework can first be agreed on.

[17] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region,3rd Task Force Meeting to Review Draft Final Report Based on the Results of the 2nd Task Force Meeting, 2nd Stakeholders Workshop and Extraordinary Taskforce Meeting of Stakeholders from Partner States, Arusha*, July 2011, p. 7. E.g., the 3rd Stakeholders Workshop agreed that BICO should develop regulations on vehicle dimensions based in part on the recommendations of this JICA study. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, p. 7.

requirements of the proposed EAC Act.[18] The suggestion is a useful one, probably best carried out by legal experts in the respective Partner States, once negotiations on the text of the EAC Act are underway.

Box 8-1: Structure of the Draft Recommended EAC Act

Title (and associated language)

PART I: PRELIMINARY PROVISIONS

1. Short Title, Application, and Commencement
2. Interpretation
3. Objectives of the Act

PART II: LEGAL LOAD LIMITS AND OVERLOADING FEES

4. Legal Load Limits
5. Overloading Fees

PART III: MANAGEMENT OF VEHICLE LOADING

6. Obligatory Weighing of Vehicles
7. Exemption from Obligatory Weighing
8. Payment of Overloading Fee
9. [Conditions for Carriage of Abnormal or Awkward Loads]
10. [Measures Relating to Live and Dangerous Cargo]
11. Transfer of Overloading [and Abnormal Load] Fees to the Road Fund
12. Duties of the Carrier

PART IV: ENFORCEMENT

13. Liability for Vehicle Overloading
14. Demerit Points System
15. Administrative Sanctions
16. Offenses

PART V: AUTHORIZED OFFICERS

17. Appointment of Authorized Officers
18. Powers of Authorized Officers
19. Duty of Drivers to Stop Upon Instruction of an Authorized Officer

PART VI: VOLUNTARY COMPLIANCE

20. Partners in Compliance Programmes

PART VII: NETWORK DEVELOPMENT

21. [Regional Network of Weighing Stations]
22. National Network Strategy
23. Outsourcing of Functions of National Road Authority
24. Agency Agreements
25. Compensation of Agents

[18] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, p. 7 [suggestion by Kenya].

8.4 Draft Annotated Text of the Legal Instrument

8.4.1 Title (and Associated Language)

THE EAST AFRICAN COMMUNITY
ACT ON MANAGEMENT OF VEHICLE LOADING

*No. … of 201_*
*Date of assent: ……., 201_*
*Date of commencement: ……., 201_*

An Act of the Community for the management and control of vehicle loading.

Enacted by the East African Community and assented to by the Heads of State.

Comment: The title follows that of the SADC Model Legislative Provisions on the Management of Vehicle Loading. The form follows standard EAC legislative drafting practice and following Article 62(3) of the EAC Treaty includes the language "enacted by the East African Community and assented to by the Heads of State". Consistent with standard EAC legislative practice, a preamble has not been provided. If required, one could be drafted based on the preamble to the SADC Model Legislative Provisions.

8.4.2 Part I: Preliminary Provisions

PART I: PRELIMINARY PROVISIONS

1. *Short Title, Application, and Commencement*

(1) This Act may be cited as the East African Community Act on Management of Vehicle Loading.
(2) This Act shall apply to the Partner States.
(3) This Act shall come into force on the date as the Council may, by notice in the Community Gazette, appoint.

Comment: Subsection (1) is a standard recital of the title of the Act. Subsections 2 and 3 are typical, as for example found in the East African Community Customs Management Act (2004) and the One Stop Border Posts Act (in process).

2. *Interpretation*

In this Act, unless the context otherwise requires:

"abnormal load" means a load, which by its nature is indivisible and the dimensions of which exceed the authorized dimensions of the motor vehicle or trailer on which it is to be loaded and the weight of which when loaded onto the motor vehicle or trailer may or may not cause such motor vehicle or trailer to exceed the prescribed maximum laden weight or maximum axle weight;

"accreditation" means certification of a weighing station by a national road authority as complying with the prescribed accreditation standards;

"authorized officer" means any person authorized to provide vehicle loading control services"

"awkward load" means a load that is hazardous in nature and which although it is divisible requires special equipment and safety precautions to offload;

"Council" means the Council of Ministers of the East African Community established by Article 9 of the Treaty";

"legal load limit" means the mass that may be borne by a single axle, an axle group, or all the axles of a vehicle as specified in the First and Second Schedules;

"national road authority" means the authority responsible for the national or primary or road network in each Partner State;

"overload" means an axle load, a load from a group of axles, or gross vehicle mass on a vehicle that exceeds the prescribed legal limits for the vehicle or for any particular part of public roads";

"overloaded vehicle" means a vehicle that is detected at a weighing station as overloaded (either with regard to the permissible maximum axle or axle unit mass or permissible maximum vehicle or vehicle combination mass);

"Partner States" means the member countries of the Republic of Burundi, the Republic of Kenya, the Republic of Rwanda, the United Republic of Tanzania, the Republic of Uganda, and any other country granted membership in the East African Community under Article 3 of the Treaty; and

"Treaty" means the Treaty for the Establishment of the East African Community.

Comment: Including a glossary at the beginning of a legal instrument is good legislative practice. However, it should be limited to concepts the meanings of which are not generally and commonly known and to terms that are used in a specific meaning. The glossary should only define a concept or term and in principle should not contain any normative rule.

Definitions have been drawn from the SADC Model Legislative Provisions (accreditation, authorized officer, legal load limit, national road authority), the Zambia Public Roads (Maximum Weight of Vehicles) Regulations (abnormal load, awkward load, overload), the Botswana Road Traffic (Vehicle Loads) Regulations (overloaded vehicle), and the East African Community One Stop Border Posts Act (in process)(Council, Partner States, Treaty), all good-practice models.

3. *Objectives of the Act*

The objectives of the Act are to:

(1) [decriminalize the carriage of loads that exceed the legal load limit and to introduce administrative control of vehicle loading;]
(2) establish a direct link between road damage caused by the carriage of loads that exceed the legal load limits and the imposition of overloading fees and abnormal and awkward load fees;
(3) ensure effective enforcement

(a) through the use of existing resources;
(b) [by outsourcing functions to other public and private sector entities on a commercial basis to expand capacity;]
(c) by establishing a network of strategically located and efficiently managed weighing stations equipped with state-of-the-art technology;
(d) discourage non-compliance through a range of effective mobility sanctions and mobility restrictions;

(4) encourage voluntary compliance
(a) *through targeted incentives providing compliant carriers with economic benefits; and*
(b) by encouraging private sector involvement in loading management on a commercial basis and in partnership with the public sector;

(5) vest primary responsibility for the management of vehicle overloading contro in road authorities or road agencies; and

(6) promote
(a) harmonization of legal load limits;
(b) complementarity in overloading feeds, and abnormal and awkward load fees, and administrative practices;
(c) complementarity in levels of compliance; and
(d) the establishment of a regional network of weighing stations

in the EAC region as well as in with the SADC and COMESA regions.

Comment: The objectives are from the SADC Model Legislative Provisions on Management of Vehicle Loading. As noted, text in "square" brackets (i.e., "[…]") here and in other sections present options to be considered by the countries. There was some discussion of decriminalization of vehicle overloading in Section 2.2.2 of this report, with experience (e.g. Zimbabwe) indicating that the introduction of administrative adjudication procedures to deal with infringements can lead to more effective control. It should also be recalled that the Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control (Nairobi, July 2008) agreed on a resolution supporting the decriminalization of overloading offenses. [19] Further, decriminalization was agreed during the current study, although Kenya has cautioned that further consultations will be required during the development of regulations on this subject.[20]

8.4.3 Part II: Legal Load Limits and Overloading Fees

PART II: LEGAL LOAD LIMITS AND OVERLOADING FEES

4. *Legal Load Limits*

(1) The legal load limit of a vehicle or trailer shall not exceed the manufacturer's permitted gross mass for such vehicle or trailer or the maximum laden mass set out in the First Schedule for such vehicle or trailer, whichever is less.

[19] InfraAfrica (Pty) Ltd in association with Africon Limited, Council for Scientific Research (CSIR), and TMT Projects (Pty), *Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control, Workshop Report*, Nairobi, 10–11 July 2008, p. 13.
[20] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, pp. 8-11.

(2) The maximum mass carried on any axle of a vehicle or trailer shall not exceed the manufacturer's permitted axle mass or the mass specified in the Second Schedule, whichever is less.

Comment: This section is drawn from Regulation 4 of the Zambia Public Roads (Maximum Weight of Vehicles) Regulations on Maximum Laden Weight and Axle Weight of Vehicles. The term "mass" has been used rather than "weight".[21] The SADC Model Legislative Provisions have not been used as a reference for this section because it does not set load limits but rather establishes a Vehicle Loading Advisory Committee to carry out that task (Sections 4-8). Specification of the required schedules will require economic and engineering (as opposed to legal) technical inputs, as well as discussion between and among the experts from the respective EAC Partner States. At the 2nd Stakeholders Workshop in Nairobi on 30-31 May 2011, all Partner States concurred with the following recommendations of the JICA Study Team: (i) a single axle load (4 tyres) of 10 tonnes, (ii) tandem and tridem limits (dual tyres of 18 and 24 tonnes, respectively); and (iii) a bridge formula. However, Kenya did not concur with a GVM/GCM of 56 tonnes and seven-axle configurations.[22] But at the 3rd Stakeholders Workshop in Nairobi on 17-19 August 2011, agreement was finally reached on a 56 tonne GVM standard on seven axles, excluding quadruple axle units. It was also agreed that interlinks will be allowed on defined corridors of the Regional Road Network without extra permits.[23]

5. *Overloading Fees*

[Overloading fees are set out in the Third and Fourth Schedules.]

[The Partner States shall set vehicle overloading fees taking into consideration costs related to:

(1) road use calculated on a weight-distance basis;
(2) road damage costs;
(3) enforcement activities;
(4) congestion factors;
(5) capital investment; and
(6) other expenditure items borne by the national road authority relating to implementation of the Act.]

Comment: This section provides for the overloading fees, either by reference to schedules to be attached, or by a statement of factors (taken from Section 7(5) of the SADC Model Legislative Provisions) for the Partner States to consider in setting overloading fees. Specification of the fees and/or the methodology for setting them will require economic and engineering (as opposed to legal) technical inputs, as well as discussion between and

[21] See, e.g., the usage in Australian Government, National Measurement Institute, *Weighbridge Operators Manual*, December 2010. However, it may be argued that it is inconsistent with the terms "weighbridge" or "weighing station", although Article 70 of the Republic of South Africa's Road Traffic Act of 1996 refers to a "mass-measuring bridge or other mass-measuring instrument".
[22] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 8, item (xvii). The 2nd Stakeholders Meeting agreed to legislate in text form as per the outcomes of the Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control (Nairobi, July 2008) and use an extensive schedule of drawings as guidelines. Previous source, p. 8, item (xviii).
[23] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, p. 7.

among the experts from the respective EAC Partner States. Road damage costs were added as a factor based on an outcome of the 2nd Task Force Meeting held in Arusha in May 2011.[24]

8.4.4 Part III: Management of Vehicle Loading and Enforcement

PART III: MANAGEMENT OF VEHICLE LOADING

6. *Obligatory Weighing of Vehicles*

(1) Subject to Section 7 of this Act, a person owning or operating [a commercial vehicle] [a vehicle with a gross vehicle mass of 3,500 kg or more] must present such vehicle to be weighed at every weighing station that is situated along the route traversed by such vehicle or that is designated for this purpose by a national road authority.
(2) If a person fails to comply with subsection 1, a national road authority may impose on such person any of the administrative sanctions contemplated in Section 15 of this Act.

Comment*: This section draws from Section 11 of the SADC Model Legislative Provisions. Similar provisions are found in Regulation 3 on mandatory weighing of vehicles in Botswana Road Traffic (Vehicle Loads) Regulations (2008), a good-practice example, which among other things offers the alternative text shown ("a vehicle with a gross vehicle mass of 3,500 kg or more").*

7. *Exemption from Obligatory Weighing*

(1) Section 6 of this Act does not apply where:
(a) a person owning or operating a vehicle has presented such vehicle to be weighed at an accredited weighing station prior to the commencement of the journey and such vehicle has been fully loaded; and
(b) a weighing station contemplated in subparagraph (a) has issued a weighting certificate certifying the weight of the vehicle does not exceed the legal load limit.
(2) Despite subsection (1), a person owning or operating a vehicle that has undergone pre-journey weighing in terms of subsection (1) must ensure that the weighing certificate issued on the occasion of the pre-journey weighing is presented for verification at every weighing station situated along the route traversed by such vehicle or that is designated for this purpose by the national road authority.
(3) An authorized officer may, despite the provisions of this section, require a vehicle in respect of which a pre-journey weighing certificate has been issued, to be weighed where there are reasonable grounds for concluding that such vehicle is carrying a load that exceeds the weight indicated on such certificate.

[24] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Taskforce Meeting to Review the Interim Report and Initial Study Recommendations*, May 2011 [matrix of outcomes attached].

Comment: This section is drawn from Section 12 of the SADC Model Legislative Provisions and is intended to encourage pre-weighing by providing an incentive in terms of cost and time savings, since routine weighing along the route can be avoided.[25] Similar language is found in Regulation 3 on mandatory weighing of vehicles in the Botswana Road Traffic (Vehicle Loads) Regulations, but the Botswana example does not include the requirement of "reasonable grounds" for finding that a vehicle is overloaded and therefore may lead to abuse of authority.

8. *Payment of Overloading Fee*

(1) An overloading fee is payable by:
(a) a credit or debit card approved by the national road authority;
(b) a bank guaranteed cheque;
(c) an electronic transfer of funds into the central account designated by the national road authority; or
(d) such other means as may be approved by the national road authority.
(2) Any unpaid fees shall be recoverable by way of civil action in any court of competent jurisdiction or upon criminal prosecution. In the case of a criminal prosecution, the court passing sentence may also make an order regarding unpaid fees.

Comment: This sections draws upon Regulation 6 of the Botswana Road Traffic (Vehicle Loads) Regulations, which provides for modern payment methods such as credit/debit cards and bank transfers. In contrast, the remittance of payment regulation in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations provides only for cash payment at the weighbridge.

[***9.*** *Conditions for Carriage of Abnormal or Awkward Loads*

(1) No person may carry an abnormal or awkward load on a public road unless:
(a) a prescribed pre-journey declaration has been made to a national road authority or its duly appointed agent;
(b) an abnormal or awkward load fee, as provided for in the Fifth Schedule, has been paid to the national road authority or its duly authorized agent; and
(c) such person has been granted an exemption, where applicable, to operate an over-dimensional vehicle on a public road in legislation dealing with vehicle dimensions,
and such person is not disqualified in terms of the conditions in subsection (2).
(2) A person is disqualified from carrying an overload if:
(a) the carriage of the overload will exceed the rated capacity of the vehicle to be used for such carriage; and
(b) such person:
(i) has an outstanding debt in respect of any monies payable under this Act due to a national road authority; and
(ii) is disqualified from carrying overloads under Section 15 of this Act.
(3) A national road authority may impose supplementary conditions on any person wishing to carry an abnormal or awkward load, including but not limited to;
(a) the presentation of the vehicle and load to be weighed;

[25] Southern Africa Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Model Legislative Provisions on Management of Vehicle Loading", p. 11].

(b) the provision of escorts;
(c) the use of warning lights and devices;
(d) travel times; or
(e) any other matter that, in the opinion of a national road authority, is necessary for the safe carriage of such load and the protection of the road infrastructure and the environment.

(4) The national road authority may prescribe a fee on any of the supplementary conditions imposed on the carriage of an overload.]

Comment: As noted during the 1st Stakeholders Workshop, this very complex subject is under the scope of a consultancy undertaken by the Bureau for Industrial Cooperation (BICO) of the University of Dar es Salaam, but not this project.[26] However, a draft section (based on Sections 13 and 14 of the SADC Model Legislative Provisions) has been included here in square brackets for consideration of the Partner States. As noted, a Schedule providing an abnormal load fee would need to be specified, although such specification is beyond the scope of the current study.

[***10.*** *Measures Relating to Live and Dangerous Cargo*

(1) An authorized officer may, with regard to an overloaded vehicle, instruct the driver to:
(a) offload animals at a designated facility in order to avoid distress or suffering that may result from the detention of such vehicle; or
(b) proceed to an appropriate location to avoid a danger to the health or safety of persons or animals posed by dangerous cargo or to offload such cargo.

(2) In the event that a vehicle is [immobilized] [impounded] under Section 13 of this Act, the national road authority may direct that the cargo be sold or otherwise disposed of or destroyed, provided:
(a) the national road authority has given the owner or operator of the vehicle written notice of the intended sale or disposal; and
(b) the owner or operator has failed within the time period specified in such notice to take appropriate measures to dispose of the cargo.

(3) The national road authority shall refund the proceeds of a sale to the owner or operator of the vehicle after deducting the overloading fee and any costs incurred by the national road authority related to such sale or disposal.

(4) The owner or operator of an overloaded vehicle shall be liable to pay compensation for any additional costs that may result from compliance with an instruction of an authorized officer under this section.]

Comment: This useful section was drawn from Regulation 8 of the Botswana Road Traffic (Vehicle Loads) Regulations and is presented in square brackets. The EAC Partner States may opt to not include it in the EAC Act if they consider that it includes a level of detail more appropriate for the EAC Regulations envisaged in Section 39.

[26] The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011, p. 10, Section 2.9, paragraph xxii.

11. *Transfer of Overloading [and Abnormal Load] Fees to the Road Fund*

(1) The national road authority or an agent appointed under Section 24 of this Act to collect overloading fees must, on a monthly basis or within such period specified by the relevant Minister pay all overloading fees [and abnormal and awkward load fees] collected to the fines and fees account of the national Road Fund.
(2) The relevant Minister may, upon recommendation of the national Road Fund, prescribe the financial management and audit procedures that a national road authority or an agent shall implement for this purpose of this section.
(3) The Road Fund may appoint independent auditors to audit the accounts of any agent appointed to collect overloading fees [and abnormal and awkward load fees] under this Act.

Comment: This section is based on Section 15 of the SADC Model Legislative Provisions. During the 1st Stakeholders Workshop, a delegate from Kenya stated that a section providing that the collection of fees will go to the national road fund would be "welcome".[27] The 3rd Stakeholders Workshop expressed concern that in most EAC Partner States road fees do not go to the road agencies but to the general treasury.[28] The earmarking or ring-fencing of road fees for road agencies may facilitate the provision and maintenance of highly productive assets by means entirely consistent with the general shift away from direct government production of goods and services.

12. *Duties of the Carrier*

A carrier:
(a) carries any load at the carrier's own risk and is liable for any damage, other than pavement damage, that may occur to roads, bridges, and other property as a result of such carriage; and
(b) may not remove any signs or structure along any road without the written permission of the person having jurisdiction over that sign or structure.

Comment: This section, based on Section 16 of the SADC Model Legislative Provisions, contains provisions that are normally included in road acts and may be considered unnecessary in this Act, although its inclusion would certainly not cause any harm.

8.4.5 Part IV: Enforcement

PART IV: ENFORCEMENT

13. *Liability for Vehicle Overloading*

(1) If it is established that a vehicle is carrying a load in excess of the legal load limit, a person owning or operating such vehicle is liable to pay the prescribed overloading fee to a national road authority or duly authorized agent.
(2) If it is established that a vehicle carrying a load in excess of the legal load limit while a journey is being undertaken, the vehicle in question may not continue its

[27] The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011, p. 13, Section 3.3, paragraph vii.
[28] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, p. 8.

journey, unless the load can be redistributed and the vehicle is, upon being reweighed, found to be within the legal load limit, or the vehicle is offloaded to lower its weight below the legal load limit and:

(i) any amounts due under subsection (1) have been paid to the national road authority or its duly appointed agent; or

(ii) a guarantee has been provided to the satisfaction of the national road authority or its duly appointed agent that such amounts will be paid within 7 days.

(3) Any amount due to a national road authority under this section may be enforced by way of a civil court order.

(4) A national road authority or its duly authorized agent is not liable for any loss or damage suffered by a carrier as a result of a vehicle being immobilized during the period contemplated in subsection (2).

(5) The provisions of this section apply in addition to any measures adopted under Section 15 of this Act.

Comment: This section draws from Section 17 on Liability for Overloading Fee in the SADC Model Legislative Provisions, which noted in its annotations that a ban on permitting a vehicle to continue a journey before overloading fees have been paid to a national road authority is an effective enforcement measure.[29] In this respect, it also addresses the detention of overloaded vehicles, which is covered by Regulation 5 of the Botswana Road Traffic (Vehicle Loads) Regulations. A provision assigning responsibility to consignors or consignees, or their managers, agents, or employees, is considered a "bridge too far" and therefore has not been provided here.

14. *Demerit Points System*

(1) The Council may issue a regulation prescribing a demerit points system providing for points to be recorded against a carrier in respect of any failure to comply with a provision of this Act.

(2) The system shall provide for:

(a) overloading to be categorized according to degree of severity;

(b) a threshold or thresholds of overloading, which if exceeded, results in one or more of the administrative sections contemplated in Section 15 of this Act being used; and

(c) a reduction of demerit points in cases in which acts of non-compliance are not recorded within specified time periods.

(3) The points contemplated in this section are recorded upon payment, by a carrier, of an overloading fee under Section 5 of this Act.

Comment: This section is based on Section 18 of the SADC Model Legislative Provisions and provides for a point system similar to that for traffic offenses applied in many jurisdictions worldwide.[30] Reference may also be made to Regulation 12 of the Botswana Road Traffic (Vehicle Loads) Regulations (2008) on Frequent Overloaders, although the

[29] Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Model Legislative Provisions on Management of Vehicle Loading", p. 13] ["A carrier will be taking a significant risk in permitting a noncompliant vehicle to go on the road as the consequences are likely to have a significant impact on bottom line profits."]

[30] E.g., the Canadian system is described at http://www.rcmp-grc.gc.ca/ns/prog_services/community_policing-police_communautaire/traff/demerit/demerit_explained-eng.htm; the New Zealand system is described at http://www.police.govt.nz/service/road/infringements_faq.html.

content of this regulation is likely too specific for insertion into an EAC Act. More specifics would be provided in a Regulation to be issued pursuant to Section 39.

15. *Administrative Sanctions*

(1) For cases in which a person fails to comply with Sections 6, 13, and 14 of this Act, the Council may issue a Regulation that in addition to recovering any overloading fees, may impose one or more of the following sanctions against the person:
(a) a temporary ban on the use of a specified road or route or generally;
(b) the imposition of a higher scale of overloading fees in respect of any future carriage of loads in excess of the legal load limit for a specified period or indeterminately; or
(c) the withdrawal of an operating license.
(2) The imposition of higher overloading fees may be linked to the demerit points system contemplated in Section 12 of this Act.

Comment: This section is based on Section 19 of the SADC Model Legislative Provisions. Rather than providing for the sanctions to be imposed by the national road authority, it contemplates an EAC Regulation for this purpose.

16. *Offenses*

Any person who:
(a) fails to pay any overloading fee legally imposed in terms of this Act;
(b) damages a road by carrying a load in respect of which an overloading fee is payable;
(c) fails to present a vehicle for obligatory weighing as required under Section 6 of this Act; or
(d) fails to comply with the direction or instruction of an authorized officer under Section 19 of this Act
is guilty of an offence upon formal admission of guilt or conviction to a fine not exceeding USD ____, or imprisonment not exceeding ____ months, or both.

Comment: This section is based on Section 35 of the SADC Model Legislative Provisions, in which it is included perhaps inappropriately in the chapter titled Offences and Miscellaneous Provisions.[31] The offenses specified are relatively few and easy to prosecute (i.e., not involving complicated questions of law or evidence).[32] The SADC Model Legislative Provisions do not specify the penalty or penalties for these offenses. For reference, as stated in Chapter 2 of this report, Tanzania's Road Traffic (Maximum Weight of Vehicles) Regulations (2001) provide for a fee of USD 2,000 for bypassing or "absconding" from a weighbridge (Regulation 13.-3).[33] The phrase "formal admission of

[31] The COMESA delegate at the 1st Stakeholders Workshop observed that the parts on offenses and miscellaneous provisions should be separated. The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011, pp. 14–15, Section 3.3, paragraph xiii.
[32] Southern Africa Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Explanatory Memorandum", section 20 (unpaginated)].
[33] Also, these Regulations provide for a fine of at least a USD 2,000 fine and/or imprisonment of up to six months for offenses related to misuse of special permits issued by the Road Authority (Regulation 6 b), or seemingly "any person who … drives or uses or causes or permits to be driven … any motor vehicle or trailer on any road in contravention of any provision of these Regulations" (Regulation 6 a), although the application of criminal penalties in the latter case is not clear in the Regulations.

guilt" is "inspired" by Part VI (Procedures for Fines and Payments) of the Zambia Public Roads (Maximum Weight of Vehicles) Regulations.

8.4.6 Part V: Authorized Officers

PART V: AUTHORIZED OFFICERS

17. *Appointment of Authorized Officers*

(1) A national road authority may [in writing] [by notice in the Gazette] appoint:
(a) an employee of the national road authority;
(b) an employee of any government agency performing functions on an agency basis under this Act;
(c) an employee of a person operating an accredited weighing station under Part VIII,
as an authorized officer and issue such officer a prescribed certificate of appointment.
(2) The notice contemplated in subsection (1) must specify the period of appointment of such officers.
(3) A national road authority may:
(a) pending an investigation into allegations of failure by an authorized officer to perform his or her duties in a fit and proper manner, suspend the appointment of such officer; and
(b) where in a properly constituted proceeding an authorized officer has been found guilty of such failure, rescind such appointment,
(4) A rescission under subsection (3) must be [made in writing] [published by notice in the Gazette.]

Comment: This section—the first of three on Authorized Officers—sets out the procedures for appointment of such officers. It draws mainly from Section 20 of the SADC Model Legislative Provisions, with reference to Regulation 37 of the Botswana Road Traffic (Vehicle Loads) Regulations (2008).

18. *Powers of Authorized Officers*

(1) An authorized officer [may] [shall have the power to]:
(a) require the driver of a vehicle to stop the vehicle for the purposes of weighing and inspecting the vehicle;
(b) direct a driver to proceed to a weighing station for the purposes of weighing the vehicle;
(c) enter the vehicle;
(d) inspect:
(i) any load being carried in or on the vehicle; and
(ii) any record relating to any load carried in or on the vehicle;
(e) weigh the vehicle and any load being carried in or on the vehicle;
(f) determine the mass of all axles or axle units on a vehicle or combination of vehicles;
(g) direct the driver to offload a vehicle at a place determined by the officer or to adjust the load to ensure that the vehicle is loaded within limits;

(h) detain a vehicle until such time as an overloading fee has been paid or proof, in the manner determined by the director of the national road authority, has been provided that arrangements have been made to pay the fee;
(i) direct the driver of a vehicle carrying live or dangerous cargo to proceed to any place determined by the officer to ensure the safety of the cargo, persons, or property;
(j) drive a vehicle to any place if a driver is incapable or unwilling to comply with an instruction of the officer, provided the officer holds a valid driving license for the vehicle or alternatively authorizes any other person with a valid license to drive the vehicle;
(k) inspect any record relating to, issued, or required under any transport law or regulation;
(l) make inquiries of any person who owns or operates the vehicle being inspected; and
(m) perform or cause to be performed tests or examinations of or in respect of the vehicle or any load carried in or on the vehicle.

(2) In exercising the powers contemplated in subsection (1), the officer shall not be liable for any damage to or loss in respect of a vehicle or its load, unless it is shown that the officer acted without reasonable care.

Comment: This section—the second of three on Authorized Officers—enumerates the powers of an authorized officer and provides them with immunity for damages caused unless they act without reasonable care. The first subsection is drawn mainly from the SADC Model Legislative Provisions, but particularly subsections (g) to (j) are drawn from Regulation 37 of Botswana Road Traffic (Vehicle Loads) Regulations. The second subsection is also based on Regulation 37 of the Botswana legal instrument.

19. *Duty of Drivers to Stop Upon Instruction of an Authorized Officer*

A driver of a vehicle must:
(a) on being signaled or requested to do so by an authorized officer with the prescribed identification markings; or
(b) if requested to do so by an authorized officer who has produced his or her certificate of appointment,
forthwith take the vehicle to a weighing station as directed by the authorized officer.

Comment: This section—the third of three on Authorized Officers—is based on Section 22 of the SADC Model Legislative Provisions. It establishes the duty of drivers to stop at the request of authorized officers and proceed with them to a weighing station if so directed.

8.4.7 Part VI: Voluntary Compliance

PART VI: VOLUNTARY COMPLIANCE

20. *Partners in Compliance Programmes*

Each national road authority shall incrementally develop a voluntary compliance programme aimed at:
(a) establishing procedures and practices that assist carriers in improving their compliance with the provisions of this Act, including measures to promote self-regulation;

(b) introducing economic or financial incentives to encourage improved rates of compliance by carriers; and
(c) encouraging investment by carriers, individually or through representative organizations, in:
(i) single or common user weighing stations; and
(ii) state-of-the-art technology applicable to weight measurement, data collection, processing, and exchange.

Comment: This section draws from Section 23 in the SADC Model Legislative Provisions but makes reference to the concept of "self-regulation" in subsection (c). This concept developed in recent years in the Republic of South Africa[34] received considerable support during all three stakeholders workshops[35] and during the country visits made by the JICA Study Team in January–February 2011.[36] There are no comparable provisions in the good-practice Botswana and Zambian models examined.[37]

8.4.8 Part VII: Network Development

PART VII: NETWORK DEVELOPMENT

[21. *Regional Network of Weighing Stations*

(1) The effectiveness of overloading control on a regional basis shall be ensured through the development of a regional network of weighing stations that will be effective and sustainable in respect of both domestic and international traffic.
(2) Weighing stations forming part of the regional network shall be strategically and equitably located on the regional trunk road network.
(3) In locating weighing stations, preference shall be given to the establishment of weighing stations in common control areas at border posts.
(4) The Council may issue a Regulation establishing the regional network of weighing stations.

[34] E.g., since March 2007, the South African sugar industry (consisting of over 42,000 growers, more than 430 transport companies, and 13 sugar mills) has implemented a Road Transport Management System (RTMS) and internally self regulated their 21 million tonne per annum sugarcane supply chain, resulting in a substantial reduction in vehicle overloading. http://www.rtms.co.za/industry-participation/sugar and http://www.selfregulation.co.za/Sugar.aspx. Also refer to Sections 6.6 of this report, including Box 6-1.

[35] E.g., At the 1st Stakeholders Workshop, "[t]he delegate from the Northern Corridor Transit Transport Coordinating Authority supported self-regulation. He called for installation of weighbridges at the port so that the shipper can determine that he/she is within allowable limits, and a certificate of compliance should be issued"; "a Uganda delegate pointed to the importance of innovative refinements such as in the area of self-regulation"; "[t]he Federation of East African Freight Forwarding Associations representative noted the importance of self-regulation"; "[a] private sector representative from Uganda noted the authorized economic operator (AEO) programme of the World Customs Organization, which provides incentives to comply with laws and regulations; "[a]nother delegate suggested that the known mechanisms for self-regulation should be considered in legal drafting". The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011.

[36] E.g., Interview with Mr. Marvin Baryaruha (Legal Counsel) and Mr. William Tumwine (Legal Officer), Uganda National Roads Authority, 25 January 2011 ["self-regulation is the solution"].

[37] The draft SADC MOU on Vehicle Loading included a brief article (Article 10) on Voluntary Compliance, simply stating that "Member States agreed to adopt appropriate arrangements to support incremental voluntary compliance which may include introduction of co-operative training programmes and additional incentives to reward increased voluntary compliance." Southern Africa Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Memorandum of Understanding on Vehicle Loading", Article 10, p. 9]. Also see the Dar es Salaam Corridor Memorandum of Understanding on Vehicle Loading in Chemonics International, Inc. [Advisor: Evans S. Marowa, Short-term Transport Operations Specialist], *Technical Report: Proposed Harmonized System for Vehicle Overload Control*, submitted to Regional Center for Southern Africa, U.S. Agency for International Development, September 2003, p. 16.

(5) The Partner States shall monitor, on an ongoing basis, the effective operation of regional network weighing stations and related equipment and, where this is found to be inadequate, the Partner States shall maximize national and regional financial and human resources, by:
(a) promoting joint use of weighing stations and related facilities;
(b) promoting joint management of weighing stations and related facilities;
(c) exploring options for joint funding of infrastructure and equipment upgrading; and
(d) jointly procuring private investment and technology transfers for upgrading of existing facilities and establishment of new facilities.]

Comment: This section, presented in square brackets for the consideration of the Partner States, is based on Article 5 of the draft SADC Memorandum of Understanding on Vehicle Loading, [38] a draft regional agreement, as opposed to the SADC Model Legislative Provisions, which comprise a draft (national) law. During the study, the Partner States agreed that the location of weighbridges will be determined by regulations in the regional legal framework.[39]

22. *National Network Strategy*

(1) [Each] [A] national road authority [shall][may], within six months of commencement of this Act, prepare an outsourcing strategy comprising:
(a) a weighing station strategic plan, consisting of:
(i) the identification of existing and future weighing stations sites along the major transport corridors and commercial vehicle routes;
(ii) a procurement schedule incorporating:
(aa) rehabilitation and upgrading of existing weighing stations;
(bb) construction and operation of new weighing stations;
(cc) outsourcing of operations; and
(dd) time scales for the actions contemplated in subparagraphs (i), (ii), and (iii) of this paragraph; and
(iii) an identification of options for private investment.
(b) an outsourcing plan, providing for:
(i) an assessment of national road authority functions contemplated in this Act that may be outsourced, including but not limited to state-of-the-art technology applicable to:
(aa) weight measurement;
(bb) data collection, processing, and exchange;
(cc) compliance records and demerit points systems; and
(dd) performance auditing
(ii) a procurement schedule identifying time scale and priorities for outsourcing; and
(iii) an identification of outsourcing options.
(2) [Each] [A] national road authority [shall][may] present its strategy to the relevant Minister for consideration and approval.

[38] It also appears in the Dar es Salaam Corridor Memorandum of Understanding on Vehicle Loading in Chemonics International, Inc. [Advisor: Evans S. Marowa, Short-term Transport Operations Specialist], *Technical Report: Proposed Harmonized System for Vehicle Overload Control*, submitted to Regional Center for Southern Africa, U.S. Agency for International Development, September 2003, p. 14 (Article 5).
[39] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 3rd Stakeholders Workshop*, August 2011, p. 12.

(3) The relevant Minister may publish the strategy or extracts in the Gazette or a newspaper of national circulation for comment.

Comment: This section is drawn from Section 25 of the SADC Model Legislation Provisions, although a choice between mandatory and optional options has been provided in subsections (1) and (2). It is mandatory in the SADC model text.

23. *Outsourcing of Functions of the National Road Authority*

(1) Subject to subsection (2) and Section 24 of this Act, a national road authority may outsource any of the functions contemplated in subsection (2), by appointing:
(a) any other government agency; or
(b) any private person,
as an agent.
(2) A national road authority may outsource:
(a) the collection of overloading fees [and abnormal and awkward load fees];
(b) the operation and maintenance of databases supporting the vehicle loading management system;
(c) the provision, operation, and maintenance of weighing stations; and
(d) the performance of enforcement and compliance functions.

Comment: This section is based on subsections (1) and (3) of Article 25 of the SADC Model Legislative Provisions,[40] which in a note state that the aim is to provide maximum flexibility in assuring that adequate institutional capacity is available for governments to implement the Provisions. If a national road authority does not currently have direct responsibility for control of vehicle overloading and a transition period is required before it can assume this responsibility, this section accommodates this requirement by allowing the road authorities to appoint authorities currently responsible for the control of overloading to continue to carry out these functions as agents of the national road authority. Also, the section provides for the outsourcing of certain functions to the private sector (e.g., fee collection) as agents in return for compensation through user fees.[41]

24. *Agency Agreements*

(1) A national road authority may conclude agency agreements to outsource any function to a person contemplated in Section 23 of this Act.
(2) An agency agreement may provide for:
(a) the setting of performance targets;
(b) bonus or incentive payments in cases in which targets are exceeded;
(c) reduced compensation in cases in which targets are not met;
(d) regular and random audits; and
(e) any other matter necessary to achieve the objectives of this Act.

Comment: This section is drawn from Section 26 of the SADC Model Legislative Provisions, and the comment on Section 23 above also applies in relation to this section.

[40] Subsections (2) and (4) relate to an Investment in Transport Act that does not apply here.
[41] Southern Africa Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Model Legislative Provisions on Management of Vehicle Loading", p. 17].

25. *Compensation of Agents*

(1) Where any agreement is concluded to outsource a function of a national road authority, such agreement must, subject to Section 24, provide for fair and adequate compensation of an agent in line with commercial principles.
(2) An agreement contemplated in subsection (1) may in the case of the outsourcing of fee collection provide for the retention of an administrative component of the fee structure as compensation.

Comment: This section follows Section 27 of the SADC Model Legislative Provisions and assures fair compensation of a national road authority for outsourced functions. Subsection (2) is a corollary of subsection (1) and perhaps need not be stated, but does add clarity in the particular case specified.

8.4.9 Part VIII: Weighing Stations, Weighing Equipment, and Weighing Operations

PART VIII: WEIGHING STATIONS, WEIGHING EQUIPMENT, AND WEIGHING OPERATIONS

26. *Power to Install Weighing Stations and Conduct Weighing Operations*

(1) A national road authority may cause weighing stations or other devices for measurement of weights to be installed on any public road.
(2) The devices may be fixed or portable.
(3) The national road authority may approve the use of weighing devices owned or leased by institutions other than the national road authority for measurement of weights only if the devices are within the specifications approved by the national road authority and authorized by the body responsible for weights and measures.
(4) The national road authority may provide guidelines for proper use of weighing devices by drivers at a weighbridge.

Comment: This section is based mainly on the section on Constitution of Weighing Devices in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations and to a lesser extent on Regulation 18 of the Botswana Road Traffic (Vehicle Loads) Regulations. It was preferred to the almost laissez-faire approach of the SADC Model Legislative Provisions, which may lead to a proliferation of weighbridges or certainly a supply of weighbridges greater than what is economically optimal. The Partner States may wish to consider closely the text on "portable" weighbridges, considering that it has been argued that portable or mobile weighbridges should be used for screening purposes only because of accuracy issues.[42]

[42] At the 2nd Task Force Meeting the Partner States agreed to allow use of portable/mobile scales for enforcement subject to accreditation. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Taskforce Meeting to Review the Interim Report and Initial Study Recommendations*, May 2011 [matrix of outcomes attached]. At the 2nd Stakeholders Workshop, Kenya stated that, particularly along the Northern Corridor, mobile axle scales should not be used for enforcement, but only for monitoring. Kenya is also moving from single axle weighbridges to group axle weighbridges, which are more accurate. Uganda observed that a mobile weighbridge can be used in the static mode for single-axle weighing and can be accurate, if properly accredited, and therefore can be used for enforcement. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 9, items (ii) and (iii).

27. *Authorization of Scales and Devices*

Only scales and devices that have been verified and calibrated according to the manufacturer's specifications and have been authorized by the body responsible for weights and measures shall be used in the enforcement of this Act.

Comment: This section is based on the section on Authorization of Devices in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations and to a lesser extent on Regulation 20 of the Botswana Road Traffic (Vehicle Loads) Regulations.

28. *Certificates of Approval*

(1) The body responsible for weights and measures shall issue a certificate of approval for each and every weighing station after a test of the device or acceptance of the recommendations of the International Organisation of Legal Metrology (Organisation Internationale de Métrologie Légale, OIML).
(2) The maximum validity of such certificates of approval is one year.
(3) The certificate shall be displayed at the weighing station and allowed to be inspected by transporters on demand.
(4) A weighing station with an invalid certificate may not be allowed to be used for enforcement purposes.

Comment: This section is based on the section on Certificates of Approval in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations. OIML (http://www.oiml.org/) is an intergovernmental organization established in 1955 to promote the global harmonization of legal metrology procedures. Kenya and Tanzania are members of OIML, while Rwanda is a "corresponding member". The JICA Study Team has added subsection (2) to require at least annual verification of weighing stations as called for by a resolution of the Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control (Nairobi, July 2008)[43] and was agreed at the 2nd Task Force Meeting.[44]

29. *Accreditation of Weighing Stations, Audits, and Random Inspections*

(1) A weighing station to be used for enforcement purposes shall be accredited by the national road authority or any institution for accreditation appointed by the national road authority.
(2) No weighing station shall be accredited for enforcement by a national road authority unless it complies with the minimum standards for accreditation issued by the national road authority.
(3) The national road authority shall issue a regulation specifying different standards for different types of weighing stations regarding:
(a) the volume of traffic on the route along which the weighing station is or will be situated;
(b) the category or type of vehicles that will be weighed at the weighbridge station;

[43] InfraAfrica (Pty) Ltd in association with Africon Limited, Council for Scientific Research (CSIR), and TMT Projects (Pty), *Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control, Workshop Report*, Nairobi, 10–11 July 2008, p. 13.
[44] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Taskforce Meeting to Review the Interim Report and Initial Study Recommendations*, May 2011 [matrix of outcomes attached, item 19].

(c) whether the weighing station will be jointly managed under a bilateral or multilateral agreement between or among governments of the Partner States; and
(d) whether the weighing station will be managed by an appointed agent to operate the weighbridge on behalf of the national road authority.

(4) The national road authority shall conduct an inspection to verify whether a weighing station complies with the standard and in the event of a positive finding issue a certificate of accreditation.

(5) An accredited weighing station shall be subject to an annual technical audit by [the national road authority] [a qualified independent audit organization appointed by the relevant Minister] to confirm that it meets the requirements for accreditation.

(6) The body responsible for operating the weighing station shall provide the national road authority with all reasonable assistance in undertaking the audit including:
(a) any information that may be requested;
(b) access to the documentation relating to the operation of the weighing station, including the storage of data records;
(c) access to any part of the weighing station and facilities; and
(d) access to any person employed with regard to the operation of the weighing station.

(7) If the findings of an annual audit are that a weighing station no longer complies with the prescribed standards, a national road authority may:
(a) issue a directive in writing to the responsible body for operating the weighing station to ensure compliance within the period specified by the directive;
(b) suspend the certificate of accreditation pending such compliance; or
(c) revoke the certificate of accreditation.

(8) A certification of accreditation may be [renewed] [reissued] if a weighing station is found to comply with the prescribed standards after an accreditation inspection has been conducted.

(9) The national road authority may at any time conduct a random inspection of a weighing station for the purpose of verifying compliance with a standard applicable to the station.

Comment: This section is mainly based on the section on Fixed Weighbridges and Their Use in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations and Sections/subsections 30(2) and 31 of the SADC Model Legislative Provisions on Accreditation of Weighing Stations and Annual Audits and Random Inspections. Subsection (5) provides for an audit, at least annually, as called for by a resolution of the Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control (Nairobi, July 2008).[45] One option, "inspired" by Regulation 39 of the Botswana Road Traffic (Vehicle Loads) Regulations, provides for audits to be performed by a qualified independent audit organization appointed by the relevant Minister. Section 29(5) is consistent with weighbridge auditing at least every 12 months depending on traffic flow as agreed by the 2nd Task Force Meeting.[46]

[45] InfraAfrica (Pty) Ltd in association with Africon Limited, Council for Scientific Research (CSIR), and TMT Projects (Pty), *Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control, Workshop Report*, Nairobi, 10–11 July 2008, p. 13.

[46] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Taskforce Meeting to Review the Interim Report and Initial Study Recommendations*, May 2011 [matrix of outcomes attached, item 20].

30. *Weighing Operations*

(1) An authorized officer shall ensure that the scale is set to zero before commencing a weighing operation.

(2) The mass of a single axle shall be determined by weighing such axle individually.

(3) The mass of an axle unit shall be determined by weighing such unit in one operation. If an axle unit cannot be weighed in one operation due to the size of the scale, the mass of the unit shall be determined by weighing each axle or axle unit individually and calculating the sum of the masses of the individual axles.

(4) The mass of a vehicle or combination of vehicles shall be determined by weighing the vehicle or entire combination in one operation. If a vehicle or combination of vehicles cannot be weighed in one operation due to the size of the scale, the gross mass of the vehicle or combination of vehicle shall be determined by weighing each axle or axle unit individually and calculating the sum of the mass of the individual axle and axle units.

[(5) An axle or combination of axles shall be deemed overloaded if the load exceeds the legal load limit after addition of x% of allowable mass and then rounding down to the nearest hundred kilograms. A vehicle shall be deemed overloaded if the load exceeds the legal load limit after addition of x% of allowable mass and then rounding down to the nearest 100 kilograms.]

Comment: This section is based mainly on Regulations 22–24 of the Botswana Road Traffic (Vehicle Loads) Regulations and the part of the Zambia Public Roads (Maximum Weight of Vehicles) Regulations on the Calculation of Load and Procedures. More details, if necessary, may be specified in a Regulation to be issued by the Council in accordance with Section 39.[47]

Subsection 5 draws from the Regulation on Overload Determination in the Zambia instrument, although in that case the tolerance (5%) only applies to an axle or combination of axles and not to gross vehicle/combination mass. As noted in Chapter 2 of this report, practice with respect to operational allowances/tolerance varies among the Partner States, although the Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control (Nairobi, July 2008) called for a mass tolerance of 5% on axle, axle unit, vehicle, and vehicle combination mass.[48] At the 2nd Stakeholders Meeting in Nairobi on 30-31 May 2011, Kenya and Tanzania stated that they prefer zero tolerance on gross vehicle/combination mass, while the other countries preferred 2% (all countries accepted 5% tolerance on axles).[49] Section 7.4.2 of this report recommends that a weighing tolerance of 5% on axles and gross vehicle/combination mass be adopted on a regional basis. However, at the Extraordinary Task Force Meeting held in Bujumbura on 29-30 June 2011, the Partner States agreed in principle that a 5% tolerance on axle weight be allowed and maximum limits for gross vehicle mass (GVM) or gross combination mass be inclusive of all tolerances.[50]

[47] At the 2nd Stakeholders Meeting, Kenya expressed support for a standardized weighbridge specification to facilitate cross-border movement. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 9, item (ii).

[48] InfraAfrica (Pty) Ltd in association with Africon Limited, Council for Scientific Research (CSIR), and TMT Projects (Pty), *Regional Workshop on Harmonization of Key Elements and Implementation of Best Practice in Overload Control, Workshop Report*, Nairobi, 10–11 July 2008, p. 13.

[49] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 13.

[50] East African Community, *Extraordinary Task Force Meeting for the Study on the Harmonization of Overload Control Regulations in the East African Community, Report of the Meeting*, June 2011, Sections 3.2 and 4.0 (iii) and (iv), pp. 4-5.

31. *Data Management*

(1) Weighing stations for enforcement purposes shall store records from operations, identifying the vehicles weighed at the stations and the data recorded locally shall be transmitted to a central database administered by the national road authority, in a mode and with the content prescribed by the national road authority.
(2) Each national road authority shall submit quarterly and annual reports collating data collected by all weighing stations to the body established in Section 32 of this Act.

Comment: This section is based on a comparable regulation on Data Storage and Operations in the Zambia Public Roads (Maximum Weight of Vehicles) Regulations and on Regulation 35 in the Botswana Road Traffic (Vehicle Loads) Regulations. The COMESA delegate at the 1st Stakeholders Workshop recommended that the legal instrument provide for (annual) reporting by management with statistics that can be shared by the EAC and other agencies.[51]

8.4.10 Part IX: Institutional Arrangements

PART IX: INSTITUTIONAL ARRANGEMENTS

32. *Establishment, Composition, and Tenure of a Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority]*

(1) A Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] comprised of equal numbers from each Partner State of representatives of the competent authorities and the private sector shall be established to coordinate and monitor activities under this Act.
(2) Each Partner State shall nominate three representatives, at least one of whom shall be a representative of the private sector, as members of the [Committee] [Subcommittee] established under subsection (1).
(3) The tenure of the individual [Committee] [Subcommittee] members shall be three years.

Comment: This section draws upon Section 49 of the One Stop Border Post Act establishing a similar body for implementation of that Act (in that case, a one-stop border posts board). At the 1st Stakeholders Workshop, the importance of providing for institutional arrangements in the Act was stressed.[52] It was observed that there is a proposal to form an EAC Transport Authority, which could be mandated to provide policy guidance on the implementation of the Act. It was noted that this is a subject for discussion by institutional experts. Article 15 of the draft SADC MOU on Vehicle Loading envisages a Regional Vehicle Overloading Control Association.[53] Once the precise title of the body is decided, it may be defined in the glossary in Section 2 of this Act so that this Part can be shortened accordingly.

[51] The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011, p. 15, Section 3.3, paragraph xiii.
[52] See source in previous footnote, p. 14, Section 3.3, paragraph ix.
[53] Southern Africa Transport and Communications Commission (SATCC), *Enabling Legal Reform: Control of Vehicle Loading*, May 2009 ["Memorandum of Understanding on Vehicle Loading", Article 15, pp. 10–11].

33. *Responsibilities of the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority]*

Without prejudice to the generality of Section 32 of this Act, the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] [shall] [may]:

- *(a) identify opportunities to integrate national overloading control systems;*
- *(b) identify the optimal regional allocation of permanent weighing stations;*
- *(c) identify the optimal utilization of mobile weighing stations in support of the regional weighing station network;*
- *(d) harmonize the development of a regional overloading control information system that accommodates trucker- and shipper-based risk analysis;*
- *(e) harmonize the design and implementation of a regional demerit points system and harmonizing penalties for vehicle offenders;*
- *(f) monitor the incidence and levels of corruption relating to vehicle loading;*
- *(g) harmonize regional training programmes for national road authority personnel, the traffic police, and other persons involved in vehicle overloading control systems; and*
- *(h) disseminate information on the objectives, design, functions, and procedures of a regional system of overloading control.*

Comment: This section mainly draws from Article 15(1) of the draft SADC MOU on Vehicle Loading. The responsibilities may be made mandatory or optional. As indicated in the introductory text (drawn from Section 50 the EAC One Stop Border Posts Act), the list is non-exclusive.

34. *Meetings of the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority]*

(1) The Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] shall meet at least [twice][four times] a year and alternate the venues of its meetings in each of the Partner States.

(2) The chair of the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] shall rotate according to the established procedures of chairing East African Community organs and institutions.

(3) The Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] shall regulate its own meetings and rules of procedure and shall adopt its decisions by consensus. It shall keep a record of its own proceedings. In the event of a failure to reach consensus, the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] shall refer such matters to the Council through the appropriate sectoral Councils.

(4) In the exercise of its functions, the Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] may co-opt any such persons as it deems appropriate on any matter for its consideration.

Comment: This section is based primarily on Section 51 of the EAC One Stop Border Posts Act on Meetings of the Board and secondarily on Article 15(1) of the draft SADC MOU on Vehicle Loading. The former calls for meeting twice a year, the latter for meetings four times a year.

35. *Liaison with Other Regional Economic Communities*

The *Regional Vehicle Loading Advisory [Committee] [Subcommittee of the EAC Transport Authority] shall regularly liaise with its counterparts in neighboring regional economic communities.*

Comment: This section is aimed at promoting further harmonization with the Tripartite framework (i.e., with COMESA and SADC) and beyond.

8.4.11 Part X: Miscellaneous Provisions

PART X: MISCELLANEOUS PROVISIONS

36. *Temporary Measures*

(1) This Act shall not affect the rights of any Partner State to take temporary measures in the interests of defense and security, public safety, public order, economic interests of the Partner State, and any other circumstances of a similar nature.
(2) Such temporary measures may include, but not be limited to, implementation of stricter legal load limits than provided for in this Act.
(3) The Partner State taking any temporary measures under this section shall, prior to taking such temporary measures, inform the other Partner States without delay through the exchange of diplomatic notes. In circumstances where prior notification is not practical, the Partner State taking such temporary measures shall simultaneously inform the other Partner State of the temporary measures imposed through the exchange of diplomatic notes.

Comment: This section is based on Sections 56 and 57 of the EAC One Stop Border Posts Act on the rights of Partner States to take temporary measures (Section 56) and their duty to inform others (Section 57). It responds to a suggestion by a Kenya delegate at the 1st Stakeholders Workshop to include a provision in the legal framework to account for emergencies (e.g., if a bridge collapses).[54]

37. *Extraterritorial Performance of Duties*

(1) Any person who is authorized to exercise his or her powers and perform his or her duties in one of the Partner States in respect of vehicle loading:
(a) may independently perform all duties and powers in another Partner State in terms of the laws of his or her Partner State;
(b) may independently perform all duties and powers within his or her Partner State on behalf of another Partner State in terms of that other Partner State's laws; and
(c) may independently perform all duties and powers in another Partner State on its behalf in terms of that other Partner State's laws.

[54] The East African Trade and Transport Facilitation Project, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 1st Stakeholders Workshop to Review the Inception Report and Initial Study Findings*, 7–8 February 2011, p. 14, Section 3.3, paragraph xi. This section is analogous to Article 40 the Greater Mekong Subregion Cross-Border Transport Agreement, which provides that "[e]ach Contracting Party may temporarily suspend the application of the Agreement with immediate effect in the case of emergencies affecting its national safety". See http://adb.org/GMS/Cross-Border/part10.asp.

(2) The duties and powers contemplated in subsection (1), must include the power to perform any of the functions contemplated in Section 18 of this Act.
(3) Any offense under the laws of one Partner State committed at a shared weighing station facility located wholly in the territory of another Partner State is deemed to have been committed in the territory of the first Partner State.

Comment: This section is based on Section 36 of the SADC Model Legislative Provisions on Extraterritorialty. During the 2nd Stakeholders Workshop, the EAC Secretariat noted the importance of extraterritorial jurisdiction with respect to weighbridges; this will go beyond what is existing in national legal regimes, adopting international good or best practice.[55] It is required if shared weighbridges at border crossing points are envisaged.

38. *Dispute Resolution*

(1) Any dispute that may arise in the interpretation, application, and implementation of this Act and any Regulations shall be resolved by and between the Partner States amicably and in the spirit of friendship and co-operation.
(2) The Partner States shall, in resolving such disputes, primarily be guided by the need to give effect to the paramount objectives of this Act.
(3) Any dispute between or among Partner States in terms of this Act that remains unresolved for a period of more than 180 days from the time such dispute is declared shall be referred for settlement in accordance with the provisions of the dispute settlement procedure stipulated in Article 32 of the Treaty.

Comment: This section is based on Sections 58 and 59 of the EAC One Stop Border Posts Act, providing for mutual resolution first (Section 58) and reference to EAC mechanism (Section 59).

39. *Regulations*

The Council may make Regulations providing for any matter which by this Act is required to be prescribed or which is considered necessary or desirable to be prescribed for giving effect to the purposes of this Act.

Comment: This is a standard provision in EAC Acts allowing the Council to issue Regulations. As mentioned in the draft text of the Act, such Regulations may for example cover measures relating to live and dangerous cargo (Section 10); imposition of administrative sanctions (Section 14); the details of a demerit points systems (Section 16); the establishment of a regional network of weighing stations (Section 21); specification of different standards for different types of weighing stations (Section 29); and sample forms (e.g., vehicle weighing report, weighing certificate). However, as noted, at this stage what is important is for the Partner States to agree on an EAC framework, an EAC Act, for harmonization of vehicle overload control.[56]

[55] East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop*, May 2011, p. 12, items (xx).
[56] At the 2nd Stakeholders Workshop, the EAC Secretariat clarified that it has developed regional regulations on similarly technical issues, e.g., in the civil aviation subsector. Short-term expert inputs can be mobilized, if necessary. East African Community, *Study on the Harmonization of Overload Control Regulations in the EAC Region, 2nd*

40. *Act to Take Precedence*

This Act shall take precedence over the Partner States' laws with respect to any matter to which its provisions relate.

Comment: This is also a standard provision in EAC Acts. Although arguably it is not required since according to subparagraph (4) of Article 8 of the EAC Treaty such a supranational Act will take precedence over contrary national laws or regulations, inclusion of this section causes no harm and provides added clarity.

41. *Requirement of Partner States to Conform Their National Laws and Regulations to this EAC Act*

Where necessary, the Partner States undertake to conform their relevant national laws and regulations to the contents of this EAC Act.

Comment: Although not a standard provision of EAC Acts to date, this proposed section would require the Partner States to align their relevant national laws and regulations to the EAC Act. Again, although arguably it is not required since according to subparagraph (5) of Article 8 of the EAC Treaty the Partner States are to undertake the necessary legal instruments to confer precedence to EAC laws over similar national ones, inclusion of this section causes no harm and may provide added clarity.

8.4.12 Schedules

Schedules to be prepared include the following:

First Schedule: Maximum Gross Vehicle Mass

Second Schedule: Maximum Axle Load Limits

[Third Schedule: Overloading Fees for Overloaded Gross Vehicle Mass

Fourth Schedule: Overloading Fees for Overloaded Axles

Fifth Schedule: Abnormal or Awkward Load Fees]

As noted, specification of the required schedules will require economic and engineering (as opposed to legal) technical inputs, as well as discussion between and among the experts from the respective EAC Partner States.

Stakeholders Workshop to Review the Interim Report and Advise on Ways Forward, Report of the Workshop, May 2011, p. 12, item (xxi).

Appendices

Appendix A Regional Economic Benefits from Harmonization of Axle Load Regulations in the East African Community

This appendix quantifies the economic benefits due to regional harmonization of axle load regulations in the East African Community (EAC), specifically focusing on transport fixed cost savings accruing from decreases in weighbridge crossing times.

The regional truck transport cost for a 40-foot freight container vehicle (at an average of 26 tonnes of freight per container) can be summarized as follows:

Total Transport Costs = (Variable Cost x *Travel Km*) + (Fixed Cost x *Travel Days*)

Variable costs include costs for fuel, lubricants, tyres, and other incidentals. Fixed costs consist of salary and equipment costs related to the operation of the vehicle. Table A-1 summarizes the variable costs (in USD/km) and fixed costs (USD/day) for the various corridors in the four regions of Sub-Saharan Africa.

Table A-1: Truck[1] Operating Costs along Four African Corridors (2008)

Corridor	Route Gateway / Destination	Variable Cost (USD/km)	Fixed Cost (USD/Day)
West Africa (Burkina Faso and Ghana)	Tema/Accra – Ouagandougou (Burkina Faso)	1.51	30
	Tema/Accra – Bamako (Mali)	1.67	36
Central Africa (Cameroon and Chad)	Douala – N'Djamena (Chad)	1.31	49
	Doula – Bangui (Central African Republic)	1.22	73
	Ngaoundere – N'Djamena (Chad)	1.83	22
	Ngaoundere – Moundou (Chad)	2.49	21
East Africa (Uganda and Kenya)	Mombasa – Kampala (Uganda)	0.98	61
	Kampala – Kigali (Rwanda)	1.47	40
Southern Africa (Zambia)	Lusaka – Johannesburg (South Africa)	1.54	55
	Lusaka – Dar es Salaam (Tanzania)	1.34	71

Source: Africa Infrastructure Country Diagnostic, *Transport Prices and Costs in Africa: A Review of the Main International Corridors*, 2008.

The fixed and variable costs for East Africa Region (with respect to the Northern Corridor originating from Mombasa Port) can be attributed to the transport kilometers and transport days summarized in Table A-2.

[1] It is assumed that the term "heavy truck" in the AICD report and the 40-foot container (26 tonnes) vehicle are the same.

Table A-2: Freight Transport Time through the Northern Corridor (Mombasa Port–Kampala/Kigali) by a 40-foot Container Vehicle (2008)

Freight Destination (Originating from Mombasa Port)	Kampala	Kigali
Distance (km)	1,119	1,683
Number of Borders	1	2
Port Dwell Time (days)	14	12
Land Transport Time (days)[2]	5	7
Driving Time (hours)	41	62
Border Crossing Time (hours)	8	10
Weighbridge Crossing Time (hours)	11	12
Clearance Time at ICD (days)	4	4
Total Transport Time (days)	23	23

Source: JICA and PADECO, *The Research on the Cross-Border Transport Infrastructure Phase 3*. Based on information from the Kenya Ports Authority (KPA), 2008; *Annual Review and Bulletin of Statistics*, 2007; East African Trade and Transport Facilitation Project (EATTFP), 2008; *Report on Inspection Tour on Northern Corridor*; and KPA, *A Study of the Central Corridor*, 2008

Combining the information from Tables A-1 and A-2, the average fixed and variable transport cost along the entire Northern Corridor is summarized in Table A-3.

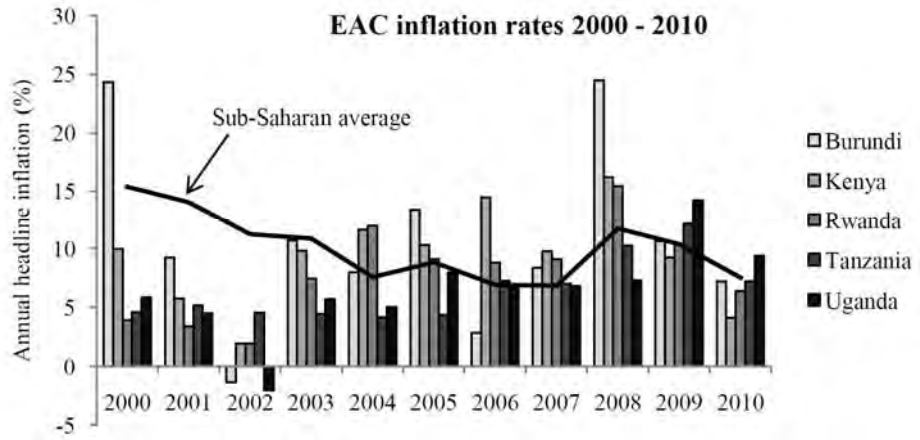
Table A-3: Fixed and Variable Cost for a 40-foot Container Vehicle (2008)

Variable Costs	Mombasa–Kampala	Kampala–Kigali
Distance (km)	1,119 km	562 km*
Variable Cost (USD/km)	USD 0.98/km	USD 1.47/km
Average Variable Cost Along the Entire Northern Corridor	USD 1.14/km **	
Fixed Costs (Land Tranpsort)* **	**Mombasa–Kampala**	**Kampala–Kigali**
Driving Time (hours)	41	21
Border Crossing Time (hours)	8	2
Weighbridge Crossing Time (hours)	11	1
Fixed Cost (USD/day)	61	41
Fixed Cost (USD/hour)****	5.1	3.4
Average Fixed Cost Along the Entire Northern Corridor (USD/hour)	USD 4.61/hour *****	

Note: * Calculated as 1,683 km – 1,119 km = 562 km;
** Calculated as [(1,119 km x USD 0.98/km) + (562 km x USD 1.47/km)] / 1,683 km;
*** Port/ICD Dwell Time omitted
****Truck Operation is assumed to be 12 hours/day;
***** Calculated as [(Total Land Transport 60hrs x USD 5.1/hr) + (24 hrs x USD 3.4/hr)] / 84 hrs
Source: JICA Study Team

As Table A-3 is based on information derived from publications and traffic surveys from 2008, the weighted average inflation rate for the five EAC countries shown in Figure A-1 was applied to establish the current fixed and variable costs.

[2] The total land transport time is defined as the sum of driving time, border crossing time, and the time spent at weighbridge stations. An hour-to-day conversion was undertaken, assuming truck operations of 12 hours a day.



Source: Ministry of Finance, Planning and Economic Development, Republic of Uganda

Figure A-1: EAC Weighted Average Inflation Rate

An average inflation rate from 2008-2010 was applied to the 2008 costs to derive the fixed and variable costs for 2011 as summarized in Table A-4.

Table A-4: Fixed and Variable Cost for a 40-foot Container Vehicle (2011)

Costs	
Average Variable Cost along the Northern Corridor (USD/km)	1.5
Average Fixed Cost along the Northern Corridor (USD/hour)	6.0

Source: JICA Study Team

As Table A-3 suggests, regional harmonization of axle load regulations in the East African Community would directly lower the fixed costs of truck transport by specifically decreasing the land transport time attributed to weighbridge crossing time. As summarized in Table A-5, for the case of the route from Mombasa to Kampala, the fixed cost attributed to weighbridge crossing time is USD 66 per trip, and constitutes approximately 18.6% of total fixed costs for land transport (omitting Port/ICD dwell time). By harmonization of axle load regulation in the EAC, this cost of weighbridge crossing could be substantially thereby generating economic benefits due to lower regional transport costs, which will facilitate regional trade.

Table A-5: Fixed Land Transport Costs for a 40-foot Container Vehicle

Fixed Costs (Land Tranpsort)	Mombasa–Kampala USD (hrs)	Kampala–Kigali USD (hrs)
Driving Time	240 (41)	126 (21)
Border Crossing Time	48 (8)	12 (2)
Weighbridge Crossing Time	66 (11)	6 (1)
Average Fixed Cost along the Northern Corridor (USD/hour)	6.0[3]	

Source: JICA Study Team

[3] This value is also in the same range as the fixed costs derived from the JICA Cross-Border Transport Infrastructure Phase 3 Report (2008), in which the total fixed costs for forward land transport of a 40-foot container from Mombasa Port to Kamala is 400 USD for a 60 hours of transport time, which roughly equates to USD 6.7/hour/40-foot container.

Tables A-6 and A-7 show that the total annual volume of goods transported by road transport along the Northern and Central Corridors are 20.3 million tonnes and 7.1 million tonnes, respectively. These values roughly equate to 780,770 trips [assuming that one trip equals one 40-foot (26-tonne) container traveling from Mombasa to Kigali[4]] along the Northern Corridor road per year, and 273,080 trips along the Central Corridor [assuming that one trip equals one 40-foot (26 tonne) container travelling from Dar es Salaam to Kampala]. Within the EAC, weighbridges have been used mainly along the Northern and Central Corridors, thus economic benefits from harmonization of axle load regulations is speculated to affect traffic along the Northern and Central Corridors specifically.

Table A-6: Northern Corridor Road Traffic (2009)

Type of Traffic	Traffic Volume (000 tonnes)
Transit	5,509
Regional	2,974
Domestic	11,817
Total	**20,300**

Source: USAID, *Corridor Diagnostic Study of the Northern and Central Corridors of East Africa*, by Nathan Associates Inc.

Table A-7: Central Corridor Road Traffic (2009)

Type of Traffic	Traffic Volume (000 tonnes)
Transit	357
Regional	658
Domestic	5,617
Total	**6,632**

Source: USAID, *Corridor Diagnostic Study of the Northern and Central Corridors of East Africa*, by Nathan Associates Inc.

Assuming that the Central Corridor will experience the same USD/time rate of savings as the Northern Corridor, the cost savings from weighbridge time savings would be as shown in Table A-8. **A 10-minute decrease in weighbridge crossing time amounts to USD 1 cost saving per trip with an annual economic benefit calculated to USD 1 million within the EAC.[5] Furthermore, a one-hour reduction in weighbridge crossing time amounts to USD 6 cost saving per trip with an annual economic benefit calculated to be USD 6.2 million within the EAC.**

[4] JICA and PADECO, *The Research on the Cross-Border Transport Infrastructure Phase 3*. Based on information from the Kenya Ports Authority (KPA), 2008; *Annual Review and Bulletin of Statistics*, 2007; East African Trade and Transport Facilitation Project (EATTFP), 2008; *Report on Inspection Tour on Northern Corridor*; and KPA, *A Study of the Central Corridor*, 2008.

[5] As explained earlier, economic benefits from reductions in weighbridge crossing time in the EAC will mainly affect traffic along the Northern and Central Corridors.

Table A-8: Economic Benefits from Savings from Weighbridge Crossing Time

Corridor	10 Minute Decrease	1 Hour Decrease
Northern Corridor	780,770	4,684,620
Central Corridor	273,080	1,638,460
EAC Total	**1,053,850**	**6,323,080**

Note: This calculation does not include benefits from time savings in the empty backhaul truck operation.
Source: JICA Study Team

Table A-9 shows that small physical improvements (e.g., computerization, increased versatile portable weighing machines, an increased number of lanes) at weighbridges result in time savings ranging from 10 minutes to a few hours. Axle load harmonization within the EAC (and in the future with SADC and COMESA) would most likely contribute to more than a 10-minute decrease in weighbridge crossing time. This finding suggests that economic benefits resulting from transport savings from decreased weighbridge crossing times will be of the order of a few million USD annually, furthermore leading to greater implications in terms of regional trade facilitation.

Table A-9: Improvements in EAC Weighbridge Crossing Times

Weighbridges	Baseline	Dec 07	May 08	Jul 09	Improvements
Mariakani	6 hrs	10 hrs	8 hrs	5 hrs	Additional lane, computerization
Athi River (Mlolongo)	–	8 hrs	8 hrs	3 hrs	Increased number of weighing machines, computerization
Maai Mahiu	–	2 hrs	1 hrs	40 min	Only escorted trucks pass through March
Gilgil	–	3 hrs	1 hrs	1.5 hrs	Only escorted trucks pass through weighbridge
Eldoret	–	50 min	20 min	30 min	Versatile portable weighing machine as been introduces
Webuye					
Amagoro (Malaba)	–	50 min	20 min	30 min	Only verification of documents take place
Busia	–	–	–	–	–
Kisumu		–	–	–	–
Busitema	–	30 min	20 min	20 min	Versatile portable weighing machine is easing operations
Masaka (Lukaya)	–	–	–	–	–
Mbarara	–	20 min	10 min	10 min	360 degree turn to weighbridge may increase process time
Mubende	–	–	–	–	–

Source: East Africa Trade and Transport Facilitation Project (EATTFP), *Report on Inspection Tour of Northern Corridor From Mombasa – Malaba – Kigali by the Seamless Transport Committee 4–12 July 2008.*

Appendix B Regional Saving in Maintenance Cost from Eliminating Overloading

In Section 4.4 the methodology adopted in this study for estimating maintenance cost with or without overloading was described. It was based on the distribution of axle loads actually measured at a limited number of points in the road network are limited. Although overloading is said to be rampant in the region, and while actual records do show some overloading, the majority of loads are under the limit. Generally, there are fewer violations on roads with high traffic volumes and more violations on roads with low traffic volumes. Two traffic types were taken as axle load distribution patterns: Type T with high traffic volumes and low violation rates and Type UB with low traffic volumes and high violation rates. Table 4-25 shows the results of HDM-4 model runs. For Type T the ratio of maintenance cost with and without overloading turned out to be 1.21, i.e., maintenance cost for the without case was 82.6% of the case with overloading. Similarly, for Type UB the without overloading case resulted in a maintenance cost 89.3% of that in the with-overloading case. The third type, a medium-traffic type, was defined as the average of the two, which gives a maintenance cost without overloading of 86.2% of the case with overloading. As explained in Section 4.4, the case of without overloading was defined assuming that all cargo on the overloaded vehicles would be transferred to vehicles at the maximum axle load limit, i.e., "ideal" loading. The number of vehicles thus would be larger than in the overloading case since the total amount of cargo must be divided into smaller individual payloads.

Road networks of each Partner State were divided into three types: high, medium, and low traffic carrying sections. Table B-1 shows the distribution of road lengths that fall into the three types by country. Applying the above-mentioned reduction factors by traffic type to the distribution of traffic type for each country, overall cost reduction factors for each country were obtained as shown in the table.

Table B-1: Average Maintenance Cost Reduction Factor by Country Due to No Overloading

Country	High Traffic %	Medium Traffic %	Low Traffic %	Average Cost Reduction Factor
Burundi	25	38	67	0.865
Kenya	6	31	63	0.879
Rwanda	31	31	38	0.862
Tanzania	1	9	90	0.889
Uganda	0	10	90	0.890

Source: JICA Study Team

The HDM-4 model was run for each country with overloading to yield the maintenance cost for each country with existing, i.e., overloading conditions. The model was run for 20 years starting from the existing conditions and assuming 3% annual traffic growth. The model determines necessary maintenance activities to achieve a given road condition level (in this case an IRI of 4.0) and calculates maintenance cost. Maintenance cost under the ideal condition, i.e., without overloading, can be obtained by applying the cost reduction factor shown above to the maintenance cost for each country. Table B-2 shows the results.

Table B-2: Maintenance Cost by Country

(USD million)

Country	Estimated Maintenance Cost for 2011–2030	Estimated Maintenance Cost without Overloading (Ideal Loading)
Burundi	20.38	17.62
Kenya	1,511.33	1,328.66
Rwanda	100.68	86.38
Tanzania	1,268.54	1,128.23
Uganda	1,306.23	1,162.20
Total	4,207.15	3,723.55

Source: JICA Team

In 20 years the elimination of overloading would save USD 484 million for the EAC region, or USD 24 million per year.

As Table A-3 was based on information derived from publications and traffic surveys from 2008, the weighted average inflation rate for the five EAC countries shown in Figure A-1 was applied to establish the current fixed and variable costs.

Appendix C EAC Trunk Road Network Data

C.1 Traffic Volume Data

Table C-1: Tanzania Traffic Data

Road	Link	Length	Traffic Volume			
			Light	Medium	Heavy	Total
T1	1	1	26280	6251	9	32540
T1	10	2	36943	3579	0	40522
T1	15	2	29693	14741	29	44463
T1	20	1	41215	5750	221	47186
T1	30	1	17841	6270	818	24929
T1	35	1	28517	4962	235	33714
T1	40	1	28930	5816	270	35016
T1	45	2	17841	6271	823	24935
T1	47	5	20116	5799	755	26670
T1	50	3	11755	4187	615	16557
T1	55	3	10659	4497	555	15711
T1	70	2	7370	4039	678	12087
T1	87	1	3988	2513	1023	7524
T1	90	2	3633	1950	1230	6813
T1	92	1	4198	3189	1422	8809
T1	96	1	1218	953	368	2539
T1	100	15	1251	1646	1053	3950
T1	105	21	1964	1098	1005	4067
T1	110	21	1888	1179	761	3828
T1	112	7	1718	1339	827	3884
T3	605	43	1783	775	468	3026
T3	607	20	1013	459	395	1867
T3	610	3	318	243	125	686
T3	612	36	281	342	243	866
T3	615	33	300	198	111	609
Total		228				
Weighted Average			3248.4	1297.7	511.6	5057.7
T3	620	14	272	316	181	769
T3	625	10	283	318	185	786
T3	630	14	272	320	192	784
T3	635	18	349	352	214	915
T3	640	17	511	300	217	1028
T3	641	1	431	258	170	859
T3	645	18	368	342	185	895
T3	650	12	505	575	231	1311
T3	653	0	965	311	260	1536
T3	654	1	6462	1309	381	8152

T3	655	26	240	218	181	639
T3	660	19	156	272	222	650
T3	665	22	194	179	364	737
T3	670	10	181	266	211	658
T3	675	0	69	77	164	310
T3	680	0	162	268	227	657
T3	685	27	122	179	385	686
T3	690	38	246	216	269	731
T3	695	2	67	100	145	312
T3	698	27	289	278	251	818
T3	700	33	179	233	222	634
T3	705	7	169	230	229	628
T3	715	19	1614	1272	2943	5829
T3	720	17	117	134	116	367
T3	725	26	57	89	184	330
T3	730	46	128	128	140	396
T3	735	9	280	201	349	830
T3	740	1	219	166	314	699
T3	745	21	216	238	299	753
T3	760	31	298	250	267	815
	Total	486				
	Weighted Average		297.3	277.6	337.5	912.4
T3	765	21	330	259	278	867
T3	770	21	445	391	343	1179
T3	775	7	227	175	188	590
T3	780	79	310	234	180	724
T3	790	47	709	437	311	1457
T3	792	8	230	117	193	540
T3	795	18	185	186	186	557
T3	800	16	300	159	195	654
	Total	217				
	Weighted Average		394.7	279.9	236.0	910.5
T3	805	32	139	146	159	444
T3	810	38	192	75	74	341
T3	815	5	373	101	122	596
T3	820	19	140	83	144	367
	Total	94				
	Weighted Average		173.1	102.2	119.6	394.9

Source: Data from Tanzania

Table C-2: Kenya Traffic Data

Region	Province	District	RoadID	Chainage	Distance	Traffic Volume			
						Light	Medium	Heavy	Total
3	Western	Teso	A104	2.20	6.12	971	364	219	5134
3	Western	Nakuru	A104	10.04	7.33	8879	5646	871	51626
3	Western	Bungoma	A104	16.86	3.48	786	607	330	5764
3	Western	Bungoma	A104	16.99	8.21	904	576	340	6086
3	Western	Bungoma	A104	33.28	8.24	1298	879	641	9595
3	Western	Bungoma	A104	33.48	0.90	735	233	99	3463
3	Western	Bungoma	A104	35.08	1.02	2123	591	299	9783
3	Western	Bungoma	A104	35.51	2.99	2005	574	300	9366
3	Western	Bungoma	A104	41.05	2.89	1417	460	168	6609
3	Western	Bungoma	A104	41.30	8.37	1450	398	107	6273
3	Western	Bungoma	A104	57.80	8.33	2092	744	227	9820
3	Western	Bungoma	A104	57.96	0.63	1999	853	326	10294
3	Western	Bungoma	A104	59.05	3.29	1483	337	47	5941
3	Western	Bungoma	A104	64.53	2.97	1841	589	286	8811
3	Western	Lugari	A104	64.99	1.25	1044	509	286	6069
3	Western	Lugari	A104	67.02	1.16	1785	577	156	8062
3	Western	Lugari	A104	67.30	2.09	1963	738	256	9591
3	Western	Lugari	A104	71.20	2.07	885	164	77	3621
3	Western	Lugari	A104	71.44	7.30	1550	499	173	7123
3	Western	Lugari	A104	85.80	7.28	1041	555	315	6340
3	Western	Lugari	A104	85.99	5.23	1770	882	509	10466
				Total Length	91.13				
					Weighted Average	2051.2	975.8	343.1	3370.1
2	Rift Valley	Uasin Gishu	A104	96.26	5.92	1633	570	299	8186
2	Rift Valley	Uasin Gishu	A104	97.84	5.43	2678	841	420	12799
2	Rift Valley	Uasin Gishu	A104	107.11	4.93	3115	1706	487	17087
2	Rift Valley	Uasin Gishu	A104	107.69	3.27	2117	1256	395	12184
2	Rift Valley	Uasin Gishu	A104	113.64	3.15	2163	813	358	10844
2	Rift Valley	Uasin Gishu	A104	114.00	5.76	1481	651	342	8128
2	Rift Valley	Uasin Gishu	A104	125.16	6.99	6971	1435	568	28787
2	Rift Valley	Uasin Gishu	A104	127.97	1.65	1333	742	461	8484
2	Rift Valley	Uasin Gishu	A104	128.47	2.64	5447	1266	684	24022
2	Rift Valley	Uasin Gishu	A104	133.25	2.81	3282	817	385	14523
2	Rift Valley	Uasin Gishu	A104	134.09	5.72	3058	801	390	13798
2	Rift Valley	Uasin Gishu	A104	144.70	5.69	5873	1537	610	25806
2	Rift Valley	Uasin Gishu	A104	145.48	2.50	3997	1292	494	18658
2	Rift Valley	Uasin Gishu	A104	149.70	2.42	1853	738	293	9348
2	Rift Valley	Uasin Gishu	A104	150.32	10.15	1648	537	298	8132
2	Rift Valley	Uasin Gishu	A104	170.01	10.08	1672	882	358	9513
2	Rift Valley	Uasin Gishu	A104	170.47	3.76	1912	813	410	10279
2	Rift Valley	Uasin Gishu	A104	177.52	3.84	1349	581	288	7266
2	Rift Valley	Uasin Gishu	A104	178.15	5.88	1081	815	433	7797
2	Rift Valley	Uasin Gishu	A104	189.28	5.86	1120	806	302	7277
2	Rift Valley	Uasin Gishu	A104	189.87	2.58	1145	522	232	6208
2	Rift Valley	Koibatek	A104	194.45	4.02	2578	1531	485	14800
2	Rift Valley	Koibatek	A104	197.91	10.73	1622	1268	502	11114
2	Rift Valley	Koibatek	A104	215.91	9.92	2106	630	286	9822
2	Rift Valley	Nakuru	A104	217.75	7.68	1381	659	287	7627
2	Rift Valley	Nakuru	A104	231.27	6.99	1414	692	260	7703
2	Rift Valley	Nakuru	A104	231.72	0.85	3383	1545	655	18235
2	Rift Valley	Nakuru	A104	232.96	0.81	3736	2130	789	21787
2	Rift Valley	Nakuru	A104	233.35	2.88	3733	2132	789	21782
2	Rift Valley	Nakuru	A104	238.72	3.24	6084	1822	619	27504
2	Rift Valley	Nakuru	A104	239.83	0.76	3179	1307	483	16236
2	Rift Valley	Nakuru	A104	240.25	7.34	3502	1378	501	17526
2	Rift Valley	Nakuru	A104	254.51	7.45	2502	1623	555	15277
2	Rift Valley	Nakuru	A104	255.15	5.74	2198	1522	553	13987
2	Rift Valley	Nakuru	A104	265.99	5.71	6725	2095	718	30665

2	Rift Valley	Nakuru	A104	266.57	5.34	5909	1928	579	26999
2	Rift Valley	Nakuru	A104	276.67	5.40	6003	2083	833	28908
2	Rift Valley	Nakuru	A104	277.37	4.00	7762	2441	870	35661
2	Rift Valley	Nakuru	A104	284.67	3.88	34228	3647	853	122397
2	Rift Valley	Nakuru	A104	285.14	2.48	22853	3848	890	87469
2	Rift Valley	Nakuru	A104	289.62	2.55	18181	3548	977	72238
2	Rift Valley	Nakuru	A104	290.23	1.22	2053	940	442	11209
2	Rift Valley	Nakuru	A104	292.06	1.16	13509	3250	1063	57009
2	Rift Valley	Nakuru	A104	292.55	12.36	9580	2116	760	39929
2	Rift Valley	Nakuru	A104	316.78	12.38	4259	2288	666	23274
2	Rift Valley	Nakuru	A104	317.31	1.80	6994	2332	667	32031
2	Rift Valley	Nakuru	A104	320.38	1.77	3342	1342	492	16882
2	Rift Valley	Nakuru	A104	320.84	8.75	3422	1360	497	17205
2	Rift Valley	Nakuru	A104	337.88	8.68	5724	3063	950	31348
2	Rift Valley	Nakuru	A104	338.21	2.35	5758	3055	890	31161
2	Rift Valley	Nakuru	A104	342.57	4.78	8378	3076	871	39441
2	Rift Valley	Nakuru	A104	347.77	2.93	5196	1067	60	19879
2	Rift Valley	Nakuru	A104	348.43	2.47	10004	3564	948	46358
2	Rift Valley	Nakuru	A104	352.71	2.57	394	226	3	1907
2	Rift Valley	Nakuru	A104	353.57	9.22	778	285	6	3328
2	Rift Valley	Nakuru	A104	371.14	9.05	5812	1336	58	22573
1	Central	Nyandarua	A104	371.67	1.69	14228	2403	60	52378
1	Central	Nyandarua	A104	374.52	1.54	3585	656	53	13510
1	Central	Nyandarua	A104	374.74	3.15	3567	662	61	13508
1	Central	Kiambu	A104	380.81	3.58	3602	649	46	13509
1	Central	Kiambu	A104	381.90	4.39	3534	676	75	13511
1	Central	Kiambu	A104	389.59	4.07	3669	622	17	13506
1	Central	Kiambu	A104	390.03	3.85	3400	730	133	13517
1	Central	Kiambu	A104	397.30	4.06	3585	933	246	15186
1	Central	Kiambu	A104	398.16	3.22	3216	526	20	11845
1	Central	Kiambu	A104	403.74	3.03	4328	487	15	15204
1	Central	Kiambu	A104	404.21	1.19	9606	2080	794	39978
1	Central	Kiambu	A104	406.12	1.48	3400	730	133	13517
1	Central	Kiambu	A104	407.17	6.05	3308	628	77	12682
1	Central	Kiambu	A104	418.22	5.56	7868	1936	798	34108
1	Central	Kiambu	A104	418.29	2.95	11525	2968	777	48587
1	Nairobi	Nairobi	A104	424.11	3.87	9570	1060	277	34615
1	Nairobi	Nairobi	A104	426.02	7.32	42375	5610	874	154093
1	Nairobi	Nairobi	A104	438.76	6.40	100361	2652	709	327965
1	Nairobi	Nairobi	A104	438.82	0.76	116234	4613	749	383386
1	Nairobi	Nairobi	A104	440.28	0.79	2889	880	195	12626
1	Nairobi	Nairobi	A104	440.40	5.10	85560	4232	741	285408
1	Nairobi	Nairobi	A104	450.49	5.46	7140	947	142	25924
1	Nairobi	Nairobi	A104	451.32	6.06	9135	2762	928	41051
				Total Length	365.83				
					Weighted Average	9027.3	1687.1	503.7	11218.1
4	Eastern	Machakos	A109	0.33	0.91	6157	3671	1162	35344
4	Coast	Mombasa	A109	1.49	6.75	12426	2933	1558	54847
4	Eastern	Machakos	A109	13.84	6.58	1458	2081	1617	18017
4	Eastern	Machakos	A109	14.65	3.77	1432	2074	1614	17902
4	Eastern	Machakos	A109	21.37	4.17	4553	2671	1042	26841
4	Eastern	Machakos	A109	22.98	7.66	2312	1799	1041	17282
4	Eastern	Machakos	A109	36.70	6.86	941	809	478	7530
4	Eastern	Machakos	A109	36.71	0.01	2512	1873	1121	18485
4	Eastern	Machakos	A109	36.72	4.75	2482	941	320	12060
4	Eastern	Machakos	A109	46.21	4.96	2676	1825	888	17798
4	Eastern	Makueni	A109	46.64	6.64	3004	2134	1056	20495
4	Eastern	Makueni	A109	59.48	6.66	4225	3307	1794	31329
4	Eastern	Makueni	A109	59.96	4.90	2685	1910	825	17911
4	Eastern	Makueni	A109	69.29	4.88	1896	2247	1657	20070
4	Eastern	Makueni	A109	69.72	7.79	1868	2129	1558	19193
4	Eastern	Makueni	A109	84.86	8.02	2320	1914	1136	18059
4	Eastern	Makueni	A109	85.76	6.70	5382	1765	1076	27018
4	Eastern	Makueni	A109	98.26	6.50	8442	1615	1015	35969
4	Eastern	Makueni	A109	98.76	0.68	2164	1593	1042	16240
4	Eastern	Makueni	A109	99.62	0.87	1510	2097	1622	18252
4	Eastern	Makueni	A109	100.50	22.69	1408	2066	1611	17791

4	Eastern	Makueni	A109	144.99	33.66	1677	1638	1120	15196
4	Eastern	Makueni	A109	167.82	11.63	1859	1537	968	14781
4	Eastern	Makueni	A109	168.26	19.58	1555	1770	1270	15881
4	Eastern	Makueni	A109	206.99	19.86	1408	1529	1032	13627
4	Eastern	Makueni	A109	207.99	23.89	1689	1687	1207	15774
4	Eastern	Makueni	A109	254.76	23.72	652	1085	713	8494
4	Eastern	Makueni	A109	255.43	5.41	1152	1624	1236	14046
4	Eastern	Makueni	A109	265.57	5.41	1339	1985	1118	15132
4	Coast	Taita Taveta	A109	266.24	8.72	1183	1579	1117	13464
4	Coast	Taita Taveta	A109	283.01	8.73	1090	1873	1351	15105
4	Coast	Taita Taveta	A109	283.69	7.63	1122	1861	1340	15121
4	Coast	Taita Taveta	A109	298.27	7.85	1016	1669	1222	13653
4	Coast	Taita Taveta	A109	299.39	1.90	1243	1737	1254	14731
4	Coast	Taita Taveta	A109	302.07	1.68	1427	1381	930	12789
4	Coast	Taita Taveta	A109	302.75	1.12	823	1200	856	9986
4	Coast	Taita Taveta	A109	304.30	1.15	1336	1498	1169	13886
4	Coast	Taita Taveta	A109	305.05	1.40	1321	470	253	6704
4	Coast	Taita Taveta	A109	307.10	1.54	1173	1220	834	11084
4	Coast	Taita Taveta	A109	308.14	12.63	851	1483	813	10660
4	Coast	Taita Taveta	A109	332.36	29.40	1671	1403	950	13741
4	Coast	Kwale	A109	366.93	18.46	1799	1424	917	14059
4	Coast	Kwale	A109	369.29	14.27	1797	1473	906	14160
4	Coast	Kwale	A109	395.48	13.97	673	737	546	6771
4	Coast	Kwale	A109	397.23	10.05	1577	1009	685	11067
4	Coast	Kwale	A109	415.57	9.82	1277	1484	1060	13185
4	Coast	Kilifi	A109	416.86	3.29	1442	1509	1060	13778
4	Coast	Kilifi	A109	422.16	3.47	1888	1455	806	13866
4	Coast	Kilifi	A109	423.80	4.61	2523	1409	921	16279
4	Coast	Kilifi	A109	431.38	3.89	3128	1014	325	14344
4	Coast	Kilifi	A109	431.59	3.07	2284	1262	693	14061
4	Coast	Kilifi	A109	437.51	3.22	1889	1655	1052	15587
4	Coast	Kilifi	A109	438.02	0.26	3508	2137	1226	22957
				Total Length	438.02				
					Weighted Average	1964.8018	1629.8736	1066.8527	4661.5281

Source: Data from Kenya

Table C-3: Uganda Traffic Data

Station	Traffic Count Station No	Road No	Traffic Volume			
			Light	Medium	Heavy	Total
Kampala	2	A001	13950	2494	913	17357
Kampala	5	A001	5634	1431	797	7862
Jinja	120	A001	3403	977	716	5096
Jinja	118	A001	2321	810	683	3814
Tororo	126	A001	910	317	456	1683
Tororo	128	A001	810	104	546	1460
		Average	4504.7	1022.2	685.2	6212.0
Mpigi	6	A002	7362	1917	202	9481
Mpigi	8	A002	1456	940	128	2524
Masaka	25	A002	1763	772	154	2689
		Average	3527	1210	161	4898
Masaka	26	A002	891	520	135	1546
Kabale	62	A002	1051	422	144	1617
		Average	971	471	140	1582

Source: Data from Uganda

Table C-4: Rwanda Traffic Data

Rd ID	Section	Type	Length (km)	Small	Medium	Large
RN1	GITIKINYONI-GITARAMA	Rural	42.343	1903	445	38
RN1	GITARAMA-NYANZA	Rural	41.587	1153	183	32
RN1	NYANZA-BUTARE	Rural	34.871	919	144	34
RN1	BUTARE-MUKONI	Urban	3.59	2865	144	10
RN1	MUKONI-AKANYARU	Rural	29.582	69	19	10
		Total Length	151.973			
			Weighted Average	1138	214	29
RN2	GATSATA- NYACYONGA	Urban	7.817	1969	948	121
RN2	NYACYONGA-GASEKE	Rural	16.179	691	211	109
RN2	GASEKE- RUKOMO	Rural	22.968	527	208	100
RN2	RUKOMO-GATUNA	Rural	28.378	272	184	107
		Total Length	75.342			
			Weighted Average	616	276	107
RN3	KIGALI-KANOMBE	Urban	9.25	3857	386	89
RN3	KANOMBE-RUGENDE	Urban	16.56	3857	386	89
RN3	RUGENDE-GISHARI	Rural	31.183	1633	378	82
RN3	GISHARI-RWAMAGANA	Urban	3.373	1343	164	1
RN3	RWAMAGANA-KAYONZA	Rural	14.026	1312	230	89
RN3	KAYONZA-KIBUNGO	Rural	31.792	685	168	90
RN3	KIBUNGO-KIBAYA	Rural	10.662	316	106	87
RN3	KIBAYA-CYUNUZI	Rural	10.022	272	54	61
RN3	CYUNUZI-RUSUMO	Rural	38.831	85	13	44
		Total Length	165.699			
			Weighted Average	1235	199	74

Source: Data from Rwanda

Table C-5: Burundi Traffic Data

Route	Location		Length (km)	Traffic Volume			
	CH.P	Station		Small	Medium	Large	Total
RN 1	**0**						
RN 1	6	Kamenge	28.5	1089	689	57	1836
RN 1	51	Bukeye	44	488	114	34	636
RN 1	94	Kayanza	42.38	235	57	19	311
RN 1	114.88						
Weighted Average				543.8	235.7	34.0	813.5

Source: Data from Burundi

C.2 Axle Load Distribution Data

Table C-6: Axle Load Distribution Data in Tanzania

Category		Number of Axles							
Low (kg)	High (kg)	Total	1 Axle	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
0	1000	2	0	1	1	0	0	0	0
1000	2000	0	0	0	0	0	0	0	0
2000	3000	9	1	1	1	2	2	2	0
3000	4000	30	8	6	3	5	5	3	0
4000	5000	49	12	12	9	4	4	6	2
5000	6000	147	64	38	20	7	9	9	0
6000	7000	284	149	53	45	16	11	10	0
7000	8000	556	203	43	51	91	82	79	7
8000	9000	386	17	117	100	54	45	48	5
9000	10000	190	0	144	30	5	7	3	1
10000	11000	38	0	38	0	0	0	0	0
11000	12000	2	0	0	0	1	1	0	0
12000	13000	0	0	0	0	0	0	0	0
13000	14000	0	0	0	0	0	0	0	0
14000	15000	0	0	0	0	0	0	0	0
15000	16000	0	0	0	0	0	0	0	0
16000	17000	0	0	0	0	0	0	0	0
17000	18000	1	0	1	0	0	0	0	0
18000	19000	0	0	0	0	0	0	0	0
19000	20000	0	0	0	0	0	0	0	0
20000	21000	0	0	0	0	0	0	0	0
21000	22000	0	0	0	0	0	0	0	0
22000	23000	0	0	0	0	0	0	0	0
23000	24000	0	0	0	0	0	0	0	0
24000	25000	0	0	0	0	0	0	0	0
25000	26000	0	0	0	0	0	0	0	0
Total		1694	454	454	260	185	166	160	15

Source: Axle load data from Tanzania (Sample N = 454 vehicles)

Table C-7: Axle Load Distribution Data in Kenya

Category		Number of Axles						
Low (kg)	High (kg)	Total	1 Axle	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles
0	1000	829	10	505	142	87	85	0
1000	2000	749	11	388	191	52	48	59
2000	3000	1251	23	581	371	96	74	106
3000	4000	2640	203	1199	637	236	175	190
4000	5000	8788	2535	3514	1126	680	420	513
5000	6000	28147	14993	6762	2009	1939	1005	1439
6000	7000	38699	18491	4185	3685	5334	3106	3898
7000	8000	55969	4562	5948	10878	11719	12320	10542
8000	9000	73600	925	12147	14630	13032	18174	14692
9000	10000	25377	34	3598	5705	5213	4168	6659
10000	11000	4910	10	1757	1498	1288	355	2
11000	12000	1628	0	665	527	353	82	1
12000	13000	630	1	301	201	110	17	0
13000	14000	249	0	136	79	25	9	0
14000	15000	105	0	64	23	16	2	0
15000	16000	44	0	33	8	2	1	0
16000	17000	10	0	8	1	1	0	0
17000	18000	7	0	4	1	1	1	0
18000	19000	4	0	3	0	1	0	0
19000	20000	0	0	0	0	0	0	0
20000	21000	0	0	0	0	0	0	0
21000	22000	0	0	0	0	0	0	0
22000	23000	0	0	0	0	0	0	0
23000	24000	0	0	0	0	0	0	0
24000	25000	0	0	0	0	0	0	0
25000	26000	0	0	0	0	0	0	0
Total		243636	41798	41798	41712	40185	40042	38101

Source: Axle load data from Kenya (Sample N = 41,798 vehicles)

Table C-8: Axle Load Distribution Data in Uganda

Category		Number of Axles							
Low (kg)	High (kg)	Total	1 Axle	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
0	1000	180	2	147	13	12	3	3	0
1000	2000	152	8	54	30	34	17	9	0
2000	3000	524	77	124	77	116	61	59	10
3000	4000	1447	374	309	166	280	156	145	17
4000	5000	3483	1275	563	326	666	329	303	21
5000	6000	6968	3080	796	795	1025	718	515	39
6000	7000	9598	3634	979	1318	1316	1197	1035	119
7000	8000	11559	2216	2396	2484	1123	1678	1475	187
8000	9000	7181	624	1854	1958	715	974	1020	36
9000	10000	3160	167	1232	832	325	294	300	10
10000	11000	2065	75	1140	433	156	119	134	8
11000	12000	1199	12	675	281	79	76	68	8
12000	13000	589	6	289	176	36	31	40	11
13000	14000	501	6	234	144	39	34	36	8
14000	15000	343	1	195	91	16	13	17	10
15000	16000	272	1	145	75	25	11	9	6
16000	17000	190	0	119	38	8	11	13	1
17000	18000	154	2	107	23	12	3	5	2
18000	19000	112	1	82	14	4	5	5	1
19000	20000	64	1	42	8	10	2	1	0
20000	21000	37	0	24	11	2	0	0	0
21000	22000	13	0	6	4	3	0	0	0
22000	23000	5	0	0	4	1	0	0	0
23000	24000	7	0	2	0	4	0	1	0
24000	25000	4	0	3	0	1	0	0	0
25000	26000	0	0	0	0	0	0	0	0
Total		49807	11562	11517	9301	6008	5732	5193	494

Source: Axle load data from Uganda (Sample N = 11,525 vehicles)

Table C-9: Axle Load Distribution Data in Burundi

Category		Number of Axles							
Low (kg)	High (kg)	Total	1 Axle	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
0	1000	3	1	2	0	0	0	0	0
1000	2000	48	21	22	1	2	1	1	0
2000	3000	198	118	53	8	8	8	3	0
3000	4000	152	69	45	16	7	9	4	2
4000	5000	99	43	36	12	3	1	3	1
5000	6000	79	38	29	5	2	2	2	1
6000	7000	83	29	34	13	4	1	1	1
7000	8000	80	24	30	10	5	6	5	0
8000	9000	63	8	28	7	8	7	3	2
9000	10000	54	4	15	6	5	9	9	6
10000	11000	49	4	18	9	5	5	5	3
11000	12000	37	2	13	3	8	4	6	1
12000	13000	22	0	9	2	1	4	6	0
13000	14000	16	0	9	3	2	0	0	2
14000	15000	18	0	9	5	2	1	0	1
15000	16000	6	0	1	3	1	0	1	0
16000	17000	4	0	2	1	0	0	1	0
17000	18000	5	0	4	1	0	0	0	0
18000	19000	1	0	1	0	0	0	0	0
19000	20000	0	0	0	0	0	0	0	0
20000	21000	1	0	1	0	0	0	0	0
21000	22000	0	0	0	0	0	0	0	0
22000	23000	0	0	0	0	0	0	0	0
23000	24000	0	0	0	0	0	0	0	0
24000	25000	0	0	0	0	0	0	0	0
25000	26000	0	0	0	0	0	0	0	0
Total		1018	361	361	105	63	58	50	20

Source: Axle load data in Burundi (Sample N = 361 vehicles)

Appendix D Japanese Design Standards

D.1 Japanese Pavement Design Standards

Items	Japan
Design Standards	Manual for Asphalt Pavement (1998)
Principle of Design Method	Method based on the AASHO Road Test and experiments in Japan
Outline of Design Method	(i) Evaluate subgrade using the California Bearing Ratio (CBR). (ii) Total thickness of asphalt concrete called T_A, which assumes that necessary thickness of pavement is composed of only asphalt concrete, is determined by accumulated heavy traffic volume and the strength of subgrade. (iii) Thickness of each layer is determined utilizing coefficients of relative strengths of each layer's material based on AASHO Road Test and the above T_A value.
Traffic Volume for Design	(i) Design traffic volume for pavement is determined by calculating average traffic volume of heavy vehicle in the design period utilizing the growth factor and the latest traffic volume data. (ii) Above T_A is calculated by converting the design traffic volume for pavement into accumulated number of standard axle loads of which standard is equivalent to 49 kN.

Source: Japan Road Association, *Manual for Asphalt Pavement*, 1998

D.2 Japanese Bridge Design Standards

Items	Japan
Design Standard	Specifications For Highway Bridges
Design Method	Permissible Stress Design Method
Design Period	Not specified
Live Load	A loading and B loading
Loading Carriageway Width: B(m)	Not specified
Uniformly Distributed Load (UDL)	@3.5 kN/m^2 + @10 kN/m^2 on 10 m of length
Truck Load	200 kN × k (1 axle) k: Extra coefficient k = 1.0 (L < 4m), k = L/32 + 7/8 (4 m < L)
Impact Load	Impact factor
Live Load for Slab Design	2@100 kN (Wheel load, 20 cm × 50 cm)

Source: Japan Road Association, *Specifications for Highway Bridges*

Appendix E Maintenance Cost Estimates, Input Data, and Modelling Results

E.1 Funding Needs Estimation using HDM-4

E.1.1 Common Maintenance Configuration for the HDM-4 Model

Maintenance Options and Scenarios

	Condition	Economic cost	Type 1	Type 2	Type 3	Type 4
Crack seal	Apply >10% of surface	5 USD/sqm	v			
Patch	Apply 10 potholes per km	12 USD/sqm	v	v	v	v
Reseal	Apply >20% damaged	34 USD/sqm		v		v
Overlay	Apply when IRI>5	45 USD/sqm			v	
Reconstruct	Apply when IRI>8	86 USD/sqm				v

Note: These unit rates are based on to the prices in Rwanda, where all of unit rates for maintenance work were collected.

Economic Cost Configuration by Country

	Condition	Rwanda, Uganda, Burundi	Kenya and Tanzania
Crack seal	Apply >10 % of surface	5 USD/sqm	3.5 USD/sqm
Patch	Apply 10 potholes per km	12 USD/sqm	9 USD/sqm
Reseal	Apply >20% damaged	34 USD/sqm	24 USD/sqm
Overlay	Apply when IRI>5	45 USD/sqm	31 USD/sqm
Reconstruct	Apply when IRI>8	86 USD/sqm	60 USD/sqm

Basic Configurations of Vehicles

Type UB loading

Motorised Vehicle Types

Name	Base Type	PCSE	No. of Wheels	No. of Axles	Tyre Type	Tyre Base Recaps	Tyre Retread Cost (%)	Annual Km	Annual Work Hours	Avg Life	Private Use (%)	Pass-engers	Work Related Trips (%)	ESALF	Oper Weigh (t	Life Model
1_6 axle(Present)	Articulated Truck	3.00	22	6	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	5.85	42.71	Optimal
1_4-5 axle(Present)	Articulated Truck	2.50	16	4	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	4.84	33.47	Optimal
1_3 axle(Present)	Heavy Truck	1.60	10	3	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	5.88	24.25	Optimal
1_2 axle(Present)	Medium Truck	1.40	6	2	Bias ply	1.30	15.00	40,000	1,200	12	0	0	0.00	4.28	15.89	Optimal
0_Cars	Medium Car	1.00	4	2	Radial ply	1.30	15.00	23,000	550	10	100	1	75.00	0.00	1.20	Constant
0_Pickup	Light Goods	1.00	4	2	Bias ply	1.30	15.00	30,000	1,300	8	0	0	0.00	0.01	1.50	Optimal
0_SmallBus	Mini Bus	1.20	4	2	Radial ply	1.30	15.00	30,000	750	8	0	10	75.00	0.01	1.50	Optimal
0_Bus	Heavy Bus	1.60	10	3	Bias ply	1.30	15.00	70,000	1,750	12	0	40	75.00	0.80	10.00	Optimal

Type T Loading

Motorised Vehicle Types

Name	Base Type	PCSE	No. of Wheels	No. of Axles	Tyre Type	Tyre Base Recaps	Tyre Retread Cost (%)	Annual Km	Annual Work Hours	Avg Life	Private Use (%)	Pass-engers	Work Related Trips (%)	ESALF	Oper Weigh (t	Life Model
1_6 axle(Present)	Articulated Truck	3.00	22	6	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	4.56	44.00	Optimal
1_4-5 axle(Present)	Articulated Truck	2.50	16	4	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	2.86	29.67	Optimal
1_3 axle(Present)	Heavy Truck	1.60	10	3	Bias ply	1.30	15.00	86,000	2,050	14	0	0	0.00	2.49	22.46	Optimal
1_2 axle(Present)	Medium Truck	1.40	6	2	Bias ply	1.30	15.00	40,000	1,200	12	0	0	0.00	2.57	16.47	Optimal
0_Cars	Medium Car	1.00	4	2	Radial ply	1.30	15.00	23,000	550	10	100	1	75.00	0.00	1.20	Constant
0_Pickup	Light Goods	1.00	4	2	Bias ply	1.30	15.00	30,000	1,300	8	0	0	0.00	0.01	1.50	Optimal
0_SmallBus	Mini Bus	1.20	4	2	Radial ply	1.30	15.00	30,000	750	8	0	10	75.00	0.01	1.50	Optimal
0_Bus	Heavy Bus	1.60	10	3	Bias ply	1.30	15.00	70,000	1,750	12	0	40	75.00	0.80	10.00	Optimal

E.1.2 Dataset for HDM-4 Analysis for Burundi

Traffic volume/composition, length, and pavement condition for the target network

Location		Length														Total	Condition		
CHP	Station	(km)														Vehicle	Good	Fair	Poor
0																			
6	Kamenge	28.5	438	399	252	54	497	136	2	0	3	0	2	29	23	1836	22.3	6.2	0.0
			438	399	252	54	497	137			5			52					
			23.9%	21.7%	13.7%	3.0%	27.1%	7.5%			0.3%			2.8%					
51	Bukeye	44	183	189	116	25	78	12	0	1	1	0	1	29	3	636	44.0	0.0	0.0
			183	189	116	25	78	12			3			32					
			28.7%	29.7%	18.2%	3.9%	12.2%	1.9%			0.5%			5.0%					
94	Kayanza	42.38	152	73	10	19	29	7	2	1	1	1	0	13	3	311	40.1	2.3	0.0
			152	73	10	19	29	9			3			16					
			48.9%	23.5%	3.2%	6.1%	9.4%	2.8%			1.0%			5.2%					
114.88																			
		114.88	234.8	198.4	110.6	30.0	163.9	40.9	0.9	0.5	1.1	0.5	0.8	23.1	8.0	813.7	106	9	0

Result of optimized maintenance programme (with Type UB Loading)

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **6. Burundi Present Case**
Run Date: **04-04-2011**

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2012	01_RN1-1-2 Fair Condition	Primary or Trunk	6.2	1947	Bituminous	Overlay 50mm at 6 IRI	0.443	2.170	2.170
2014	02_RN1-2	Primary or Trunk	44.0	715	Bituminous	Reseal at 30% surface d	-0.703	1.540	3.710
	03_RN1-3-2 Fair Condition	Primary or Trunk	2.3	350	Bituminous	Overlay 50mm at 6 IRI	-0.819	0.805	4.515
2015	03_RN1-3-1 Good Condition	Primary or Trunk	40.1	360	Bituminous	Reseal at 30% surface d	-0.863	1.404	5.919
2021	01_RN1-1-1 Good Condition	Primary or Trunk	22.3	2541	Bituminous	Overlay 50mm at 6 IRI	0.049	7.805	13.724
2024	02_RN1-2	Primary or Trunk	44.0	962	Bituminous	Reseal at 30% surface d	-0.703	1.540	15.264
	03_RN1-3-1 Good Condition	Primary or Trunk	40.1	470	Bituminous	Reseal at 30% surface d	-0.863	1.404	16.667
2025	01_RN1-1-2 Fair Condition	Primary or Trunk	6.2	2860	Bituminous	Overlay 50mm at 6 IRI	0.443	2.170	18.837
2029	02_RN1-2	Primary or Trunk	44.0	1115	Bituminous	Reseal at 30% surface d	-0.703	1.540	20.377

Year	Cost	NPV
2011	0	0.496488
2012	2.17	
2013	0	
2014	2.345	
2015	1.4035	
2016	0	
2017	0	
2018	0	
2019	0	
2020	0	
2021	7.805	
2022	0	
2023	0	
2024	2.9435	
2025	2.17	
2026	0	
2027	0	
2028	0	
2029	1.54	
2030	0	
Total	20.38	
annual	1.02	

Result of optimized maintenance programme (with Type T Loading)

H D M - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **6. Burundi TKmodel**
Run Date: **02-08-2011**

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2013	01_RN1-1-2 Fair Condition	Primary or Trunk	6.2	2006	Bituminous	Overlay 50mm at 6 IRI	0.294	2.170	2.170
2014	02_RN1-2	Primary or Trunk	44.0	715	Bituminous	Reseal at 30% surface dan	-0.658	1.540	3.710
	03_RN1-3-2 Fair Condition	Primary or Trunk	2.3	350	Bituminous	Overlay 50mm at 6 IRI	-0.821	0.805	4.515
2015	03_RN1-3-1 Good Condition	Primary or Trunk	40.1	360	Bituminous	Reseal at 30% surface dan	-0.900	1.404	5.919
2024	01_RN1-1-1 Good Condition	Primary or Trunk	22.3	2777	Bituminous	Overlay 50mm at 6 IRI	-0.246	7.805	13.724
	02_RN1-2	Primary or Trunk	44.0	962	Bituminous	Reseal at 30% surface dan	-0.658	1.540	15.264
2025	03_RN1-3-1 Good Condition	Primary or Trunk	40.1	484	Bituminous	Reseal at 30% surface dan	-0.900	1.404	16.667
2029	01_RN1-1-2 Fair Condition	Primary or Trunk	6.2	3219	Bituminous	Overlay 50mm at 6 IRI	0.294	2.170	18.837
2030	03_RN1-3-1 Good Condition	Primary or Trunk	40.1	561	Bituminous	Reseal at 30% surface dan	-0.900	1.404	20.241

Year	Cost	NPV
2011	0.00	0.441472
2012	0.00	
2013	2.17	
2014	2.35	
2015	1.40	
2016	0.00	
2017	0.00	
2018	0.00	
2019	0.00	
2020	0.00	
2021	0.00	
2022	0.00	
2023	0.00	
2024	9.35	
2025	1.40	
2026	0.00	
2027	0.00	
2028	0.00	
2029	2.17	
2030	1.40	
Total	20.24	
annual	1.01	

E.1.3 Dataset for HDM-4 Analysis for Kenya

Traffic volume/composition

	Car	Pick-up - Utility	4WD - Jeep	Minibus - Matatu	Small Bus	Large Bus	Medium Truck	Heavy Truck	Articulated Truck
Low	21.5%	10.6%	12.2%	18.6%	2.8%	2.0%	11.9%	11.3%	9.1%
Medium	23.7%	6.5%	9.4%	12.1%	4.7%	2.6%	9.1%	16.8%	15.0%
High	36.7%	8.0%	13.0%	25.5%	2.9%	1.6%	7.1%	3.1%	2.1%

Result of optimized maintenance programme with Type UB loading

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **4. Kenya present case**
Run Date: **04-04-2011**

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	36726	Bituminous	Overlay 50mm at 5 IRI	42.703	4.200	4.200
	06_AM_Paved Middle Traffic Po	Primary or Trunk	271.0	5972	Bituminous	Reconstruct at 9 IRI	15.380	0.027	4.227
	05_AM_Paved Middle Traffic Fa	Primary or Trunk	39.0	5972	Bituminous	Overlay 50mm at 5.5 IRI	8.622	13.650	17.877
	09_AM_Paved Low Traffic Poor	Primary or Trunk	1,048.0	1030	Bituminous	Overlay 50mm at 6 IRI	1.597	366.800	384.677
2013	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	38963	Bituminous	Overlay 50mm at 5 IRI	35.186	11.200	395.877
	08_AM_Paved Low Traffic Fair	Primary or Trunk	92.0	1092	Bituminous	Overlay 50mm at 6 IRI	0.023	32.200	428.077
2015	04_AM_Paved Middle Traffic Gc	Primary or Trunk	276.0	6722	Bituminous	Overlay 50mm at 5.5 IRI	9.050	96.600	524.677
2017	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	43853	Bituminous	Overlay 50mm at 5 IRI	42.703	4.200	528.877
	06_AM_Paved Middle Traffic Po	Primary or Trunk	271.0	7132	Bituminous	Overlay 50mm at 5.5 IRI	15.380	94.850	623.727
	05_AM_Paved Middle Traffic Fa	Primary or Trunk	39.0	7132	Bituminous	Overlay 50mm at 5.5 IRI	8.622	13.650	637.377
2019	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	46524	Bituminous	Overlay 50mm at 5 IRI	35.186	11.200	648.577
2021	04_AM_Paved Middle Traffic Gc	Primary or Trunk	276.0	8027	Bituminous	Overlay 50mm at 5.5 IRI	9.050	96.600	745.177
2023	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	52363	Bituminous	Overlay 50mm at 5 IRI	42.703	4.200	749.377
	06_AM_Paved Middle Traffic Po	Primary or Trunk	271.0	8516	Bituminous	Overlay 50mm at 5.5 IRI	15.380	94.850	844.227
	05_AM_Paved Middle Traffic Fa	Primary or Trunk	39.0	8516	Bituminous	Overlay 50mm at 5.5 IRI	8.622	13.650	857.877
2024	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	53934	Bituminous	Overlay 50mm at 5 IRI	35.186	11.200	869.077
	07_AM_Paved Low Traffic Goo	Primary or Trunk	65.0	1512	Bituminous	Overlay 50mm at 6 IRI	-0.449	22.750	891.827
2025	09_AM_Paved Low Traffic Poor	Primary or Trunk	1,048.0	1557	Bituminous	Overlay 50mm at 6 IRI	1.597	366.800	1,258.627
2027	04_AM_Paved Middle Traffic Gc	Primary or Trunk	276.0	9584	Bituminous	Overlay 50mm at 5.5 IRI	9.050	96.600	1,355.227
2028	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	56451	Bituminous	Overlay 50mm at 5 IRI	42.703	4.200	1,359.427
2029	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	56451	Bituminous	Overlay 50mm at 5 IRI	35.186	11.200	1,370.627
	06_AM_Paved Middle Traffic Po	Primary or Trunk	271.0	10168	Bituminous	Overlay 50mm at 5.5 IRI	15.380	94.850	1,465.477
	08_AM_Paved Low Traffic Fair	Primary or Trunk	92.0	1753	Bituminous	Overlay 50mm at 6 IRI	0.023	32.200	1,497.677
2030	05_AM_Paved Middle Traffic Fa	Primary or Trunk	39.0	10473	Bituminous	Overlay 50mm at 5.5 IRI	8.622	13.650	1,511.327

Year	Cost	NPV
2011	384.7	40.0
2012	0.0	
2013	43.4	
2014	0.0	
2015	96.6	
2016	0.0	
2017	112.7	
2018	0.0	
2019	11.2	
2020	0.0	
2021	96.6	
2022	0.0	
2023	112.7	
2024	33.9	
2025	366.8	
2026	0.0	
2027	96.6	
2028	4.2	
2029	138.3	
2030	13.6	
Total	1511.3	
annual	75.6	

Result of optimized maintenance programme with Type T loading

H D M - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **4-2. Kenya present case with Tk model**
Run Date: **02-08-2011**

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	02_AM_Paved High Traffic Fair Con	Primary or Trunk	12.0	36726	Bituminous	Overlay 50mm at 5 IRI	44.391	4.200	4.200
	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	271.0	5972	Bituminous	Reconstruct at 9 IRI	23.471	0.027	4.227
	05_AM_Paved Middle Traffic Fair Cc	Primary or Trunk	39.0	5972	Bituminous	Overlay 50mm at 5.5 IRI	11.300	13.650	17.877
	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	1,048.0	1030	Bituminous	Overlay 50mm at 6 IRI	1.492	366.800	384.677
2012	04_AM_Paved Middle Traffic Good I	Primary or Trunk	276.0	6152	Bituminous	Reseal at 30% surface dan	11.936	9.660	394.337
2013	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	92.0	1092	Bituminous	Overlay 50mm at 6 IRI	0.688	32.200	426.537
	07_AM_Paved Low Traffic Good Cc	Primary or Trunk	65.0	1092	Bituminous	Reseal at 30% surface dan	0.136	2.275	428.812
2014	01_AM_Paved High Traffic Good Cc	Primary or Trunk	32.0	40132	Bituminous	Overlay 50mm at 5 IRI	47.294	11.200	440.012
2017	02_AM_Paved High Traffic Fair Con	Primary or Trunk	12.0	43853	Bituminous	Overlay 50mm at 5 IRI	44.391	4.200	444.212
	04_AM_Paved Middle Traffic Good I	Primary or Trunk	276.0	7132	Bituminous	Reseal at 30% surface dan	11.936	9.660	453.872
2018	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	271.0	7346	Bituminous	Overlay 50mm at 5.5 IRI	23.471	94.850	548.722
2019	05_AM_Paved Middle Traffic Fair Cc	Primary or Trunk	39.0	7566	Bituminous	Overlay 50mm at 5.5 IRI	11.300	13.650	562.372
2020	01_AM_Paved High Traffic Good Cc	Primary or Trunk	32.0	47920	Bituminous	Overlay 50mm at 5 IRI	47.294	11.200	573.572
2022	04_AM_Paved Middle Traffic Good I	Primary or Trunk	276.0	8267	Bituminous	Overlay 50mm at 5.5 IRI	11.936	96.600	670.172
2023	02_AM_Paved High Traffic Fair Con	Primary or Trunk	12.0	52363	Bituminous	Overlay 50mm at 5 IRI	44.391	4.200	674.372
	07_AM_Paved Low Traffic Good Cc	Primary or Trunk	65.0	1468	Bituminous	Reseal at 30% surface dan	0.136	2.275	676.647
2025	01_AM_Paved High Traffic Good Cc	Primary or Trunk	32.0	55552	Bituminous	Overlay 50mm at 5 IRI	47.294	11.200	687.847
	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	271.0	9034	Bituminous	Overlay 50mm at 5.5 IRI	23.471	94.850	782.697
	05_AM_Paved Middle Traffic Fair Cc	Primary or Trunk	39.0	9034	Bituminous	Overlay 50mm at 5.5 IRI	11.300	13.650	796.347
2028	04_AM_Paved Middle Traffic Good I	Primary or Trunk	276.0	9872	Bituminous	Overlay 50mm at 5.5 IRI	11.936	96.600	892.947
	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	1,048.0	1702	Bituminous	Overlay 50mm at 6 IRI	1.492	366.800	1,259.747
	07_AM_Paved Low Traffic Good Cc	Primary or Trunk	65.0	1702	Bituminous	Reseal at 30% surface dan	0.136	2.275	1,262.022
2029	02_AM_Paved High Traffic Fair Con	Primary or Trunk	12.0	56451	Bituminous	Overlay 50mm at 5 IRI	44.391	4.200	1,266.222

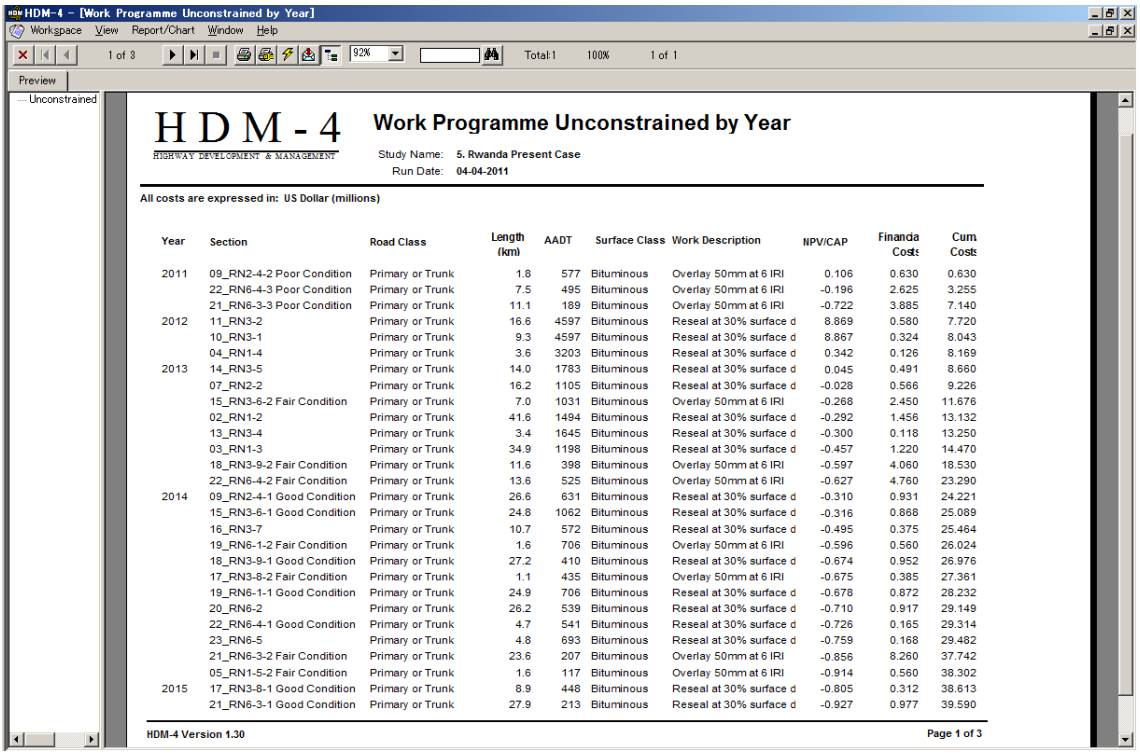
Year	Cost	NPV
2011	4.2	29.8
2012	9.7	
2013	48.1	
2014	378.0	
2015	0.0	
2016	0.0	
2017	13.9	
2018	94.9	
2019	13.7	
2020	11.2	
2021	0.0	
2022	96.6	
2023	6.5	
2024	0.0	
2025	119.7	
2026	0.0	
2027	0.0	
2028	465.7	
2029	4.2	
2030	0.0	
Total	1266.2	
annual	63.3	

E.1.4 Dataset for HDM-4 Analysis for Rwanda

Sections, length, traffic volume, vehicle composition, and initial pavement condition

Length (km)	Cars	Pick up	Minibus& Jeep4x4	Bus	2 Axles Truck	3 Axles Truck	Trailer–Truck	Trailer	TOTAL without Motorcycles	Good	Fair	Poor
42.343	250	61	1592	32	366	47	14	24	2386	42.343	0	0
	10.5%	2.6%	66.7%	1.3%	15.3%	2.0%	0.6%	1.0%				
41.587	151	28	974	15	147	21	15	17	1368	41.587	0	0
	11.0%	2.0%	71.2%	1.1%	10.7%	1.5%	1.1%	1.2%				
34.871	101	15	803	16	111	17	15	19	1097	34.871	0	0
	9.2%	1.4%	73.2%	1.5%	10.1%	1.5%	1.4%	1.7%				
3.59	954	123	1788	9	120	15	4	6	3020	3.59	0	0
	31.6%	4.1%	59.2%	0.3%	4.0%	0.5%	0.1%	0.2%				
29.582	21	3	45	6	4	9	3	7	104	27.982	1.6	0
	21.4%	3.1%	45.9%	6.1%	4.1%	9.2%	3.1%	7.1%				
7.817	480	97	1392	30	763	155	74	47	3038	7.817	0	0
	15.8%	3.2%	45.8%	1.0%	25.1%	5.1%	2.4%	1.5%				
16.179	106	88	497	29	130	52	60	49	1012	16.179	0	0
	10.5%	8.7%	49.2%	2.9%	12.9%	5.1%	5.9%	4.8%				
22.968	93	73	361	30	122	56	55	45	836	22.968	0	0
	11.1%	8.7%	43.2%	3.6%	14.6%	6.7%	6.6%	5.4%				
28.378	67	5	200	32	95	57	60	47	561	26.578	0	1.8
	11.9%	0.9%	35.5%	5.7%	16.9%	10.1%	10.7%	8.3%				
9.25	784	416	2657	133	237	16	82	7	4334	9.25	0	0
	18.1%	9.6%	61.3%	3.1%	5.5%	0.4%	1.9%	0.2%				
16.56	784	416	2657	133	237	16	82	7	4334	16.56	0	0
	18.1%	9.6%	61.3%	3.1%	5.5%	0.4%	1.9%	0.2%				
31.183	251	91	1291	44	317	17	76	6	2093	31.183	0	0
	12.0%	4.3%	61.7%	2.1%	15.1%	0.8%	3.6%	0.3%				
3.373	198	48	1097	38	124	2	1	0	1506	3.373	0	0
	13.1%	3.2%	72.7%	2.5%	8.2%	0.1%	0.1%	0.0%				
14.026	167	254	891	96	127	7	82	7	1632	14.026	0	0
	10.2%	15.6%	54.6%	5.9%	7.8%	0.4%	5.0%	0.4%				
31.792	90	37	558	1	164	3	85	5	944	24.792	7	0
	9.5%	3.9%	59.2%	0.1%	17.4%	0.3%	9.0%	0.5%				
10.662	28	14	274	3	99	4	82	5	509	10.662	0	0
	5.5%	2.8%	53.8%	0.6%	19.4%	0.8%	16.1%	1.0%				
10.022	26	8	238	1	50	3	56	5	387	8.922	1.1	0
	6.7%	2.1%	61.5%	0.3%	12.9%	0.8%	14.5%	1.3%				
38.831	12	4	69	0	7	6	39	5	365	27.231	11.6	0
	8.5%	2.8%	48.6%	0.0%	4.9%	4.2%	27.5%	3.5%				
26.501	61	38	413	31	61	6	10	8	628	24.901	1.6	0
	9.7%	6.1%	65.8%	4.9%	9.7%	1.0%	1.6%	1.3%				
26.228	32	10	319	6	81	8	12	10	479	26.228	0	0
	6.7%	2.1%	66.7%	1.3%	16.9%	1.7%	2.5%	2.1%				
62.645	17	6	106	7	25	11	8	5	184	27.945	23.6	11.1
	9.2%	3.2%	57.3%	3.8%	13.5%	5.9%	4.3%	2.7%				
25.765	37	8	288	15	86	18	14	16	481	4.665	13.6	7.5
	7.7%	1.7%	59.8%	3.1%	17.8%	3.7%	2.9%	3.3%				
4.79	186	26	285	0	91	6	10	11	616	4.79	0	0
	30.2%	4.2%	46.3%	0.0%	14.8%	1.0%	1.6%	1.8%				

HDM analysis results (work programme for Rwanda and cumulative cost for maintenance with Type UB loading)



HDM-4 - [Work Programme Unconstrained by Year]

Workspace View Report/Chart Window Help

1 of 3 92% Total:1 100% 1 of 1

Preview

Unconstrained

H D M - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: **5. Rwanda Present Case**
Run Date: **04-04-2011**

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	09_RN2-4-2 Poor Condition	Primary or Trunk	1.8	577	Bituminous	Overlay 50mm at 6 IRI	0.106	0.630	0.630
	22_RN6-4-3 Poor Condition	Primary or Trunk	7.5	495	Bituminous	Overlay 50mm at 6 IRI	-0.196	2.625	3.255
	21_RN6-3-3 Poor Condition	Primary or Trunk	11.1	189	Bituminous	Overlay 50mm at 6 IRI	-0.722	3.885	7.140
2012	11_RN3-2	Primary or Trunk	16.6	4597	Bituminous	Reseal at 30% surface d	8.869	0.580	7.720
	10_RN3-1	Primary or Trunk	9.3	4597	Bituminous	Reseal at 30% surface d	8.867	0.324	8.043
	04_RN1-4	Primary or Trunk	3.6	3203	Bituminous	Reseal at 30% surface d	0.342	0.126	8.169
2013	14_RN3-5	Primary or Trunk	14.0	1783	Bituminous	Reseal at 30% surface d	0.045	0.491	8.660
	07_RN2-2	Primary or Trunk	16.2	1105	Bituminous	Reseal at 30% surface d	-0.028	0.566	9.226
	15_RN3-6-2 Fair Condition	Primary or Trunk	7.0	1031	Bituminous	Overlay 50mm at 6 IRI	-0.268	2.450	11.676
	02_RN1-2	Primary or Trunk	41.6	1494	Bituminous	Reseal at 30% surface d	-0.292	1.456	13.132
	13_RN3-4	Primary or Trunk	3.4	1645	Bituminous	Reseal at 30% surface d	-0.300	0.118	13.250
	03_RN1-3	Primary or Trunk	34.9	1198	Bituminous	Reseal at 30% surface d	-0.457	1.220	14.470
	18_RN3-9-2 Fair Condition	Primary or Trunk	11.6	398	Bituminous	Overlay 50mm at 6 IRI	-0.597	4.060	18.530
	22_RN6-4-2 Fair Condition	Primary or Trunk	13.6	525	Bituminous	Overlay 50mm at 6 IRI	-0.627	4.760	23.290
2014	09_RN2-4-1 Good Condition	Primary or Trunk	26.6	631	Bituminous	Reseal at 30% surface d	-0.310	0.931	24.221
	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1062	Bituminous	Reseal at 30% surface d	-0.316	0.868	25.089
	16_RN3-7	Primary or Trunk	10.7	572	Bituminous	Reseal at 30% surface d	-0.495	0.375	25.464
	19_RN6-1-2 Fair Condition	Primary or Trunk	1.6	706	Bituminous	Overlay 50mm at 6 IRI	-0.596	0.560	26.024
	18_RN3-9-1 Good Condition	Primary or Trunk	27.2	410	Bituminous	Reseal at 30% surface d	-0.674	0.952	26.976
	17_RN3-8-2 Fair Condition	Primary or Trunk	1.1	435	Bituminous	Overlay 50mm at 6 IRI	-0.675	0.385	27.361
	19_RN6-1-1 Good Condition	Primary or Trunk	24.9	706	Bituminous	Reseal at 30% surface d	-0.678	0.872	28.232
	20_RN6-2	Primary or Trunk	26.2	539	Bituminous	Reseal at 30% surface d	-0.710	0.917	29.149
	22_RN6-4-1 Good Condition	Primary or Trunk	4.7	541	Bituminous	Reseal at 30% surface d	-0.726	0.165	29.314
	23_RN6-5	Primary or Trunk	4.8	693	Bituminous	Reseal at 30% surface d	-0.759	0.168	29.482
	21_RN6-3-2 Fair Condition	Primary or Trunk	23.6	207	Bituminous	Overlay 50mm at 6 IRI	-0.856	8.260	37.742
	05_RN1-5-2 Fair Condition	Primary or Trunk	1.6	117	Bituminous	Overlay 50mm at 6 IRI	-0.914	0.560	38.302
2015	17_RN3-8-1 Good Condition	Primary or Trunk	8.9	448	Bituminous	Reseal at 30% surface d	-0.805	0.312	38.613
	21_RN6-3-1 Good Condition	Primary or Trunk	27.9	213	Bituminous	Reseal at 30% surface d	-0.927	0.977	39.590

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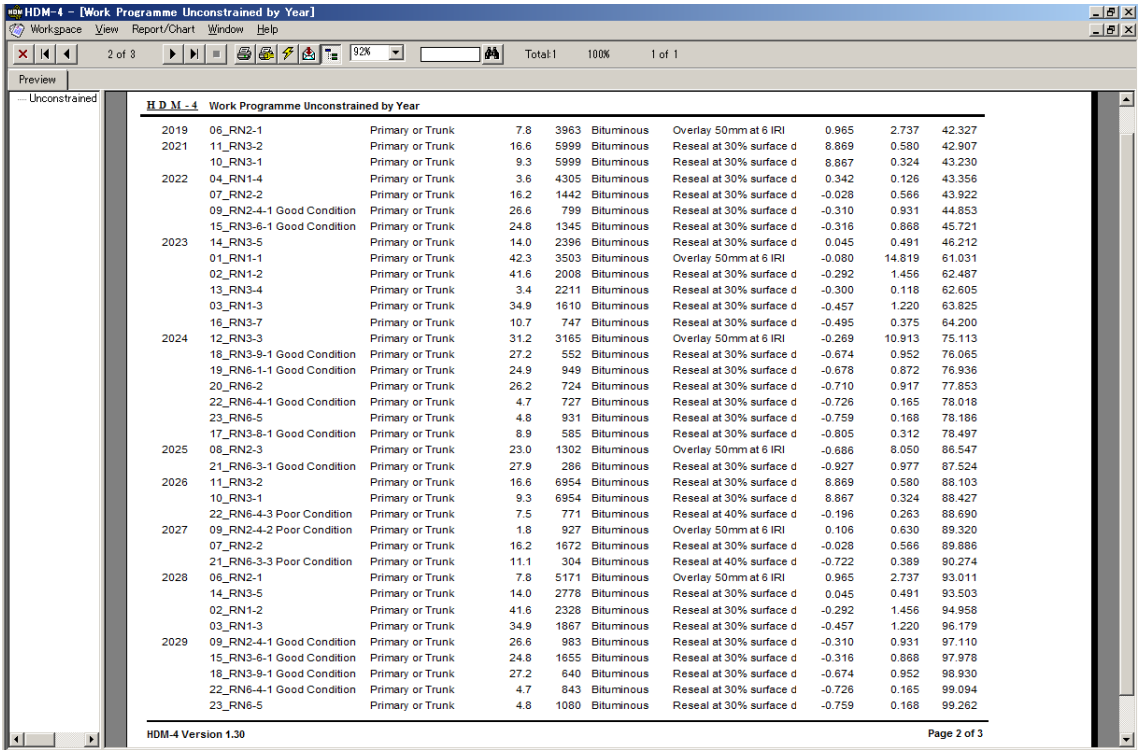

HDM-4 - [Work Programme Unconstrained by Year]

Workspace View Report/Chart Window Help

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Preview

Unconstrained

H D M - 4 **Work Programme Unconstrained by Year**

2019	06_RN2-1	Primary or Trunk	7.8	3963	Bituminous	Overlay 50mm at 6 IRI	0.965	2.737	42.327
2021	11_RN3-2	Primary or Trunk	16.6	5999	Bituminous	Reseal at 30% surface d	8.869	0.580	42.907
	10_RN3-1	Primary or Trunk	9.3	5999	Bituminous	Reseal at 30% surface d	8.867	0.324	43.230
2022	04_RN1-4	Primary or Trunk	3.6	4305	Bituminous	Reseal at 30% surface d	0.342	0.126	43.356
	07_RN2-2	Primary or Trunk	16.2	1442	Bituminous	Reseal at 30% surface d	-0.028	0.566	43.922
	09_RN2-4-1 Good Condition	Primary or Trunk	26.6	799	Bituminous	Reseal at 30% surface d	-0.310	0.931	44.853
	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1345	Bituminous	Reseal at 30% surface d	-0.316	0.868	45.721
2023	14_RN3-5	Primary or Trunk	14.0	2396	Bituminous	Reseal at 30% surface d	0.045	0.491	46.212
	01_RN1-1	Primary or Trunk	42.3	3503	Bituminous	Overlay 50mm at 6 IRI	-0.080	14.819	61.031
	02_RN1-2	Primary or Trunk	41.6	2008	Bituminous	Reseal at 30% surface d	-0.292	1.456	62.487
	13_RN3-4	Primary or Trunk	3.4	2211	Bituminous	Reseal at 30% surface d	-0.300	0.118	62.605
	03_RN1-3	Primary or Trunk	34.9	1610	Bituminous	Reseal at 30% surface d	-0.457	1.220	63.825
	16_RN3-7	Primary or Trunk	10.7	747	Bituminous	Reseal at 30% surface d	-0.495	0.375	64.200
2024	12_RN3-3	Primary or Trunk	31.2	3165	Bituminous	Overlay 50mm at 6 IRI	-0.269	10.913	75.113
	18_RN3-9-1 Good Condition	Primary or Trunk	27.2	552	Bituminous	Reseal at 30% surface d	-0.674	0.952	76.065
	19_RN6-1-1 Good Condition	Primary or Trunk	24.9	949	Bituminous	Reseal at 30% surface d	-0.678	0.872	76.936
	20_RN6-2	Primary or Trunk	26.2	724	Bituminous	Reseal at 30% surface d	-0.710	0.917	77.853
	22_RN6-4-1 Good Condition	Primary or Trunk	4.7	727	Bituminous	Reseal at 30% surface d	-0.726	0.165	78.018
	23_RN6-5	Primary or Trunk	4.8	931	Bituminous	Reseal at 30% surface d	-0.759	0.168	78.186
	17_RN3-8-1 Good Condition	Primary or Trunk	8.9	585	Bituminous	Reseal at 30% surface d	-0.805	0.312	78.497
2025	08_RN2-3	Primary or Trunk	23.0	1302	Bituminous	Overlay 50mm at 6 IRI	-0.686	8.050	86.547
	21_RN6-3-1 Good Condition	Primary or Trunk	27.9	286	Bituminous	Reseal at 30% surface d	-0.927	0.977	87.524
2026	11_RN3-2	Primary or Trunk	16.6	6954	Bituminous	Reseal at 30% surface d	8.869	0.580	88.103
	10_RN3-1	Primary or Trunk	9.3	6954	Bituminous	Reseal at 30% surface d	8.867	0.324	88.427
	22_RN6-4-3 Poor Condition	Primary or Trunk	7.5	771	Bituminous	Reseal at 40% surface d	-0.196	0.263	88.690
2027	09_RN2-4-2 Poor Condition	Primary or Trunk	1.8	927	Bituminous	Overlay 50mm at 6 IRI	0.106	0.630	89.320
	07_RN2-2	Primary or Trunk	16.2	1672	Bituminous	Reseal at 30% surface d	-0.028	0.566	89.886
	21_RN6-3-3 Poor Condition	Primary or Trunk	11.1	304	Bituminous	Reseal at 40% surface d	-0.722	0.389	90.274
2028	06_RN2-1	Primary or Trunk	7.8	5171	Bituminous	Overlay 50mm at 6 IRI	0.965	2.737	93.011
	14_RN3-5	Primary or Trunk	14.0	2778	Bituminous	Reseal at 30% surface d	0.045	0.491	93.503
	02_RN1-2	Primary or Trunk	41.6	2328	Bituminous	Reseal at 30% surface d	-0.292	1.456	94.958
	03_RN1-3	Primary or Trunk	34.9	1867	Bituminous	Reseal at 30% surface d	-0.457	1.220	96.179
2029	09_RN2-4-1 Good Condition	Primary or Trunk	26.6	983	Bituminous	Reseal at 30% surface d	-0.310	0.931	97.110
	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1655	Bituminous	Reseal at 30% surface d	-0.316	0.868	97.978
	18_RN3-9-1 Good Condition	Primary or Trunk	27.2	640	Bituminous	Reseal at 30% surface d	-0.674	0.952	98.930
	22_RN6-4-1 Good Condition	Primary or Trunk	4.7	843	Bituminous	Reseal at 30% surface d	-0.726	0.165	99.094
	23_RN6-5	Primary or Trunk	4.8	1080	Bituminous	Reseal at 30% surface d	-0.759	0.168	99.262

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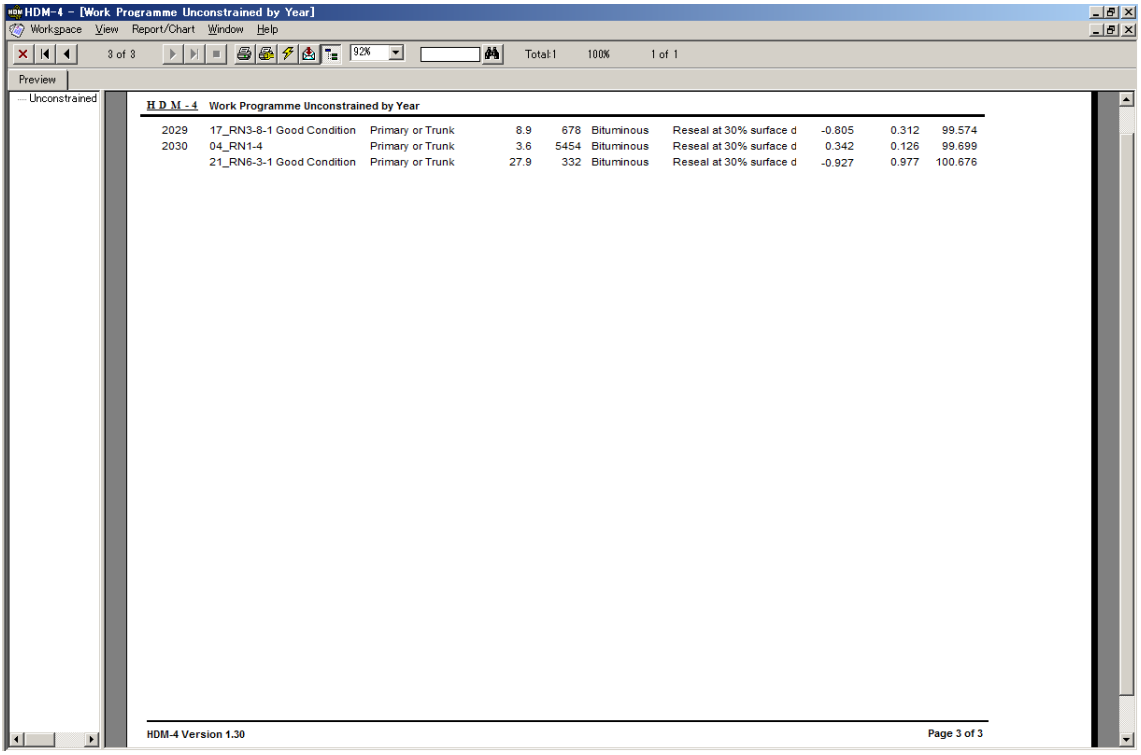


Year	Cost	NPV
2011	7.14	2.60
2012	1.03	
2013	15.12	
2014	15.01	
2015	1.29	
2016	0.00	
2017	0.00	
2018	0.00	
2019	2.74	
2020	0.00	
2021	0.90	
2022	2.49	
2023	18.48	
2024	14.30	
2025	9.03	
2026	1.17	
2027	1.58	
2028	5.90	
2029	3.40	
2030	1.10	
Total	100.68	
annual	5.03	

HDM analysis results (work programme for Rwanda and cumulative cost for maintenance with Type T loading)

HDM-4 HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: 5. Rwanda Present Case(Tmodel)
Run Date: 02-08-2011

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financial Costs	Cum. Costs
2011	09_RN2-4-2 Poor Condition	Primary or Trunk	1.8	577	Bituminous	Overlay 50mm at 6 IRI	0.098	0.630	0.630
	22_RN6-4-3 Poor Condition	Primary or Trunk	7.5	495	Bituminous	Overlay 50mm at 6 IRI	-0.214	2.625	3.255
	21_RN6-3-3 Poor Condition	Primary or Trunk	11.1	189	Bituminous	Overlay 50mm at 6 IRI	-0.718	3.885	7.140
2012	11_RN3-2	Primary or Trunk	16.6	4597	Bituminous	Reseal at 30% surface dar	6.964	0.580	7.720
	10_RN3-1	Primary or Trunk	9.3	4597	Bituminous	Reseal at 30% surface dar	6.963	0.324	8.043
	01_RN1-1	Primary or Trunk	42.3	2531	Bituminous	Reseal at 30% surface dar	0.837	1.482	9.525
	12_RN3-3	Primary or Trunk	31.2	2220	Bituminous	Reseal at 30% surface dar	0.370	1.091	10.617
	04_RN1-4	Primary or Trunk	3.6	3203	Bituminous	Reseal at 40% surface dar	0.350	0.126	10.742
2013	14_RN3-5	Primary or Trunk	14.0	1783	Bituminous	Reseal at 30% surface dar	-0.128	0.491	11.233
	07_RN2-2	Primary or Trunk	16.2	1105	Bituminous	Reseal at 30% surface dar	-0.236	0.566	11.800
	02_RN1-2	Primary or Trunk	41.6	1494	Bituminous	Reseal at 30% surface dar	-0.256	1.456	13.255
	15_RN3-6-2 Fair Condition	Primary or Trunk	7.0	1031	Bituminous	Overlay 50mm at 6 IRI	-0.307	2.450	15.705
	13_RN3-4	Primary or Trunk	3.4	1645	Bituminous	Reseal at 30% surface dar	-0.398	0.118	15.823
	03_RN1-3	Primary or Trunk	34.9	1198	Bituminous	Reseal at 30% surface dar	-0.421	1.220	17.044
2014	08_RN2-3	Primary or Trunk	23.0	940	Bituminous	Reseal at 30% surface dar	-0.167	0.805	17.849
	09_RN2-4-1 Good Condition	Primary or Trunk	26.6	631	Bituminous	Reseal at 30% surface dar	-0.303	0.931	18.780
	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1062	Bituminous	Reseal at 30% surface dar	-0.481	0.868	19.648
	16_RN3-7	Primary or Trunk	10.7	572	Bituminous	Reseal at 30% surface dar	-0.572	0.375	20.022
	18_RN3-9-2 Fair Condition	Primary or Trunk	11.6	410	Bituminous	Overlay 50mm at 6 IRI	-0.603	4.060	24.082
	19_RN6-1-2 Fair Condition	Primary or Trunk	1.6	706	Bituminous	Overlay 50mm at 6 IRI	-0.607	0.560	24.642
	18_RN3-9-1 Good Condition	Primary or Trunk	27.2	410	Bituminous	Reseal at 30% surface dar	-0.626	0.952	25.594
	22_RN6-4-2 Fair Condition	Primary or Trunk	13.6	541	Bituminous	Overlay 50mm at 6 IRI	-0.630	4.760	30.354
	17_RN3-8-2 Fair Condition	Primary or Trunk	1.1	435	Bituminous	Overlay 50mm at 6 IRI	-0.685	0.385	30.739
	21_RN6-3-2 Fair Condition	Primary or Trunk	23.6	207	Bituminous	Overlay 50mm at 6 IRI	-0.859	8.260	38.999
	05_RN1-5-2 Fair Condition	Primary or Trunk	1.6	117	Bituminous	Overlay 50mm at 6 IRI	-0.915	0.560	39.559
2015	22_RN6-4-1 Good Condition	Primary or Trunk	4.7	557	Bituminous	Reseal at 40% surface dar	-0.762	0.165	39.724
	17_RN3-8-1 Good Condition	Primary or Trunk	8.9	448	Bituminous	Reseal at 30% surface dar	-0.771	0.312	40.035
	19_RN6-1-1 Good Condition	Primary or Trunk	24.9	728	Bituminous	Reseal at 40% surface dar	-0.772	0.872	40.907

2015	23_RN6-5	Primary or Trunk	4.8	714	Bituminous	Reseal at 40% surface dar	-0.796	0.168	41.075
	20_RN6-2	Primary or Trunk	26.2	555	Bituminous	Reseal at 40% surface dar	-0.805	0.917	41.992
2021	11_RN3-2	Primary or Trunk	16.6	5999	Bituminous	Reseal at 30% surface dar	6.964	0.580	42.571
	10_RN3-1	Primary or Trunk	9.3	5999	Bituminous	Reseal at 30% surface dar	6.963	0.324	42.895
	06_RN2-1	Primary or Trunk	7.8	4205	Bituminous	Overlay 50mm at 6 IRI	1.119	2.736	45.631
	01_RN1-1	Primary or Trunk	42.3	3302	Bituminous	Reseal at 30% surface dar	0.837	1.482	47.113
2022	12_RN3-3	Primary or Trunk	31.2	2984	Bituminous	Reseal at 30% surface dar	0.370	1.091	48.204
	04_RN1-4	Primary or Trunk	3.6	4305	Bituminous	Reseal at 40% surface dar	0.350	0.126	48.330
2023	14_RN3-5	Primary or Trunk	14.0	2396	Bituminous	Reseal at 30% surface dar	-0.128	0.491	48.821
	08_RN2-3	Primary or Trunk	23.0	1227	Bituminous	Reseal at 30% surface dar	-0.167	0.805	49.626
	07_RN2-2	Primary or Trunk	16.2	1486	Bituminous	Reseal at 30% surface dar	-0.236	0.566	50.192
	02_RN1-2	Primary or Trunk	41.6	2008	Bituminous	Reseal at 30% surface dar	-0.256	1.456	51.648
	09_RN2-4-1 Good Condition	Primary or Trunk	26.6	823	Bituminous	Reseal at 30% surface dar	-0.303	0.931	52.579
	13_RN3-4	Primary or Trunk	3.4	2211	Bituminous	Reseal at 30% surface dar	-0.398	0.118	52.697
	03_RN1-3	Primary or Trunk	34.9	1610	Bituminous	Reseal at 30% surface dar	-0.421	1.220	53.917
2024	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1427	Bituminous	Reseal at 30% surface dar	-0.481	0.868	54.785
	16_RN3-7	Primary or Trunk	10.7	769	Bituminous	Reseal at 30% surface dar	-0.572	0.375	55.160
	18_RN3-9-1 Good Condition	Primary or Trunk	27.2	552	Bituminous	Reseal at 30% surface dar	-0.626	0.952	56.112
	17_RN3-8-1 Good Condition	Primary or Trunk	8.9	585	Bituminous	Reseal at 30% surface dar	-0.771	0.312	56.423
2025	22_RN6-4-1 Good Condition	Primary or Trunk	4.7	749	Bituminous	Reseal at 40% surface dar	-0.762	0.165	56.588
	19_RN6-1-1 Good Condition	Primary or Trunk	24.9	978	Bituminous	Reseal at 40% surface dar	-0.772	0.872	57.459
	23_RN6-5	Primary or Trunk	4.8	959	Bituminous	Reseal at 40% surface dar	-0.796	0.168	57.627
	20_RN6-2	Primary or Trunk	26.2	746	Bituminous	Reseal at 40% surface dar	-0.805	0.917	58.544
2026	22_RN6-4-3 Poor Condition	Primary or Trunk	7.5	771	Bituminous	Reseal at 40% surface dar	-0.214	0.263	58.807
2027	12_RN3-3	Primary or Trunk	31.2	3459	Bituminous	Reseal at 30% surface dar	0.370	1.091	59.898
2028	11_RN3-2	Primary or Trunk	16.6	7378	Bituminous	Reseal at 30% surface dar	6.964	0.580	60.478
	10_RN3-1	Primary or Trunk	9.3	7378	Bituminous	Reseal at 30% surface dar	6.963	0.324	60.802
	01_RN1-1	Primary or Trunk	42.3	4062	Bituminous	Reseal at 30% surface dar	0.837	1.482	62.284
	14_RN3-5	Primary or Trunk	14.0	2778	Bituminous	Reseal at 30% surface dar	-0.128	0.491	62.774
	07_RN2-2	Primary or Trunk	16.2	1722	Bituminous	Reseal at 30% surface dar	-0.236	0.566	63.341
2029	09_RN2-4-2 Poor Condition	Primary or Trunk	1.8	983	Bituminous	Overlay 50mm at 6 IRI	0.098	0.630	63.971
	15_RN3-6-1 Good Condition	Primary or Trunk	24.8	1655	Bituminous	Reseal at 30% surface dar	-0.481	0.868	64.839

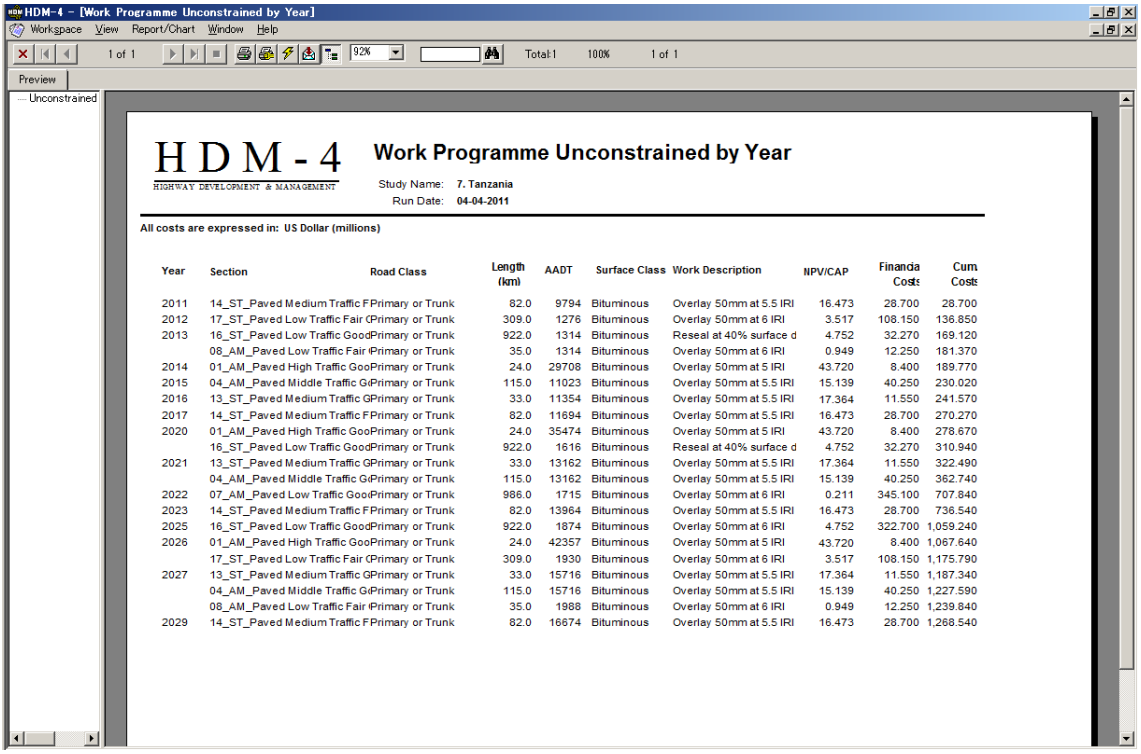
Year	Cost	NPV
2011	7.1	2.0
2012	3.6	
2013	6.3	
2014	22.5	
2015	2.4	
2016	0.0	
2017	0.0	
2018	0.0	
2019	0.0	
2020	0.0	
2021	5.1	
2022	1.2	
2023	5.6	
2024	2.5	
2025	2.1	
2026	0.3	
2027	1.1	
2028	3.4	
2029	1.5	
2030	0.0	
Total	64.8	
annual	3.2	

E.1.5 Dataset for HDM-4 Analysis for Tanzania

Traffic composition

	Cars	PUs Vans	Small Buses	Large Buses	Light Lorries	Med. Lorries	Heavy Lorries	V.H. Lorries
Low	16.6%	20.7%	11.0%	14.1%	8.4%	10.0%	12.7%	6.6%
Medium	19.0%	24.7%	22.2%	8.1%	6.3%	6.9%	5.7%	7.1%
High	35.2%	21.7%	21.1%	13.1%	4.6%	2.6%	1.3%	0.5%

HDM analysis results (work programme for Tanzania and cumulative cost for maintenance with Type UB loading)

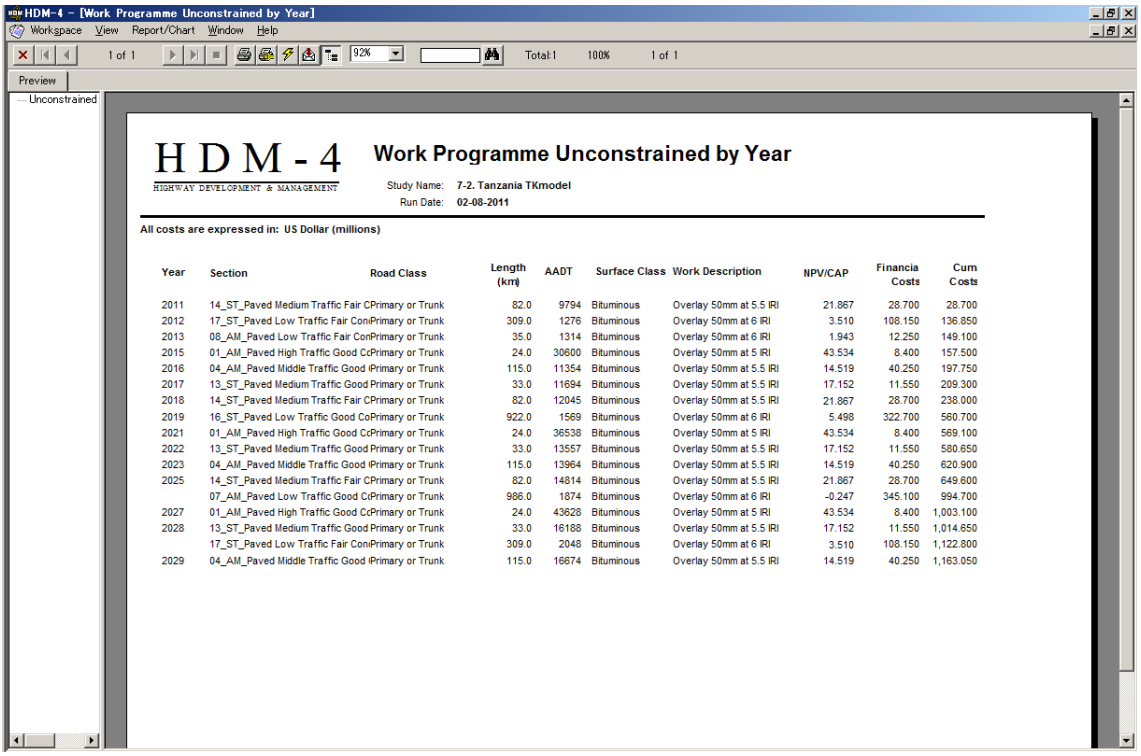


Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	14_ST_Paved Medium Traffic F	Primary or Trunk	82.0	9794	Bituminous	Overlay 50mm at 5.5 IRI	16.473	28.700	28.700
2012	17_ST_Paved Low Traffic Fair	Primary or Trunk	309.0	1276	Bituminous	Overlay 50mm at 6 IRI	3.517	108.150	136.850
2013	16_ST_Paved Low Traffic Good	Primary or Trunk	922.0	1314	Bituminous	Reseal at 40% surface d	4.752	32.270	169.120
	08_AM_Paved Low Traffic Fair	Primary or Trunk	35.0	1314	Bituminous	Overlay 50mm at 6 IRI	0.949	12.250	181.370
2014	01_AM_Paved High Traffic Goo	Primary or Trunk	24.0	29708	Bituminous	Overlay 50mm at 5 IRI	43.720	8.400	189.770
2015	04_AM_Paved Middle Traffic G	Primary or Trunk	115.0	11023	Bituminous	Overlay 50mm at 5.5 IRI	15.139	40.250	230.020
2016	13_ST_Paved Medium Traffic G	Primary or Trunk	33.0	11354	Bituminous	Overlay 50mm at 5.5 IRI	17.364	11.550	241.570
2017	14_ST_Paved Medium Traffic F	Primary or Trunk	82.0	11694	Bituminous	Overlay 50mm at 5.5 IRI	16.473	28.700	270.270
2020	01_AM_Paved High Traffic Goo	Primary or Trunk	24.0	35474	Bituminous	Overlay 50mm at 5 IRI	43.720	8.400	278.670
	16_ST_Paved Low Traffic Good	Primary or Trunk	922.0	1616	Bituminous	Reseal at 40% surface d	4.752	32.270	310.940
2021	13_ST_Paved Medium Traffic G	Primary or Trunk	33.0	13162	Bituminous	Overlay 50mm at 5.5 IRI	17.364	11.550	322.490
	04_AM_Paved Middle Traffic G	Primary or Trunk	115.0	13162	Bituminous	Overlay 50mm at 5.5 IRI	15.139	40.250	362.740
2022	07_AM_Paved Low Traffic Goo	Primary or Trunk	986.0	1715	Bituminous	Overlay 50mm at 6 IRI	0.211	345.100	707.840
2023	14_ST_Paved Medium Traffic F	Primary or Trunk	82.0	13964	Bituminous	Overlay 50mm at 5.5 IRI	16.473	28.700	736.540
2025	16_ST_Paved Low Traffic Good	Primary or Trunk	922.0	1874	Bituminous	Overlay 50mm at 6 IRI	4.752	322.700	1,059.240
2026	01_AM_Paved High Traffic Goo	Primary or Trunk	24.0	42357	Bituminous	Overlay 50mm at 5 IRI	43.720	8.400	1,067.640
	17_ST_Paved Low Traffic Fair	Primary or Trunk	309.0	1930	Bituminous	Overlay 50mm at 6 IRI	3.517	108.150	1,175.790
2027	13_ST_Paved Medium Traffic G	Primary or Trunk	33.0	15716	Bituminous	Overlay 50mm at 5.5 IRI	17.364	11.550	1,187.340
	04_AM_Paved Middle Traffic G	Primary or Trunk	115.0	15716	Bituminous	Overlay 50mm at 5.5 IRI	15.139	40.250	1,227.590
	08_AM_Paved Low Traffic Fair	Primary or Trunk	35.0	1988	Bituminous	Overlay 50mm at 6 IRI	0.949	12.250	1,239.840
2029	14_ST_Paved Medium Traffic F	Primary or Trunk	82.0	16674	Bituminous	Overlay 50mm at 5.5 IRI	16.473	28.700	1,268.540

Type UB

Year	Cost	NPV
2011	28.7	28.0
2012	108.2	
2013	44.5	
2014	8.4	
2015	40.3	
2016	11.6	
2017	28.7	
2018	0.0	
2019	0.0	
2020	40.7	
2021	51.8	
2022	345.1	
2023	28.7	
2024	0.0	
2025	322.7	
2026	116.6	
2027	64.1	
2028	0.0	
2029	28.7	
2030	0.0	
Total	1268.5	
annual	63.4	

HDM analysis results (work programme for Tanzania and cumulative cost for maintenance with Type T loading)



Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	14_ST_Paved Medium Traffic Fair C	Primary or Trunk	82.0	9794	Bituminous	Overlay 50mm at 5.5 IRI	21.867	28.700	28.700
2012	17_ST_Paved Low Traffic Fair Con	Primary or Trunk	309.0	1276	Bituminous	Overlay 50mm at 6 IRI	3.510	108.150	136.850
2013	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	35.0	1314	Bituminous	Overlay 50mm at 6 IRI	1.943	12.250	149.100
2015	01_AM_Paved High Traffic Good Cc	Primary or Trunk	24.0	30600	Bituminous	Overlay 50mm at 5 IRI	43.534	8.400	157.500
2016	04_AM_Paved Middle Traffic Good I	Primary or Trunk	115.0	11354	Bituminous	Overlay 50mm at 5.5 IRI	14.519	40.250	197.750
2017	13_ST_Paved Medium Traffic Good	Primary or Trunk	33.0	11694	Bituminous	Overlay 50mm at 5.5 IRI	17.152	11.550	209.300
2018	14_ST_Paved Medium Traffic Fair C	Primary or Trunk	82.0	12045	Bituminous	Overlay 50mm at 5.5 IRI	21.867	28.700	238.000
2019	16_ST_Paved Low Traffic Good Co	Primary or Trunk	922.0	1569	Bituminous	Overlay 50mm at 6 IRI	5.498	322.700	560.700
2021	01_AM_Paved High Traffic Good Cc	Primary or Trunk	24.0	36538	Bituminous	Overlay 50mm at 5 IRI	43.534	8.400	569.100
2022	13_ST_Paved Medium Traffic Good	Primary or Trunk	33.0	13557	Bituminous	Overlay 50mm at 5.5 IRI	17.152	11.550	580.650
2023	04_AM_Paved Middle Traffic Good I	Primary or Trunk	115.0	13964	Bituminous	Overlay 50mm at 5.5 IRI	14.519	40.250	620.900
2025	14_ST_Paved Medium Traffic Fair C	Primary or Trunk	82.0	14814	Bituminous	Overlay 50mm at 5.5 IRI	21.867	28.700	649.600
	07_AM_Paved Low Traffic Good Cc	Primary or Trunk	986.0	1874	Bituminous	Overlay 50mm at 6 IRI	-0.247	345.100	994.700
2027	01_AM_Paved High Traffic Good Cc	Primary or Trunk	24.0	43628	Bituminous	Overlay 50mm at 5 IRI	43.534	8.400	1,003.100
2028	13_ST_Paved Medium Traffic Good	Primary or Trunk	33.0	16188	Bituminous	Overlay 50mm at 5.5 IRI	17.152	11.550	1,014.650
	17_ST_Paved Low Traffic Fair Con	Primary or Trunk	309.0	2048	Bituminous	Overlay 50mm at 6 IRI	3.510	108.150	1,122.800
2029	04_AM_Paved Middle Traffic Good I	Primary or Trunk	115.0	16674	Bituminous	Overlay 50mm at 5.5 IRI	14.519	40.250	1,163.050

Type T

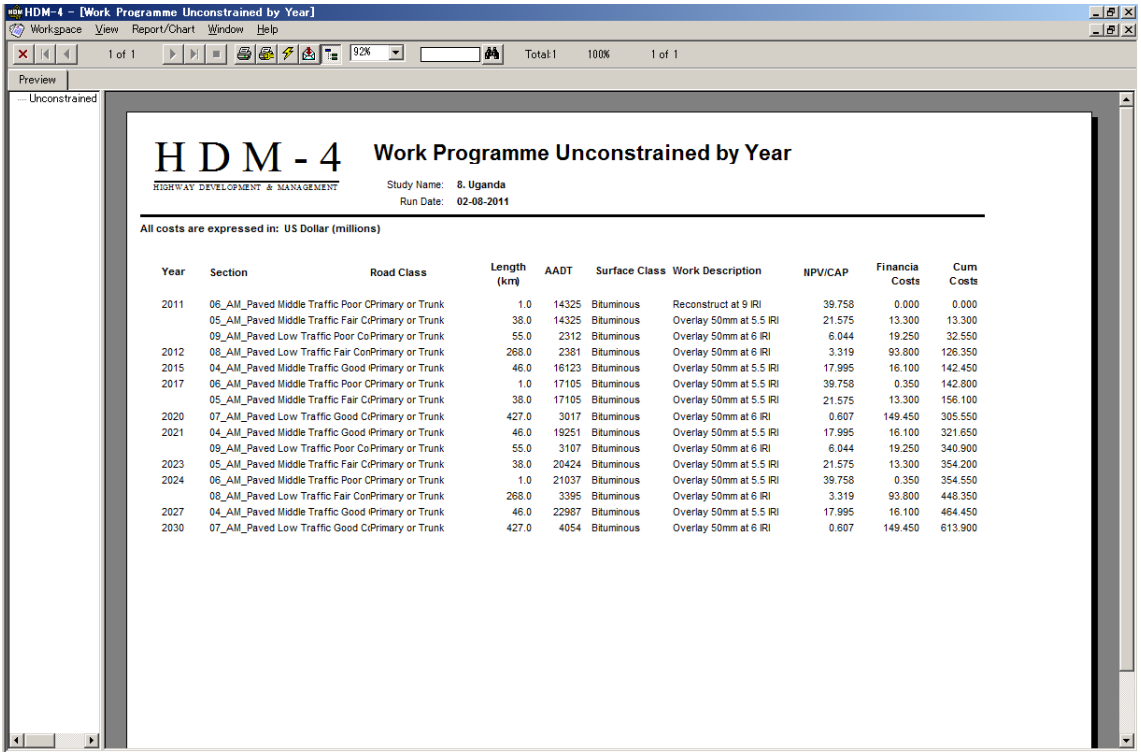
Year	Cost	NPV
2011	28.7	26.3
2012	108.2	
2013	12.3	
2014	0.0	
2015	8.4	
2016	40.3	
2017	11.6	
2018	28.7	
2019	322.7	
2020	0.0	
2021	8.4	
2022	11.6	
2023	40.3	
2024	0.0	
2025	373.8	
2026	0.0	
2027	8.4	
2028	119.7	
2029	40.3	
2030	0.0	
Total	1163.0	
annual	58.2	

E.1.6 Dataset for HDM-4 Analysis for Uganda

Traffic Composition

	Saloon cars and Taxies	Light Goods	Small Buses	Buses	Light Single Unit Truck	Medium/Large Single Unit Truck	Truck Trailer and Semi Trailer
Low	18.4%	22.2%	22.6%	4.3%	8.1%	12.7%	11.7%
Medium	27.5%	23.6%	29.1%	1.2%	6.8%	7.7%	4.0%

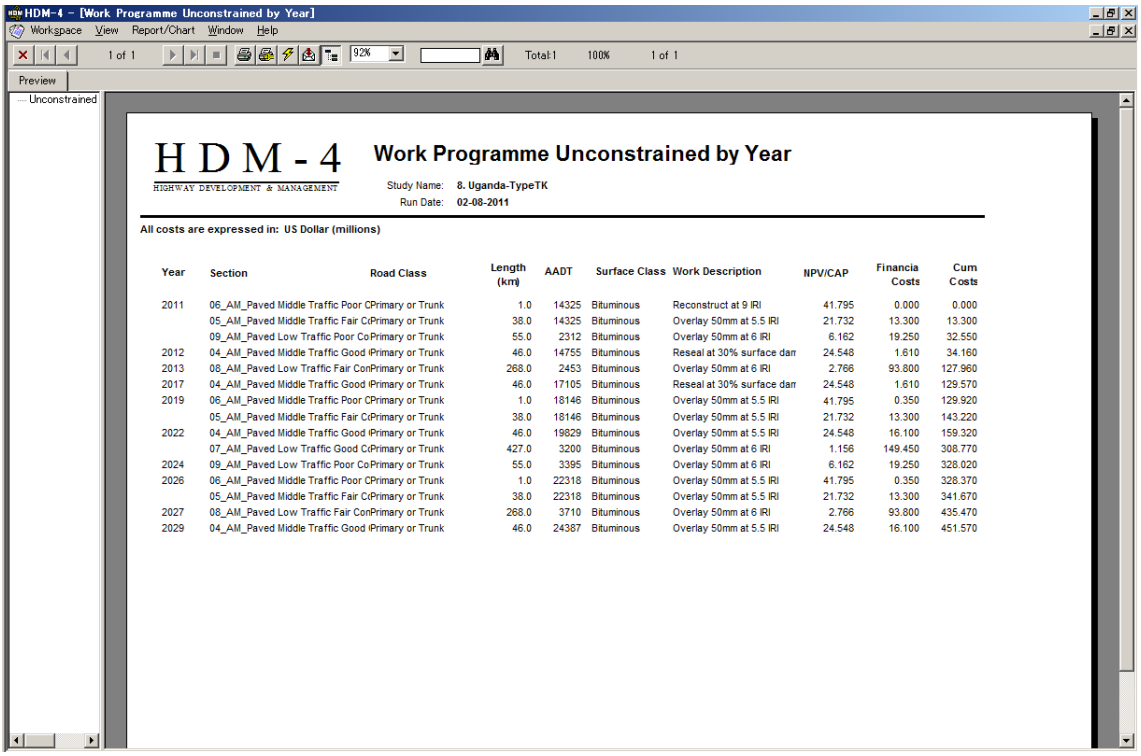
HDM Analysis results (work programme for Uganda and cumulative cost of maintenance with Type UB loading)



Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	14325	Bituminous	Reconstruct at 9 IRI	39.758	0.000	0.000
	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	14325	Bituminous	Overlay 50mm at 5.5 IRI	21.575	13.300	13.300
	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	55.0	2312	Bituminous	Overlay 50mm at 6 IRI	6.044	19.250	32.550
2012	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	268.0	2381	Bituminous	Overlay 50mm at 6 IRI	3.319	93.800	126.350
2015	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	16123	Bituminous	Overlay 50mm at 5.5 IRI	17.995	16.100	142.450
2017	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	17105	Bituminous	Overlay 50mm at 5.5 IRI	39.758	0.350	142.800
	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	17105	Bituminous	Overlay 50mm at 5.5 IRI	21.575	13.300	156.100
2020	07_AM_Paved Low Traffic Good C	Primary or Trunk	427.0	3017	Bituminous	Overlay 50mm at 6 IRI	0.607	149.450	305.550
2021	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	19251	Bituminous	Overlay 50mm at 5.5 IRI	17.995	16.100	321.650
	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	55.0	3107	Bituminous	Overlay 50mm at 6 IRI	6.044	19.250	340.900
2023	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	20424	Bituminous	Overlay 50mm at 5.5 IRI	21.575	13.300	354.200
2024	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	21037	Bituminous	Overlay 50mm at 5.5 IRI	39.758	0.350	354.550
	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	268.0	3395	Bituminous	Overlay 50mm at 6 IRI	3.319	93.800	448.350
2027	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	22987	Bituminous	Overlay 50mm at 5.5 IRI	17.995	16.100	464.450
2030	07_AM_Paved Low Traffic Good C	Primary or Trunk	427.0	4054	Bituminous	Overlay 50mm at 6 IRI	0.607	149.450	613.900

Year	Cost	NPV
2011	0.0	14.0
2012	107.1	
2013	19.3	
2014	0.0	
2015	16.1	
2016	0.0	
2017	0.4	
2018	13.3	
2019	0.0	
2020	149.5	
2021	16.1	
2022	19.3	
2023	13.3	
2024	0.4	
2025	93.8	
2026	0.0	
2027	16.1	
2028	0.0	
2029	0.0	
2030	149.5	
Total	613.9	
annual	30.7	

HDM Analysis results (work programme for Uganda and cumulative cost of maintenance with Type T loading)



Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	14325	Bituminous	Reconstruct at 9 IRI	41.795	0.000	0.000
	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	14325	Bituminous	Overlay 50mm at 5.5 IRI	21.732	13.300	13.300
	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	55.0	2312	Bituminous	Overlay 50mm at 6 IRI	6.162	19.250	32.550
2012	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	14755	Bituminous	Reseal at 30% surface dan	24.548	1.610	34.160
2013	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	268.0	2453	Bituminous	Overlay 50mm at 6 IRI	2.766	93.800	127.960
2017	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	17105	Bituminous	Reseal at 30% surface dan	24.548	1.610	129.570
2019	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	18146	Bituminous	Overlay 50mm at 5.5 IRI	41.795	0.350	129.920
	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	18146	Bituminous	Overlay 50mm at 5.5 IRI	21.732	13.300	143.220
2022	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	19829	Bituminous	Overlay 50mm at 5.5 IRI	24.548	16.100	159.320
	07_AM_Paved Low Traffic Good C	Primary or Trunk	427.0	3200	Bituminous	Overlay 50mm at 6 IRI	1.156	149.450	308.770
2024	09_AM_Paved Low Traffic Poor Co	Primary or Trunk	55.0	3395	Bituminous	Overlay 50mm at 6 IRI	6.162	19.250	328.020
2026	06_AM_Paved Middle Traffic Poor C	Primary or Trunk	1.0	22318	Bituminous	Overlay 50mm at 5.5 IRI	41.795	0.350	328.370
	05_AM_Paved Middle Traffic Fair C	Primary or Trunk	38.0	22318	Bituminous	Overlay 50mm at 5.5 IRI	21.732	13.300	341.670
2027	08_AM_Paved Low Traffic Fair Con	Primary or Trunk	268.0	3710	Bituminous	Overlay 50mm at 6 IRI	2.766	93.800	435.470
2029	04_AM_Paved Middle Traffic Good	Primary or Trunk	46.0	24387	Bituminous	Overlay 50mm at 5.5 IRI	24.548	16.100	451.570

Year	Cost	NPV
2011	32.6	11.0
2012	1.6	
2013	93.8	
2014	0.0	
2015	0.0	
2016	0.0	
2017	1.6	
2018	0.0	
2019	13.7	
2020	0.0	
2021	0.0	
2022	165.6	
2023	0.0	
2024	19.3	
2025	0.0	
2026	13.7	
2027	93.8	
2028	0.0	
2029	16.1	
2030	0.0	
Total	451.6	
annual	22.6	

E.2 Analysis of Overloading Measurement Records by Country

E.2.1 Uganda

The recorded axle loads of each axle of all passing traffic at two weighbridge stations, Mbaraba and Masaka, located along the Central Corridor, shown as below, were recorded in the following format.

Figure E-1: Location of Measurement

Table E-1: Measurement Record Format for Uganda

Items	Actual record as example	Notes by the study team
Ticket_No	28	
Axle_Format		
Units_Measure	kg	
Axle 1	6900	Recorded by each axle, no group measurement. For this case, Axle 2,3,4 and 6 are overloading
Axle 2	8400	
Axle 3	8250	
Axle 4	8350	
Axle 5	7700	
Axle 6	8200	
Axle 7		
Axle 8		
Axle 9		
Axle_Groups	4,5,6	Just shows the number of axle
GVW(Kgs)	47800	
OverWeight_(Kgs)	250	
PGOW_(%)	1.04	
Mobile Station	LUKAYA	
Cargo_Type	FUEL	Over 250 kinds of goods are recorded; there is no standardized manner in record.
Permit_No	J594***	(The asterisks are for protection of personal information)
Driver's_Signature	MWEBAZE***	
WB_Operator's_Name	SOOXXX	
WB_Controller's_Name		
Action Taken	SM-S2T8T12 (1*12-222)	
WB_Controller's_Signature		

The measurements covered the period from June to August 2010, measured 11,572 freight vehicles, and detected about 57% of freight traffic exceeding axle load and/or GVM limits. The following tables summarize the measurements.

Table E-2: Summary of Freight Vehicle Overloading Measurements in Uganda

# of Axles	# of Measured Vehicles	# of Overloading Vehicles	Share of Overloading	ESAL per vehicle	GVM per Vehicle
2	2271	1462	64.4%	4.28	15887.1
3	3293	1782	54.1%	5.88	24245.0
4	276	121	43.8%	3.13	27495.5
5	539	289	53.6%	5.73	36532.9
6	4699	2606	55.5%	5.76	42707.0
7	494	317	64.2%	13.85	56167.3

Source: JICA Study Team and Uganda National Road Authority

Table E-3: Overloading Measurement Results by Weighbridge Stations

Summary of GVM and ESAL data (Mbarara Weighbridge, Uganda)

	Total			Overweight Vehicle			Non-Overweight Vehicle		
	# of Vehi.	Ave. GMV	Ave. ESAL	# of Vehi.	Ave. GMV	Ave. ESA	# of Vehi.	Ave. GMV	Ave. ESAL
2 Axle	632	14382.6	3.13	312	16870.2	5.06	320	11912.3	1.23
3 Axle	1459	22717.5	3.85	562	26024.4	7.16	897	20645.7	1.77
4 Axle	183	27509.0	3.15	81	29477.8	4.37	102	25945.6	2.22
5 Axle	366	35715.7	5.17	172	39517.4	7.72	194	32345.1	2.91
6 Axle	2313	41119.3	4.55	1045	44933.0	6.52	1268	37976.3	2.93
7 Axle	71	48758.5	5.20	43	52007.0	6.40	28	43769.6	3.36

Summary of GVM and ESAL data (Masaka Weighbridge, Uganda)

	Total			Overweight Vehicle			Non-Overweight Vehicle		
	# of Vehi.	Ave. GMV	Ave. ESAL	# of Vehi.	Ave. GMV	Ave. ESA	# of Vehi.	Ave. GMV	Ave. ESAL
2 Axle	1639	16467.2	4.72	1150	17742.9	6.03	489	13467.2	1.66
3 Axle	1834	25460.2	7.49	1220	27802.2	10.20	614	20806.6	2.12
4 Axle	93	27468.8	3.09	40	29586.3	4.22	53	25870.8	2.23
5 Axle	173	38261.8	6.92	117	41248.3	8.80	56	32022.3	2.99
6 Axle	2386	44246.1	6.93	1561	47340.0	8.84	825	38392.1	3.32
7 Axle	423	57410.9	15.30	274	62140.3	20.50	149	48713.8	5.73

Source: JICA Study Team and Uganda National Road Authority

	Overload	Total	Share
GVM	801	2261	35%
1 axle	128	2261	6%
2 axle	1428	2261	63%

The following chart presents a summary of loading per axle by vehicle type. For example, examining the axle loading of 2-axle vehicles, it was found that 63% of vehicles exceeded its rear axle weight limits (10 tonnes), but only 6% of the front axles exceeded the limit (8 tonnes), and 35% of vehicles violated the GVM regulation. This suggests that 30% of overloaded freight is caused by overloading of the rear axle, and damage to pavement by overloading can be alleviated by improving the loading distribution.

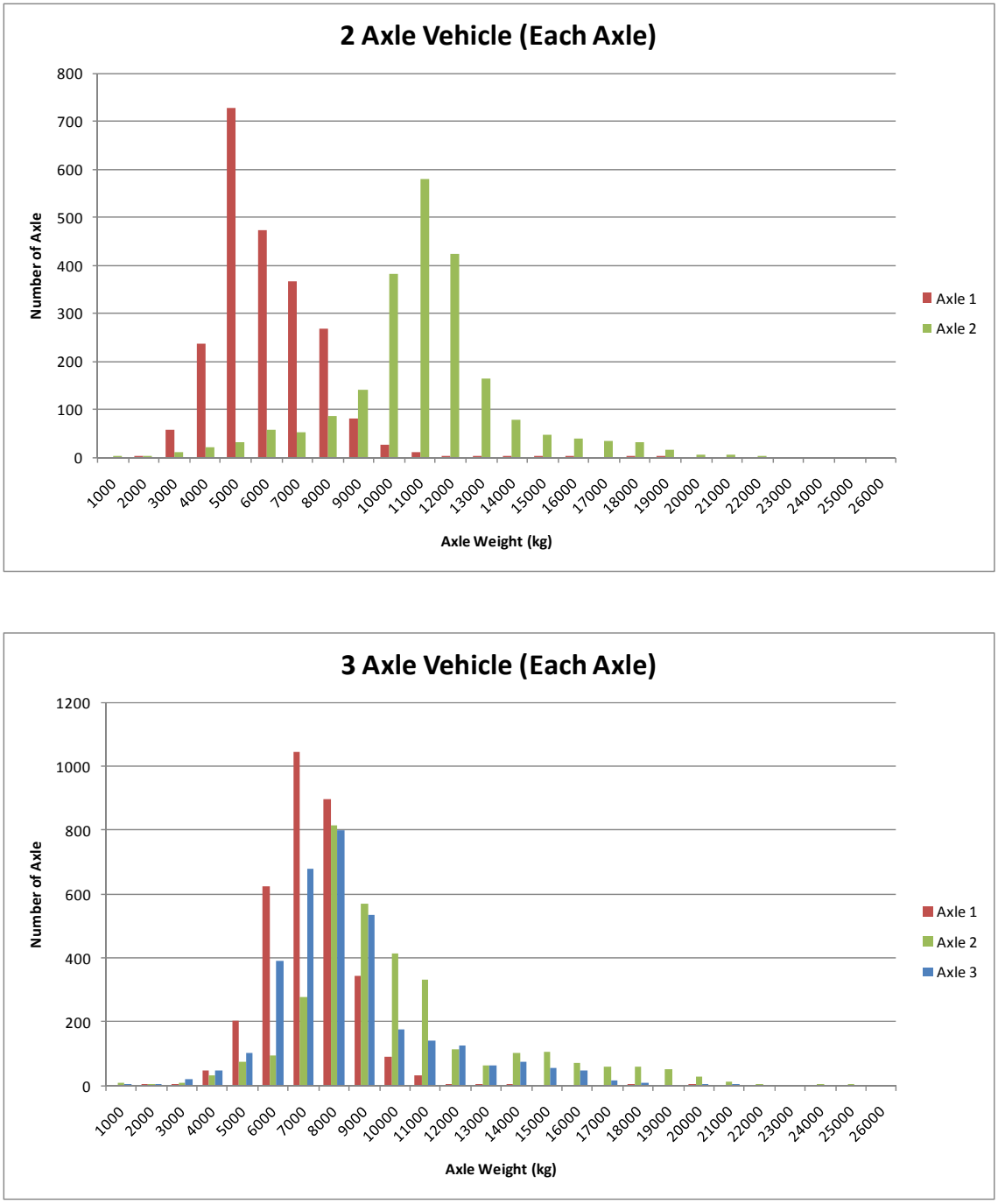
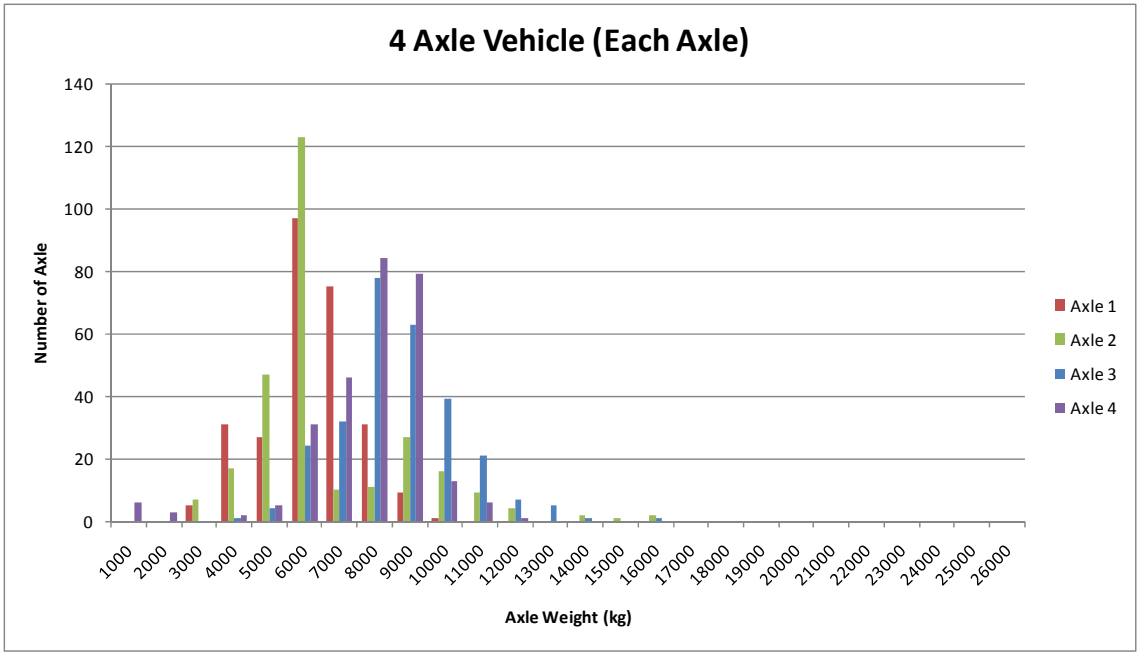


Figure E-2: Axle Load Distribution by Freight Vehicle Types (UGANDA)



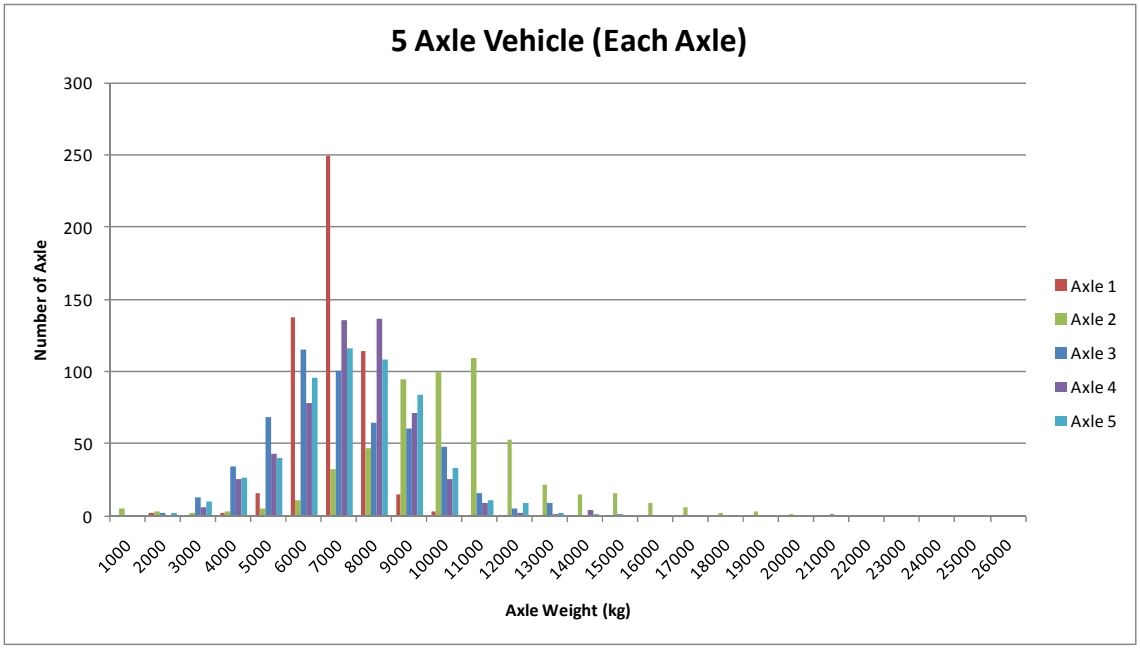
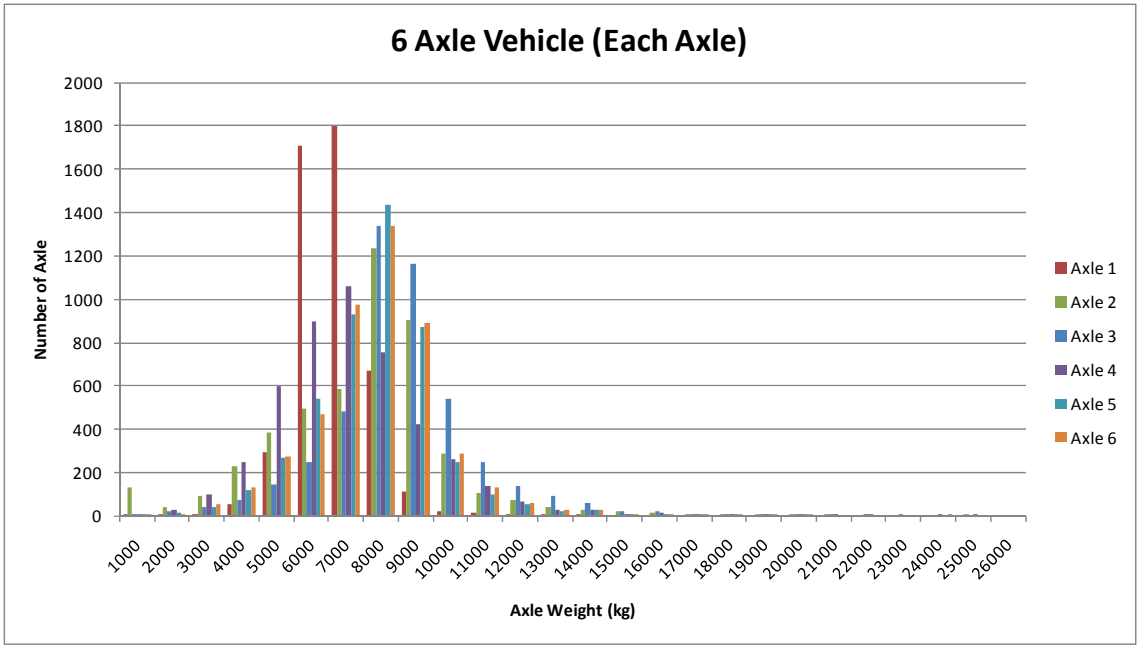


Figure E-2: Axle Load Distribution by Freight Vehicle Types (UGANDA) (continued)



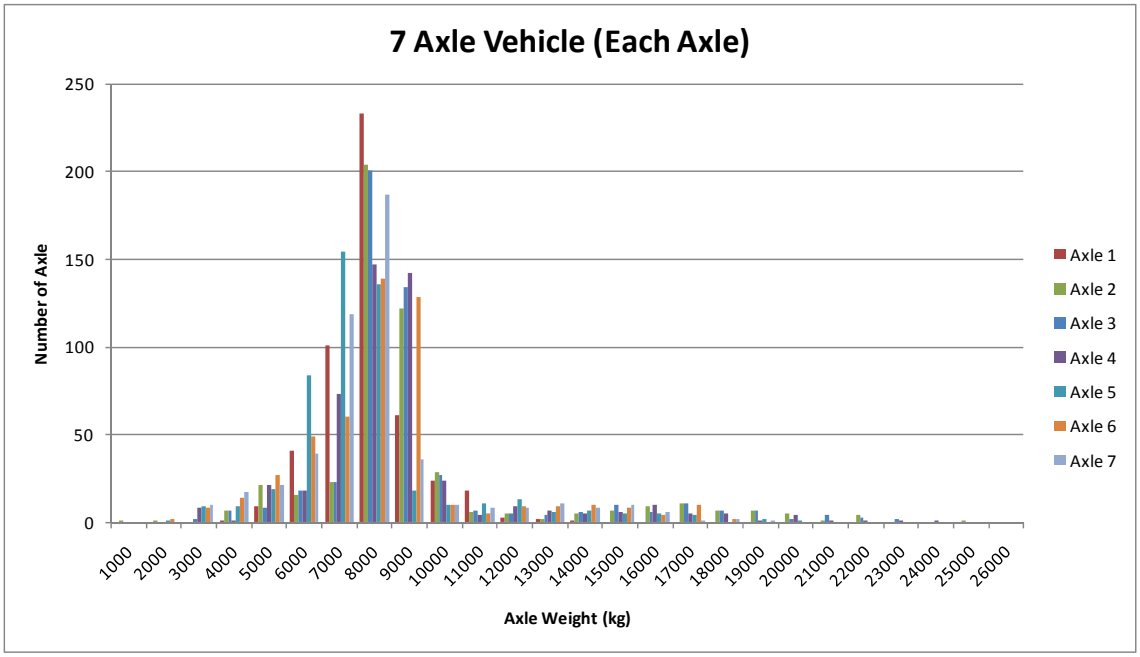


Figure E-2: Axle Load Distribution by Freight Vehicle Types (UGANDA) (continued)

The JICA Study Team also examined the types of goods involved in overloading as shown in the following table, which lists the top goods groups involved at each location. Overloading is higher in Masaka. Major overloading items at Masaka are fuel, cement, beer, matoke, and coffee. The rate of overloading exceeds 50% for several goods types, e.g., coffee, cassava, bitumen, and salt. For Mbaraba, the major overloaded goods are fuel and construction materials (e.g., cement, limestone). Also, the rate of overloading is high among transporters of construction materials.

This set of measurement records is extensive, which suggests strengthening of measurement by industry. It covers only freight movements over months; however, other seasonal agro products should be been monitored.

Table E-4: State of Overloading by Goods (Masaka)

Masaka	Not OL	OL	Total	OL rate
Fuel	769	436	1205	36%
Cement	409	170	579	29%
Beer	320	132	452	29%
Assorted	193	136	329	41%
Matooke	139	89	228	39%
Coffee	54	126	180	70%
Soda	91	58	149	39%
Soap	93	43	136	32%
Timber	60	59	119	50%
Steel	50	57	107	53%
Water	43	54	97	56%
Sugar	34	49	83	59%
Posho	35	38	73	52%
Beans	37	33	70	47%
Oil	26	32	58	55%
Salt	20	33	53	62%
Cassava	10	37	47	79%
Bitumen	16	26	42	62%
Tea	20	21	41	51%

Table E-5: State of Overloading by Goods (Mbaraba)

Mbalaba	Not OL	OL	Total	OL rate
Cement	1093	302	1395	22%
Pozzolana	714	178	892	20%
Fuel	241	84	325	26%
Limestone	105	136	241	56%
Beer	132	54	186	29%
Salt	98	34	132	26%
Assorted Goods	98	26	124	21%
Food	56	15	71	21%
Millet	36	7	43	16%
Maize	67	7	74	9%
Coffee	26	5	31	16%
Soda	44	11	55	20%
Sand	10	15	25	60%
Tyres	19	5	24	21%
Empty	22		22	0%
Plastics	18	2	20	10%
Rice	19	1	20	5%

E.2.2 Tanzania

Tanzania's overloading measurements were collected at the Kibaha weighbridge on 12 July 2010 (Monday), located along the A7 central corridor, 30 km from the Dar es Salaam. The records were collected in the following format, by stopping all freight vehicles in both directions. A total of 454 records were collected.

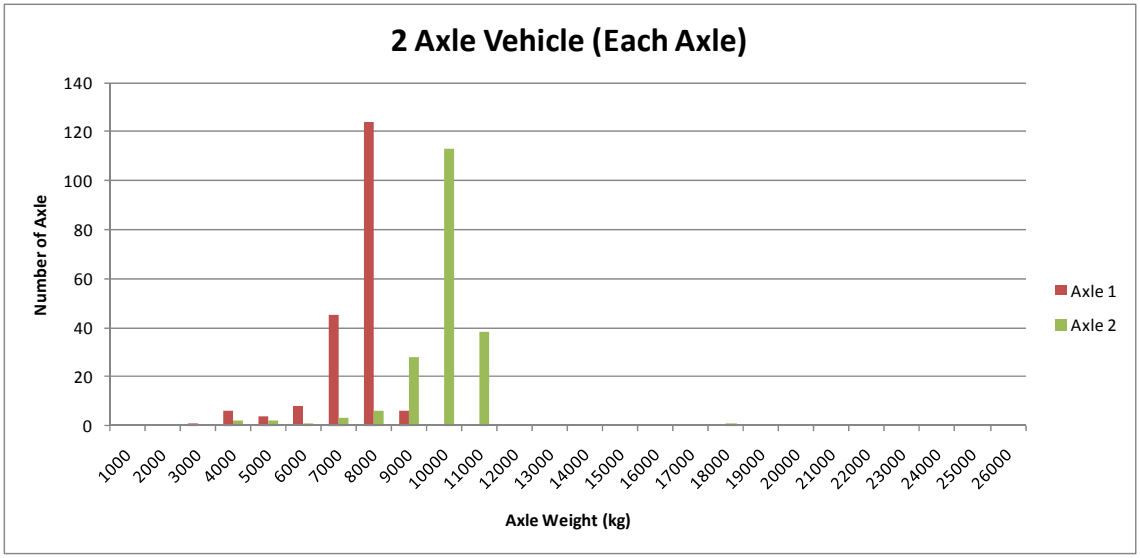
Item	1	2	Notes
Date	12/07/2010	12/07/2010	
Weighbridge Station	SOUTH	SOUTH	
Ticket Number	1304186	1304187	
Time	0:01	0:05	Showing 24-hour operation
Vehicle Reg.No.	T 153 XXX	T 190 XXX	
Axle Configuration	1-22+2-22	1-22-222	
Axle Grp.Wt1 (Kg)	6500	6600	Measured by axle group, and the JICA Study Team estimated weight per axle.
Axle Grp.Wt2 (Kg)	18050	11650	
Axle Grp.Wt3 (Kg)	8550	17600	
Axle Grp.Wt4 (Kg)	17950		
Total GVM (Kg)	51050	35850	

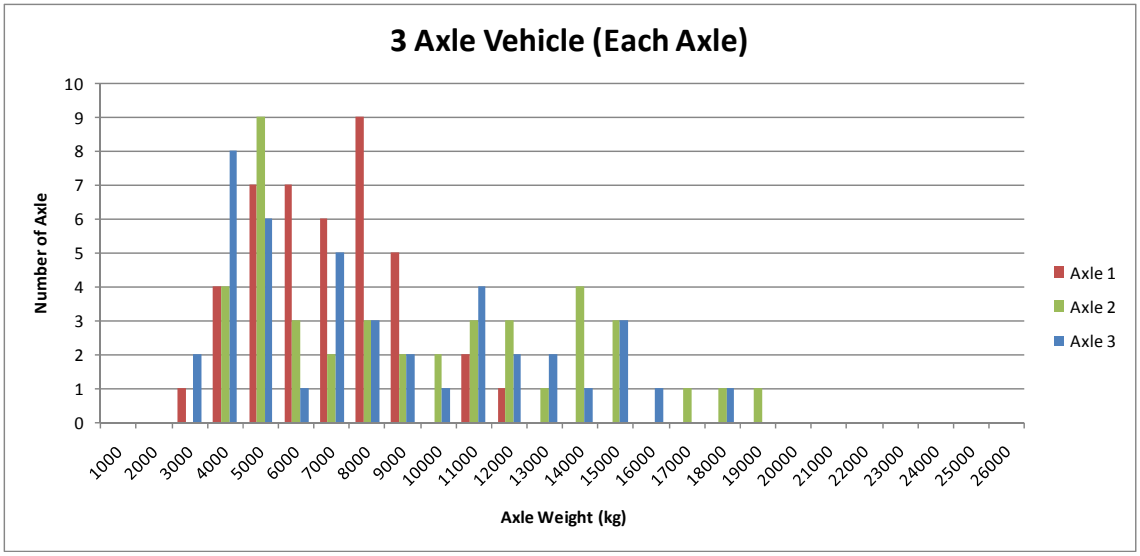
The following table is a summary of measurement records. This shows that 29.1% of freight vehicles are overloaded, and heavier vehicles had a high ratio of overloading.

Table E-6: Summary of Freight Vehicle Overloading Measurement in Tanzania

	Total			Overweight Vehicle			Non-Overweight Vehicle			OL Ratio
	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	
2 Axle	194	16470.9	2.57	45	17475.6	3.44	149	16167.4	2.31	23.2%
3 Axle	75	22456.0	2.49	16	24465.6	3.33	59	22456.0	2.27	21.3%
4 Axle	19	26881.6	2.14	6	27416.7	2.23	13	26634.6	2.10	31.6%
5 Axle	6	38500.0	5.12	3	41950.0	7.43	3	35050.0	2.82	50.0%
6 Axle	145	44033.8	4.56	56	47508.0	5.81	89	41847.8	3.77	38.6%
7 Axle	15	49690.0	5.06	6	53541.7	6.05	9	47122.2	4.40	40.0%
	454			132			322			29.1%

The distribution of load per axle is illustrated in the following charts. Compared with Uganda, the records show good compliance to the limit value. Figures for 4 and 5 axles have been omitted due to the small number of samples.





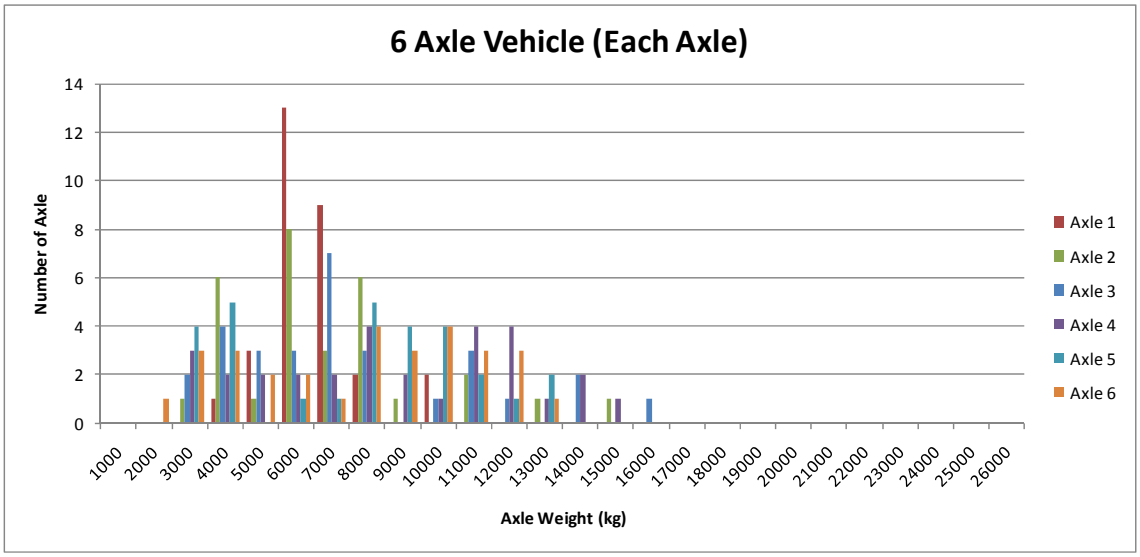


Figure E-3: Axle Loading Distribution by Freight Vehicle Types (Tanzania)

E.2.3 Burundi

Overloading measurement results were collected from several weighbridges in the country, without information on the location of weighbridges. A total of 361 records were collected. The following summary shows that the overloading rate was 28%, and heavier vehicles particularly those of 6 and 7 axles, had a higher overloading tendency.

Table E-7: Summary of Freight Vehicle Overloading Measurement in Burundi

	Total			Overweight Vehicle			Non-Overweight Vehicle			OL Ratio
	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	
2 Axle	256	9172.1	0.87	38	18185.8	2.77	218	7601.0	0.29	14.8%
3 Axle	42	23050.2	7.23	22	30284.1	13.21	20	15093.0	0.65	52.4%
4 Axle	4	27310.0	7.03	2	39070.0	13.78	2	15550.0	0.27	50.0%
5 Axle	9	21504.4	1.29	1	38920.0	7.97	8	19327.5	0.46	11.1%
6 Axle	30	42313.2	7.83	20	50837.8	11.35	10	25264.0	0.78	66.7%
7 Axle	20	63319.5	19.03	18	67097.2	21.06	2	29320.0	0.71	90.0%
	361			101			260			28.0%

The distribution of load per axle is illustrated in the following charts. The records for 2-axle vehicles show compliance with the limit value. The figures for 4 and 5 axles have been omitted due to the small sample size.

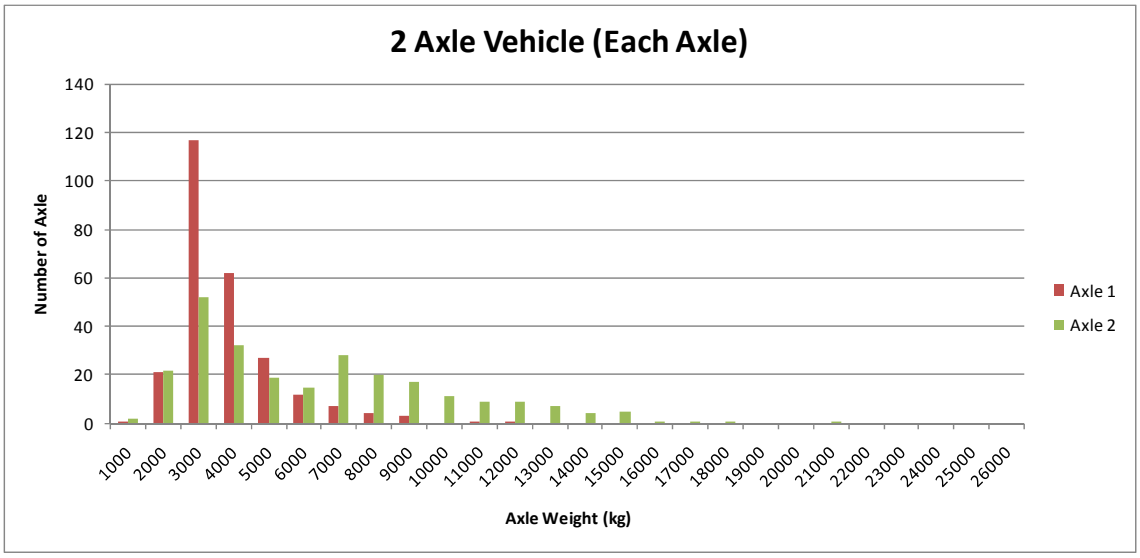
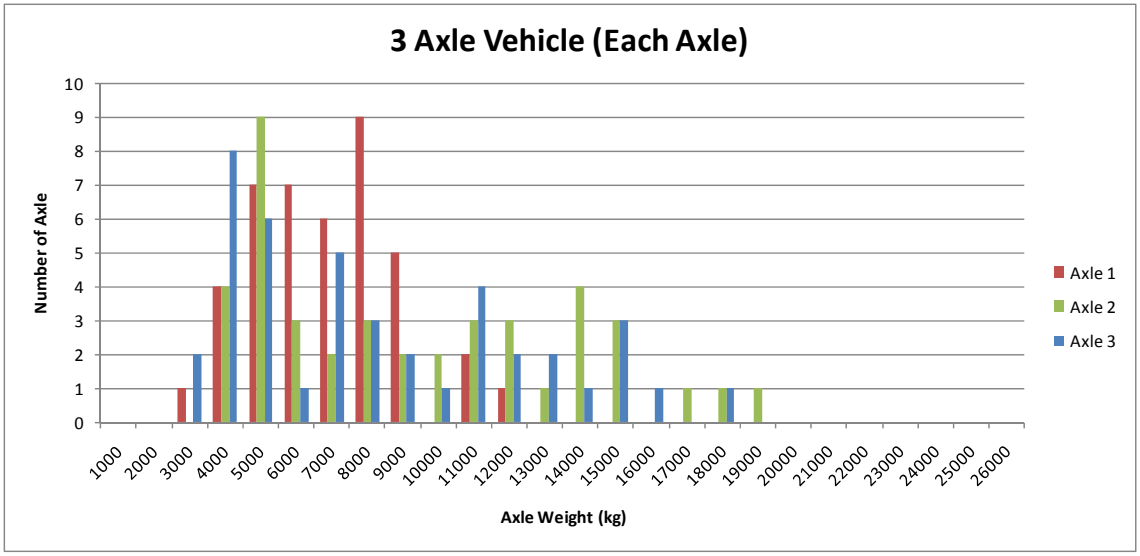


Figure E-4: Axle Loading Distribution by Freight Vehicle Types (Burundi)



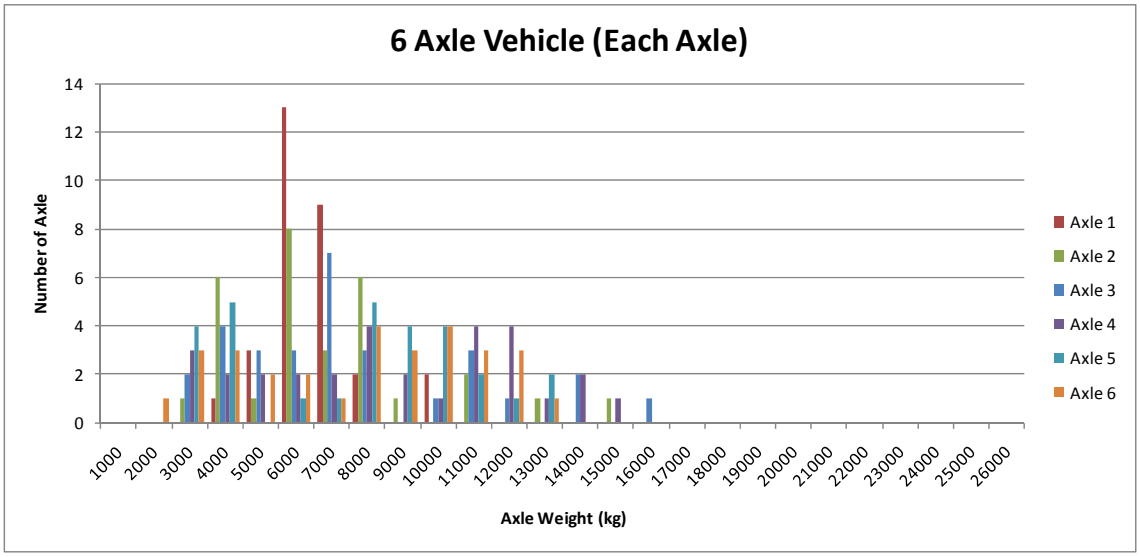


Figure E-4: Axle Loading Distribution by Freight Vehicle Types (Burundi) (continued)

E.2.4 Kenya

Over 40,000 measurement results were provided by the Kenyan authority without information on the location of weighbridges. The following summary shows the overloading rate as 61%, which is the highest among the countries. Note that the data for 6-axle freight vehicle accounts for over 90% of measurements, and the JICA Study Team requested an explanation of background for this occurrence.

Table E-8: Summary of Freight Vehicle Overloading Measurement in Kenya

	Total			Overweight Vehicle			Non-Overweight Vehicle			
	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	# of Vehi.	Ave. GVM	Ave. ESAL	OL Ratio
2 Axle	86	14348.9	2.33	35	16770.9	3.81	51	12686.8	1.31	41%
3 Axle	1,527	23431.3	2.89	741	23718.6	3.21	786	23718.6	3.21	49%
4 Axle	143	29484.7	3.73	70	30829.4	4.34	73	28195.1	3.15	49%
5 Axle	1,941	39179.2	6.03	1,359	39611.7	6.54	582	38169.2	4.82	70%
6 Axle	38,101	45006.9	5.40	23,098	45298.5	5.76	15,003	44557.9	4.83	61%
7 Axle	-	-	-	-	-	-	-	-	-	
	41,798			25,303						61%

The distribution of load per axle is illustrated in the following charts. The records for 2-axle vehicle show its compliance to the limit value.

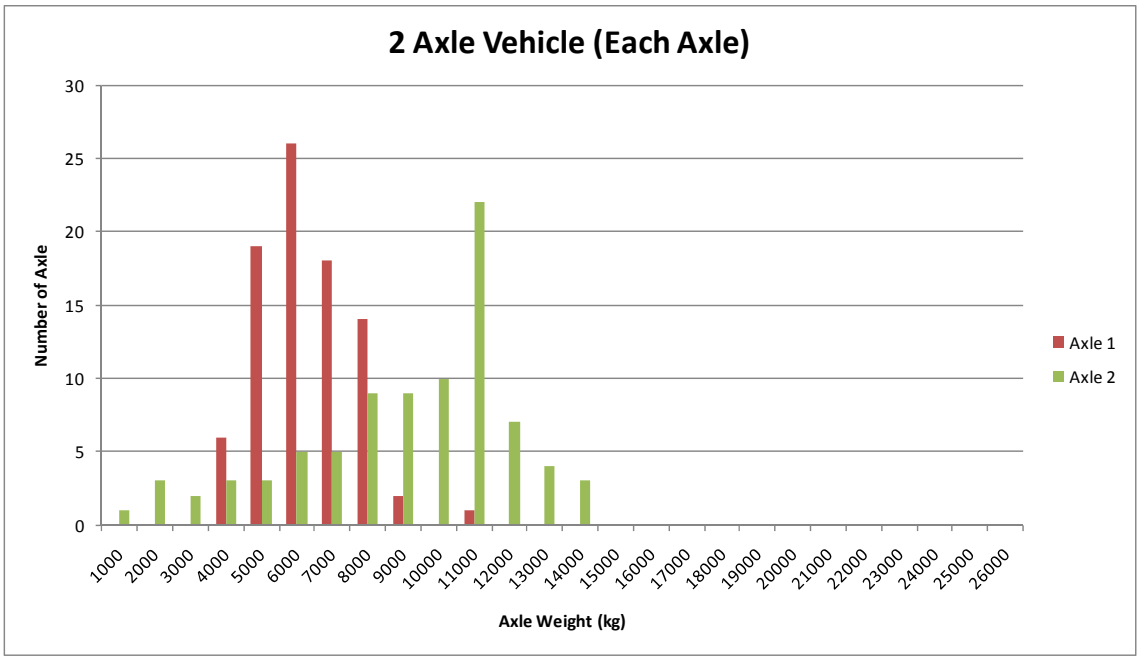
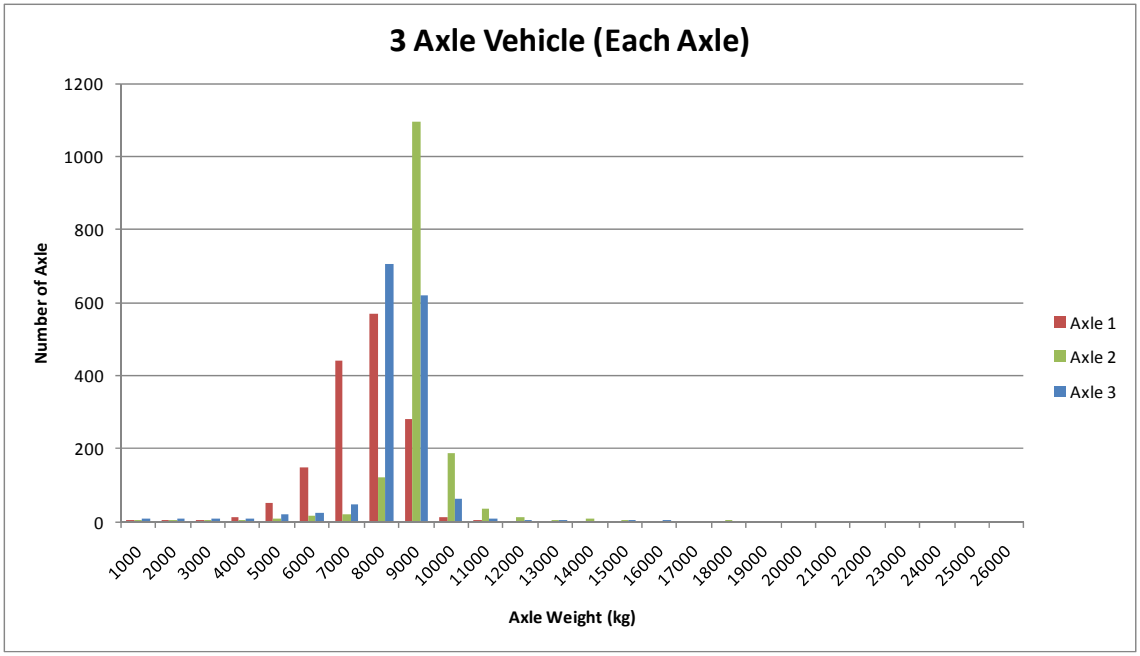


Figure E-5: Axle Loading Distribution by Freight Vehicle Types (Kenya)



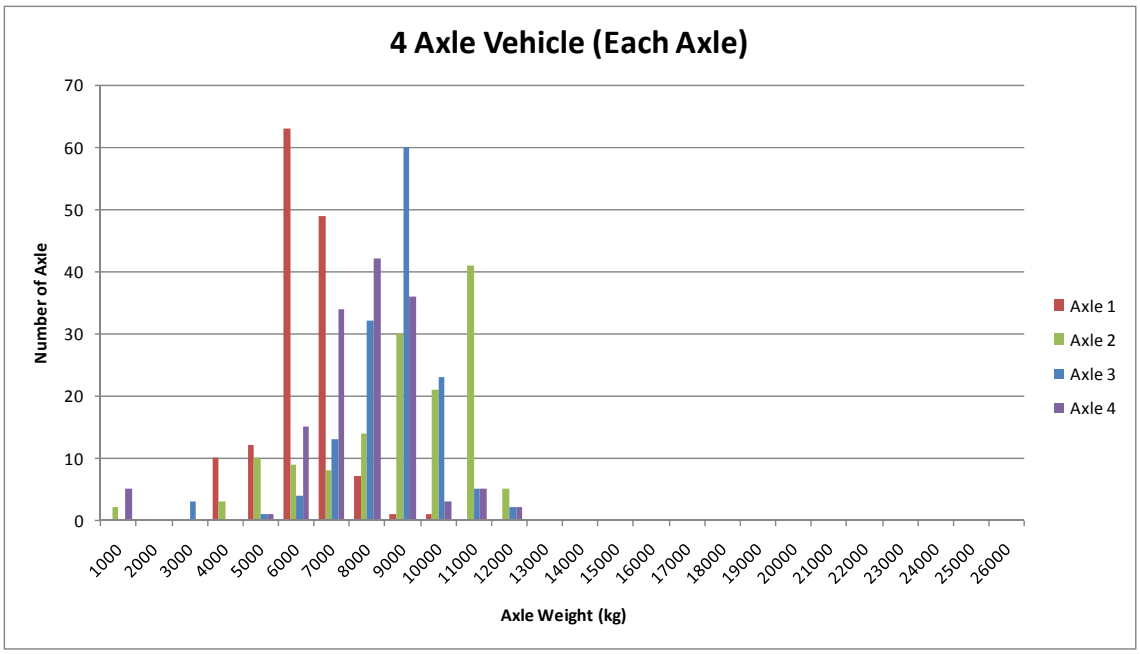
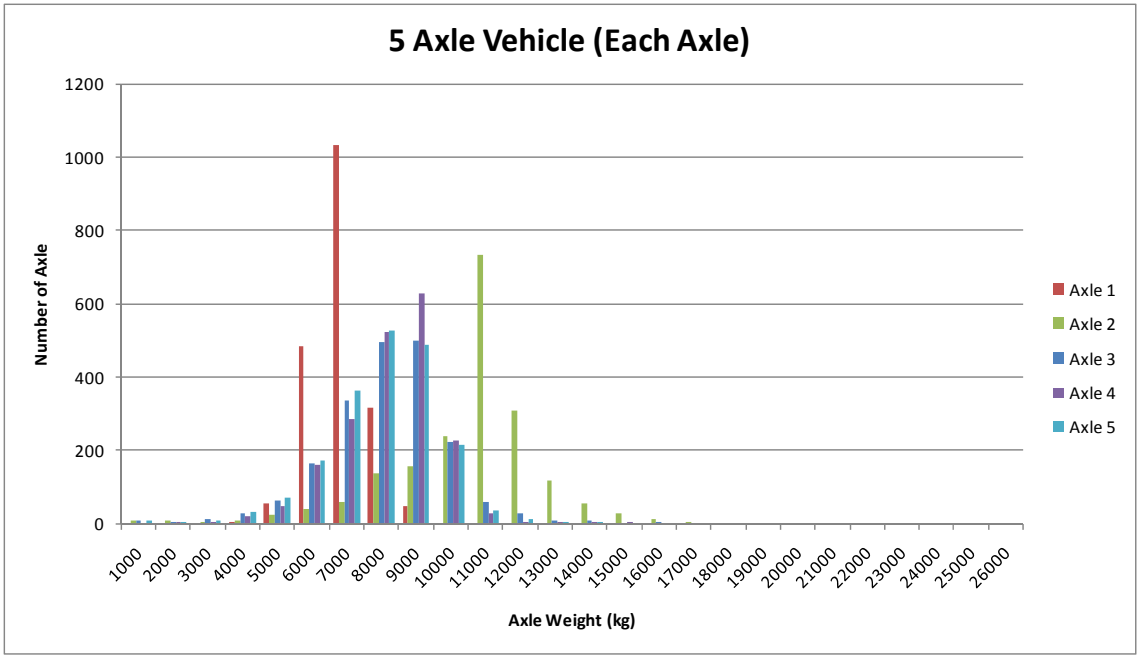


Figure E-5: Axle Loading Distribution by Freight Vehicle Types (Kenya) (continued)



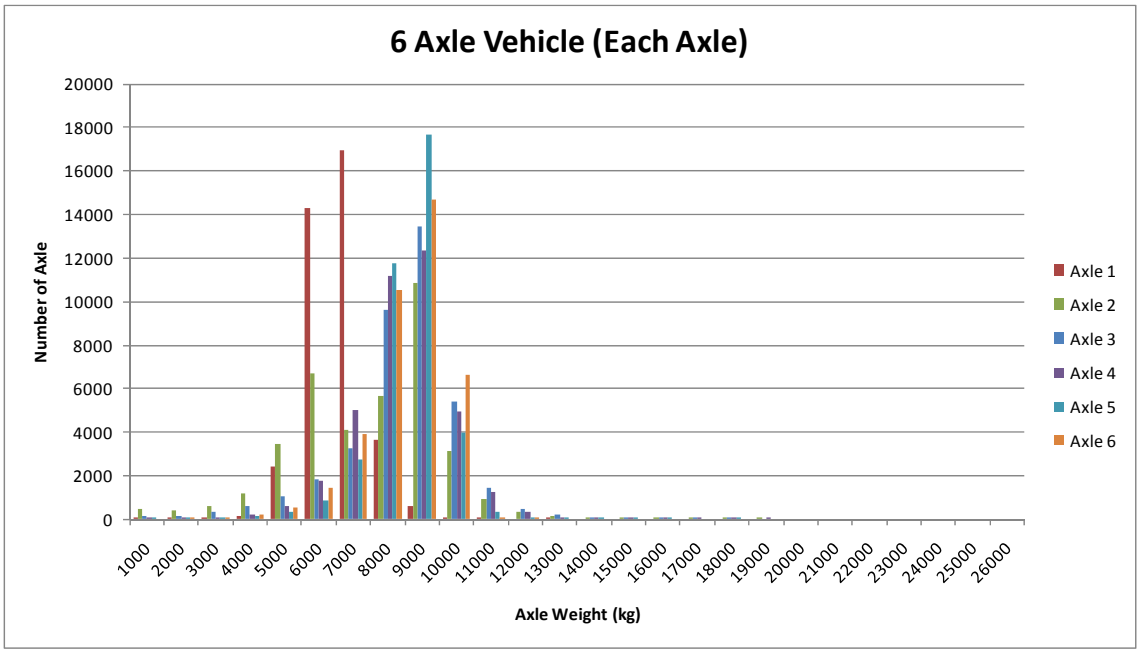


Figure E-5: Axle Loading Distribution by Freight Vehicle Types (Kenya) (continued)

E.3 Assumptions in the Analysis With/Without Overloading

E.3.1 Input Data

(1) Sample Network for Analysis

Name	Condition Year	Length (km)	Roughness IRI (m/km)	Total Cracking Area (%)	Ravelled Area (%)	Edge Break (m^2/km)	Rut Depth (mm)	ADT (veh.)
01_AM_Paved High Traffic Good Condition	2010	32.00	3.00	1.00	1.00	0.00	0.00	10,000
02_AM_Paved High Traffic Fair Condition	2010	12.00	5.50	5.00	5.00	8.00	5.00	10,000
03_AM_Paved High Traffic Poor Condition	2010	80.00	8.00	10.00	15.00	50.00	10.00	10,000

(2) Traffic Composition

		TYPE TK (%)		TYPE UB (%)	
		with OL	without OL	with OL	without OL
Common for both cases (passenger traffic)	Cars	35.1	35.1	35.1	35.1
	Pick up	21.7	21.7	21.7	21.7
	Minibus	21.1	21.1	21.1	21.1
	Bus	13.1	13.1	13.1	13.1
Composition for overloading cases referring to actual status	2 Axles Truck	3.8		1.8	
	3 Axles Truck	1.5		2.6	
	Trailer	0.5		0.6	
	Trailer-Truck	3.2		4.0	
Composition for non-overloaded vehicles	2 Axles Truck		3.0		0.6
	3 Axles Truck		1.2		1.1
	Trailer		0.3		0.3
	Trailer-Truck		2.0		1.8
Composition of ideal loading vehicles replacing overloading amount	2 Axles Truck		0.9		1.1
	3 Axles Truck		0.3		1.5
	Trailer		0.2		0.3
	Trailer-Truck		1.2		2.2

(due to rounding)

(3) Specification for ESAL and GVM

		TYPE T		TYPE UB	
		GVM (kg)	ESAL	GVM (kg)	ESAL
Overloading cases referring to actual status	2 Axles Truck	17,475	3.44	19,735	4.28
	3 Axles Truck	24,465	3.33	28,953	5.88
	Trailer	29,670	2.86	34,244	4.85
	Trailer-Truck	47,508	5.81	48,455	5.76
Non-overloaded vehicles	2 Axles Truck	16,167	2.31	15,162	1.49
	3 Axles Truck	22,456	2.27	21,865	1.91
	Trailer	28,212	2.24	29,462	2.66
	Trailer-Truck	41,847	3.77	41,452	3.09
Ideally loaded vehicles	2 Axles Truck	18,000	3.18	18,000	3.18
	3 Axles Truck	24,000	2.77	24,000	2.77
	Trailer	35,000	4.19	35,000	4.19
	Trailer-Truck	48,000	5.54	48,000	5.54

E.3.2 Analysis Results

(1) With Overloading Case for Type T

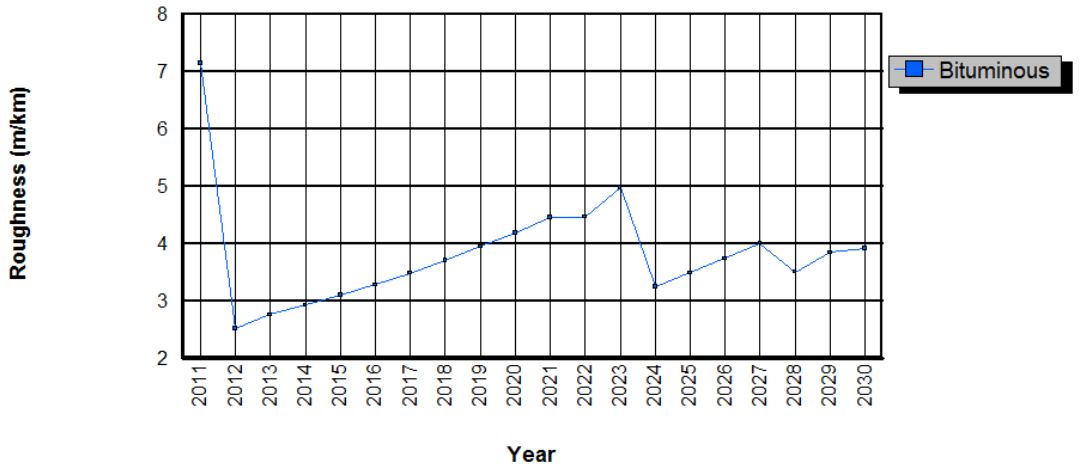
1. Progress of IRI during the project period

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Roughness: Average for Road Network by Pavement Surface (Graph)

Study Name: 9.1-3 Overloading with TK by kenroad
Run Date: 28-03-2011

Annual Average Roughness for each Surface Class of the Unconstrained Work Programme (weighted by length)



2. Optimized Work Programme and Cumulative Maintenance Expenditure

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: 9.1-3 Overloading with TK by kenroad
Run Date: 04-04-2011

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	10300	Bituminous	Reconstruct at 8 IRI	18.975	56.000	56.000
	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	10300	Bituminous	Overlay 50mm at 5 IRI	14.936	4.200	60.200
2012	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	10609	Bituminous	Reseal at 20% surface d	27.130	1.120	61.320
2018	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	12667	Bituminous	Reseal at 20% surface d	27.130	1.120	62.440
2021	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	13842	Bituminous	Overlay 50mm at 5 IRI	14.936	4.200	66.640
2023	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	14685	Bituminous	Reseal at 20% surface d	27.130	1.120	67.760
	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	14685	Bituminous	Overlay 50mm at 5 IRI	18.975	28.000	95.760
2027	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	16528	Bituminous	Overlay 50mm at 5 IRI	27.130	11.200	106.960
2029	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	17535	Bituminous	Overlay 50mm at 5 IRI	14.936	4.200	111.160

(2) Without Overloading Case for Type T

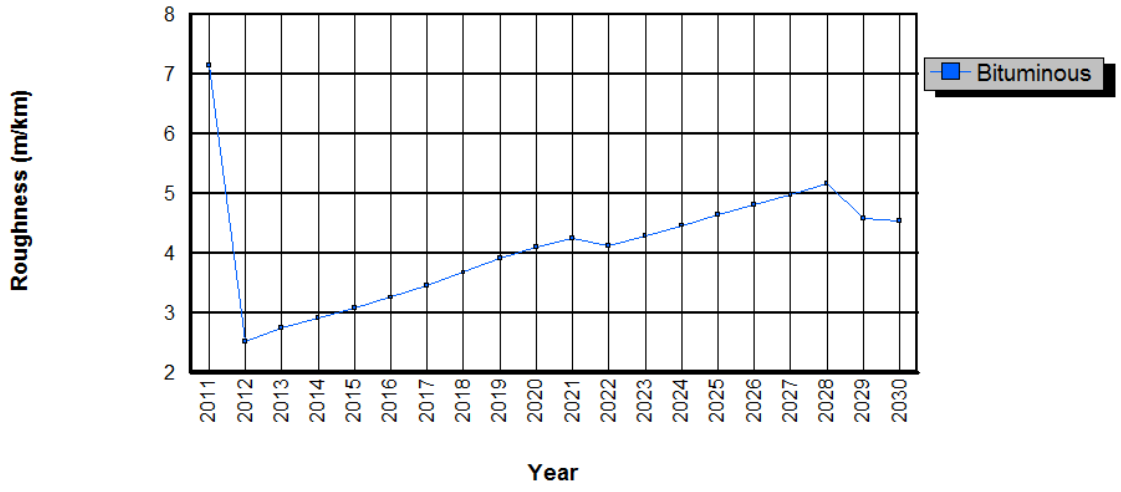
1. Progress of IRI during the project period

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Roughness: Average for Road Network by Pavement Surface (Graph)

Study Name: 9.2-3 non-Overloading with TK by Kenroad
Run Date: 28-03-2011

Annual Average Roughness for each Surface Class of the Unconstrained Work Programme (weighted by length)



2. Optimized Work Programme and Cumulative Maintenance Expenditure

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: 9.2-3 non-Overloading with TK by Kenroad
Run Date: 04-04-2011

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	10300	Bituminous	Reseal at 20% surface d	106.907	0.420	0.420
	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	10300	Bituminous	Reconstruct at 8 IRI	24.509	56.000	56.420
2017	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	12298	Bituminous	Reseal at 20% surface d	106.907	0.420	56.840
2019	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	13047	Bituminous	Reseal at 20% surface d	24.509	2.800	59.640
2023	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	14685	Bituminous	Reseal at 20% surface d	106.907	0.420	60.060
2024	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	15125	Bituminous	Reseal at 20% surface d	24.509	2.800	62.860
2028	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	17024	Bituminous	Reseal at 20% surface d	106.907	0.420	63.280
2029	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	17535	Bituminous	Reseal at 20% surface d	24.509	2.800	66.080

(3) With Overloading Case for Type UB

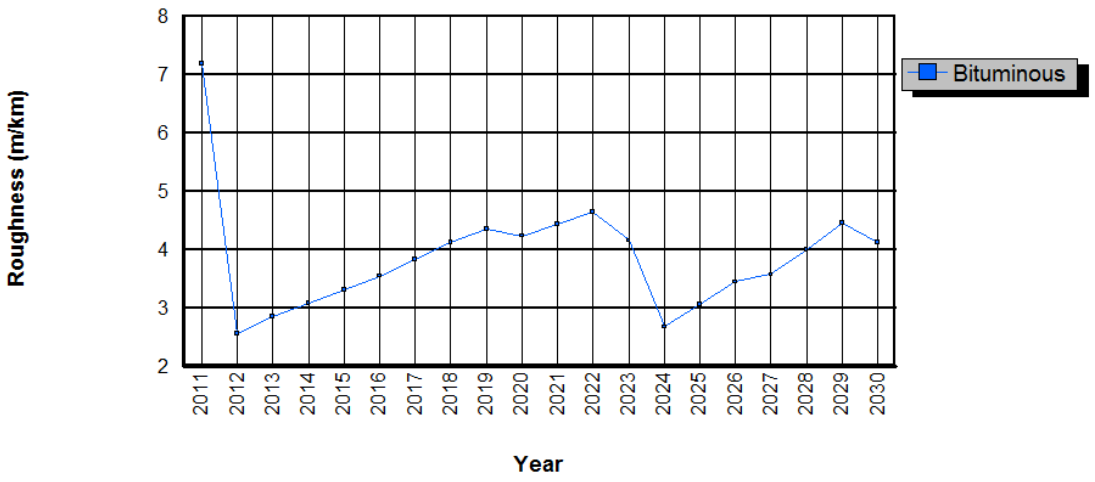
1. Progress of IRI during the project period

H D M - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Roughness: Average for Road Network by Pavement Surface (Graph)

Study Name: 9.1-2 Overloading with UBR by kenroad
Run Date: 22-03-2011

Annual Average Roughness for each Surface Class of the Unconstrained Work Programme (weighted by length)



2. Optimized Work Programme and Cumulative Maintenance Expenditure

H D M - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: 9.1-2 Overloading with UBR by kenroad
Run Date: 04-04-2011

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	10300	Bituminous	Reconstruct at 8 IRI	19.020	56.000	56.000
	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	10300	Bituminous	Overlay 50mm at 5 IRI	15.574	4.200	60.200
2012	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	10609	Bituminous	Reseal at 20% surface d	16.662	1.120	61.320
2017	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	12298	Bituminous	Reseal at 20% surface d	16.662	1.120	62.440
2018	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	12667	Bituminous	Reseal at 20% surface d	19.020	2.800	65.240
2019	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	13047	Bituminous	Overlay 50mm at 5 IRI	15.574	4.200	69.440
2022	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	14257	Bituminous	Overlay 50mm at 5 IRI	16.662	11.200	80.640
2023	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	14685	Bituminous	Overlay 50mm at 5 IRI	19.020	28.000	108.640
2026	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	16047	Bituminous	Overlay 50mm at 5 IRI	15.574	4.200	112.840
2029	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	17535	Bituminous	Overlay 50mm at 5 IRI	16.662	11.200	124.040

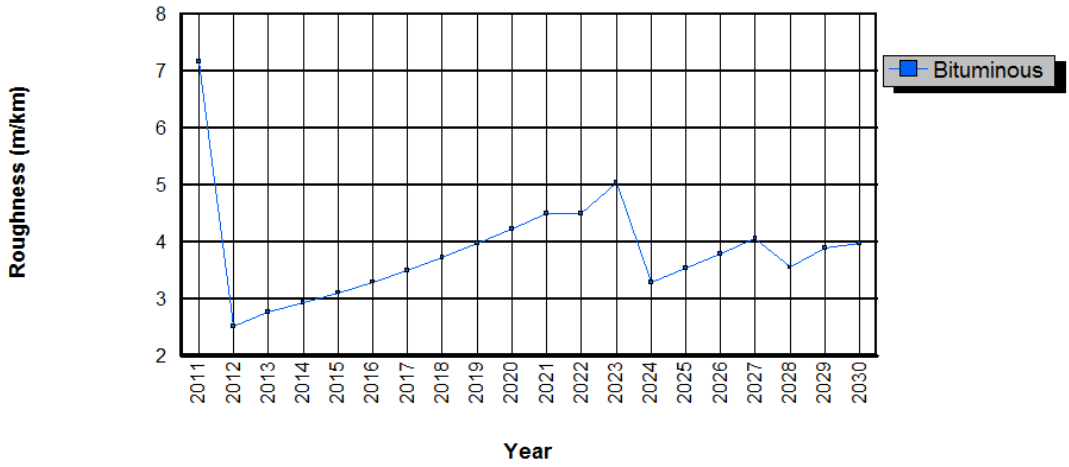
(4) Without Overloading Case for Type UB

1. Progress of IRI during the project period

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Roughness: Average for Road Network by Pavement Surface (Graph)

Study Name: 9.2-2 non-Overloading with UBR by Kenroad
Run Date: 22-03-2011



2. Optimized Work Programme and Cumulative Maintenance Expenditure

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Work Programme Unconstrained by Year

Study Name: 9.2-2 non-Overloading with UBR by Kenroad
Run Date: 05-04-2011

All costs are expressed in: US Dollar (millions)

Year	Section	Road Class	Length (km)	AADT	Surface Class	Work Description	NPV/CAP	Financia Costs	Cum Costs
2011	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	10300	Bituminous	Reconstruct at 8 IRI	19.637	56.000	56.000
	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	10300	Bituminous	Overlay 50mm at 5 IRI	15.539	4.200	60.200
2012	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	10609	Bituminous	Reseal at 20% surface d	28.227	1.120	61.320
2018	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	12667	Bituminous	Reseal at 20% surface d	28.227	1.120	62.440
2021	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	13842	Bituminous	Overlay 50mm at 5 IRI	15.539	4.200	66.640
2023	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	14685	Bituminous	Reseal at 20% surface d	28.227	1.120	67.760
	03_AM_Paved High Traffic Poo	Primary or Trunk	80.0	14685	Bituminous	Overlay 50mm at 5 IRI	19.637	28.000	95.760
2027	01_AM_Paved High Traffic Goo	Primary or Trunk	32.0	16528	Bituminous	Overlay 50mm at 5 IRI	28.227	11.200	106.960
2029	02_AM_Paved High Traffic Fair	Primary or Trunk	12.0	17535	Bituminous	Overlay 50mm at 5 IRI	15.539	4.200	111.160

Appendix F Overloading Charge Estimates, Input Data, and Calculation Results

F.1 Estimation using the Results of the Funding Needs Estimation

Using the input data of the HDM Model for the Funding Needs Estimation by applying Type T loading (low rate of overloading), described in Section 4.3 and Appendix D.1, the sum of the number of ESALs per day at each section and the length of each section (km) of the model road network in this HDM analysis was calculated, which was converted to the total number of ESALs per day for the model road network. Then, assuming 3% annual traffic growth, the total number of ESALs over the 20-year analysis period for each model road network was estimated. The level of responsibility of a vehicle axle for road maintenance cost per ESAL per km was estimated from the road maintenance cost for the analysis period per km calculated in Section 4.3 and the average ESAL for that period. This estimation was conducted for both Power 4.0 Case and Power 4.5 Case as described in Section 4.5.

The data used for this calculation and the calculation results for both the Power 4.0 Case and Power 4.5 Case are presented on the following pages.

F.1.1 Power 4.0 Case (Type T)

Common Assumption of Average ESAL

Vehicle Type	Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle
ESAL	0.00	0.01	0.01	0.80	2.57	2.55	2.49	2.86	4.56

Calculation Result of the Total Number of ESALs*km per Day (2010) and Input Data of HDM Model Used for this Calculation

		Traffic Composition									Road Length (km)				ESALs* km/day (2010)
Country	Traffic Volume	Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle	Good	Fair	Poor	Total	
Kenya	35,657	36.7%	21.0%	28.4%	1.6%	-	7.1%	-	3.1%	2.1%	32	12	80	124	1,696,081
	5,799	23.7%	15.9%	16.8%	2.6%	-	9.1%	-	16.8%	15.0%	276	39	271	586	4,835,055
	1,000	21.5%	22.8%	21.4%	2.0%	-	11.9%	-	11.3%	9.1%	65	92	1,048	1,205	1,281,548
Tanzania	26,396	35.2%	21.7%	21.1%	13.1%	4.6%	-	2.6%	1.3%	0.5%	24	-	-	24	221,565
	9,509	19.0%	24.7%	22.2%	8.1%	6.3%	-	6.9%	5.7%	7.1%	148	82	-	230	1,944,682
	1,203	16.6%	20.7%	11.0%	14.1%	8.4%	-	10.0%	12.7%	6.6%	1,908	344	-	2,252	3,370,676
Burundi	1,836	23.9%	21.7%	13.7%	3.0%	27.1%	-	7.5%	0.3%	2.8%	22	6	0	29	54,797
	636	28.7%	29.7%	18.2%	3.9%	12.2%	-	1.9%	0.5%	5.0%	44	0	0	44	17,854
	311	48.9%	23.5%	3.2%	6.1%	9.4%	-	2.8%	1.0%	5.2%	40	2	0	42	8,294
Rwanda	2,386	10.5%	2.6%	66.7%	1.3%	15.3%	-	2.0%	0.6%	1.0%	42	0	0	42	52,918
	1,368	11.0%	2.0%	71.2%	1.1%	10.7%	-	1.5%	1.1%	1.2%	42	0	0	42	23,817
	1,097	9.2%	1.4%	73.2%	1.5%	10.1%	-	1.5%	1.4%	1.7%	35	0	0	35	16,677
	3,020	31.6%	4.1%	59.2%	0.3%	4.0%	-	0.5%	0.1%	0.2%	4	0	0	4	1,476
	104	21.4%	3.1%	45.9%	6.1%	4.1%	-	9.2%	3.1%	7.1%	28	2	0	30	2,464
	3,038	15.8%	3.2%	45.8%	1.0%	25.1%	-	5.1%	2.4%	1.5%	8	0	0	8	21,989
	1,012	10.5%	8.7%	49.2%	2.9%	12.9%	-	5.1%	5.9%	4.8%	16	0	0	16	14,379
	836	11.1%	8.7%	43.2%	3.6%	14.6%	-	6.7%	6.6%	5.4%	23	0	0	23	19,409
	561	11.9%	0.9%	35.5%	5.7%	16.9%	-	10.1%	10.7%	8.3%	27	0	2	28	22,617
	4,334	18.1%	9.6%	61.3%	3.1%	5.5%	-	0.4%	1.9%	0.2%	9	0	0	9	9,743
	4,334	18.1%	9.6%	61.3%	3.1%	5.5%	-	0.4%	1.9%	0.2%	17	0	0	17	17,442
	2,093	12.0%	4.3%	61.7%	2.1%	15.1%	-	0.8%	3.6%	0.3%	31	0	0	31	35,896
	1,506	13.1%	3.2%	72.7%	2.5%	8.2%	-	0.1%	0.1%	0.0%	3	0	0	3	1,241
	1,632	10.2%	15.6%	54.6%	5.9%	7.8%	-	0.4%	5.0%	0.4%	14	0	0	14	9,805

Country	Traffic Volume	Traffic Composition									Road Length (km)				ESALs* km/day (2010)
		Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle	Good	Fair	Poor	Total	
	944	9.5%	3.9%	59.2%	0.1%	17.4%	-	0.3%	9.0%	0.5%	25	7	0	32	22,334
	509	5.5%	2.8%	53.8%	0.6%	19.4%	-	0.8%	16.1%	1.0%	11	0	0	11	5,620
	387	6.7%	2.1%	61.5%	0.3%	12.9%	-	0.8%	14.5%	1.3%	9	1	0	10	3,229
	365	8.5%	2.8%	48.6%	0.0%	4.9%	-	4.2%	27.5%	3.5%	27	12	0	39	16,770
	628	9.7%	6.1%	65.8%	4.9%	9.7%	-	1.0%	1.6%	1.3%	25	2	0	27	7,054
	479	6.7%	2.1%	66.7%	1.3%	16.9%	-	1.7%	2.5%	2.1%	26	0	0	26	8,310
	184	9.2%	3.2%	57.3%	3.8%	13.5%	-	5.9%	4.3%	2.7%	28	24	11	63	8,978
	481	7.7%	1.7%	59.8%	3.1%	17.8%	-	3.7%	2.9%	3.3%	5	14	8	26	10,128
	616	30.2%	4.2%	46.3%	0.0%	14.8%	-	1.0%	1.6%	1.8%	5	0	0	5	1,587
Uganda	13,908	27.5%	23.6%	29.1%	1.2%	6.8%	-	7.7%	0.5%	3.5%	46	38	1	84	653,432
	2,245	18.4%	22.2%	22.6%	4.3%	8.1%	-	12.7%	1.6%	10%	427	268	55	750	1,801,684

Calculation Result of the Total Number of ESALs for the Model Road Network for 20 years (2010-2030)

Year	Total ESALs for 20 Years				
	Kenya	Tanzania	Burundi	Rwanda	Uganda
2010	1,489,102	806,455	257,180	226,124	1,074,239
2011	1,533,775	830,649	264,895	232,908	1,106,466
2012	1,579,788	855,568	272,842	239,895	1,139,660
2013	1,627,181	881,235	281,027	247,092	1,173,850
2014	1,675,997	907,672	289,458	254,505	1,209,066
2015	1,726,277	934,903	298,142	262,140	1,245,338
2016	1,778,065	962,950	307,086	270,004	1,282,698
2017	1,831,407	991,838	316,299	278,104	1,321,179
2018	1,886,349	1,021,593	325,788	286,447	1,360,814
2019	1,942,940	1,052,241	335,561	295,041	1,401,638
2020	2,001,228	1,083,808	345,628	303,892	1,443,688
2021	2,061,265	1,116,323	355,997	313,009	1,486,998
2022	2,123,103	1,149,812	366,677	322,399	1,531,608
2023	2,186,796	1,184,307	377,677	332,071	1,577,556
2024	2,252,400	1,219,836	389,007	342,033	1,624,883

Year	Total ESALs for 20 Years				
	Kenya	**Tanzania**	**Burundi**	**Rwanda**	**Uganda**
2025	2,319,972	1,256,431	400,678	352,294	1,673,630
2026	2,389,571	1,294,124	412,698	362,863	1,723,838
2027	2,461,258	1,332,948	425,079	373,749	1,775,554
2028	2,535,096	1,372,936	437,831	384,961	1,828,820
2029	2,611,149	1,414,124	450,966	396,510	1,883,685
Total (20 years)	**40,012,715**	**21,669,755**	**6,910,515**	**6,076,037**	**28,865,207**

Responsibility of a Vehicle Axle per ESAL for Road Maintenance Cost

Country	M. Cost ($) ('10-'30)	Road Length (km)	M. Cost (US$)/ km ('10-'30)	ESALs*km/day (2010)	Total ESALs/day (2010)	Total ESALs ('10-'30) with 3% annual traffic growth	M. Cost (US$)/ ESAL/km)	M. Cost (US$)/ ESAL/100 km
Kenya	1,266,200,000	1,915	661201.04	7,812,683	4,080	40,012,715	0.0165	1.65
Tanzania	1,163,000,000	2,506	464086.19	5,536,923	2,209	21,669,755	0.0214	2.14
Burundi	20,200,000	115	175835.65	80,945	705	6,910,515	0.0254	2.54
Rwanda	64,800,000	539	120235.35	333,885	620	6,076,037	0.0198	1.98
Uganda	451,600,000	834	541364.78	2,455,116	2,943	28,865,207	0.0188	1.88
Average	**-**	**-**	**392,544.60**	3,243,910	**2,111**	**20,706,846**	**0.0204**	**2.04**

F.1.2 Power 4.5 Case (Type T)

Common Assumption of Average ESAL

Vehicle Type	Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle
ESAL	0.00	0.01	0.01	0.68	2.76	2.68	2.49	2.85	4.49

Calculation Result of the Total Number of ESALs*km per Day (2010) and Input Data of HDM Model Used for this Calculation

		Traffic Composition									Road Length (km)				ESALs* km/day (2010)
Country	Traffic Volume	Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle	Good	Fair	Poor	Total	
Kenya	35,657	36.7%	21.0%	28.4%	1.6%	-	7.1%	-	3.1%	2.1%	32	12	80	124	1,710,391
	5,799	23.7%	15.9%	16.8%	2.6%	-	9.1%	-	16.8%	15.0%	276	39	271	586	4,820,430
	1,000	21.5%	22.8%	21.4%	2.0%	-	11.9%	-	11.3%	9.1%	65	92	1,048	1,205	1,286,470
Tanzania	26,396	35.2%	21.7%	21.1%	13.1%	4.6%	-	2.6%	1.3%	0.5%	24	-	-	24	215,128
	9,509	19.0%	24.7%	22.2%	8.1%	6.3%	-	6.9%	5.7%	7.1%	148	82	-	230	1,932,229
	1,203	16.6%	20.7%	11.0%	14.1%	8.4%	-	10.0%	12.7%	6.6%	1,908	344	-	2,252	3,346,105
Burundi	1,836	23.9%	21.7%	13.7%	3.0%	27.1%	-	7.5%	0.3%	2.8%	22	6	0	29	57,031
	636	28.7%	29.7%	18.2%	3.9%	12.2%	-	1.9%	0.5%	5.0%	44	0	0	44	18,196
	311	48.9%	23.5%	3.2%	6.1%	9.4%	-	2.8%	1.0%	5.2%	40	2	0	42	8,364
Rwanda	2386	10.5%	2.6%	66.7%	1.3%	15.3%	-	2.0%	0.6%	1.0%	42	0	0	42	55,197
	1368	11.0%	2.0%	71.2%	1.1%	10.7%	-	1.5%	1.1%	1.2%	42	0	0	42	24,612
	1097	9.2%	1.4%	73.2%	1.5%	10.1%	-	1.5%	1.4%	1.7%	35	0	0	35	17,135
	3020	31.6%	4.1%	59.2%	0.3%	4.0%	-	0.5%	0.1%	0.2%	4	0	0	4	1,517
	104	21.4%	3.1%	45.9%	6.1%	4.1%	-	9.2%	3.1%	7.1%	28	2	0	30	2,442
	3038	15.8%	3.2%	45.8%	1.0%	25.1%	-	5.1%	2.4%	1.5%	8	0	0	8	22,971
	1012	10.5%	8.7%	49.2%	2.9%	12.9%	-	5.1%	5.9%	4.8%	16	0	0	16	14,600
	836	11.1%	8.7%	43.2%	3.6%	14.6%	-	6.7%	6.6%	5.4%	23	0	0	23	19,710
	561	11.9%	0.9%	35.5%	5.7%	16.9%	-	10.1%	10.7%	8.3%	27	0	2	28	22,866
	4334	18.1%	9.6%	61.3%	3.1%	5.5%	-	0.4%	1.9%	0.2%	9	0	0	9	9,845
	4334	18.1%	9.6%	61.3%	3.1%	5.5%	-	0.4%	1.9%	0.2%	17	0	0	17	17,625
	2093	12.0%	4.3%	61.7%	2.1%	15.1%	-	0.8%	3.6%	0.3%	31	0	0	31	37,297
	1506	13.1%	3.2%	72.7%	2.5%	8.2%	-	0.1%	0.1%	0.0%	3	0	0	3	1,284
	1632	10.2%	15.6%	54.6%	5.9%	7.8%	-	0.4%	5.0%	0.4%	14	0	0	14	9,870

Country	Traffic Volume	Traffic Composition									Road Length (km)				ESALs* km/day (2010)
		Cars	Pickup	Small Bus	Bus	2 Axle	2.5 Axle	3 Axle	4.5 Axle	6 Axle	Good	Fair	Poor	Total	
	944	9.5%	3.9%	59.2%	0.1%	17.4%	-	0.3%	9.0%	0.5%	25	7	0	32	23,154
	509	5.5%	2.8%	53.8%	0.6%	19.4%	-	0.8%	16.1%	1.0%	11	0	0	11	5,780
	387	6.7%	2.1%	61.5%	0.3%	12.9%	-	0.8%	14.5%	1.3%	9	1	0	10	3,298
	365	8.5%	2.8%	48.6%	0.0%	4.9%	-	4.2%	27.5%	3.5%	27	12	0	39	16,779
	628	9.7%	6.1%	65.8%	4.9%	9.7%	-	1.0%	1.6%	1.3%	25	2	0	27	7,177
	479	6.7%	2.1%	66.7%	1.3%	16.9%	-	1.7%	2.5%	2.1%	26	0	0	26	8,621
	184	9.2%	3.2%	57.3%	3.8%	13.5%	-	5.9%	4.3%	2.7%	28	24	11	63	9,151
	481	7.7%	1.7%	59.8%	3.1%	17.8%	-	3.7%	2.9%	3.3%	5	14	8	26	10,421
	616	30.2%	4.2%	46.3%	0.0%	14.8%	-	1.0%	1.6%	1.8%	5	0	0	5	1,656
Uganda	13,908	27.5%	23.6%	29.1%	1.2%	6.8%	-	7.7%	0.5%	3.5%	46	38	1	84	660,697
	2,245	18.4%	22.2%	22.6%	4.3%	8.1%	-	12.7%	1.6%	10%	427	268	55	750	1,803,071

Calculation Result of the Total Number of ESALs for the Model Road Network for 20 years (2010–2030)

Year	Total ESALs for 20 Years				
	Kenya	Tanzania	Burundi	Rwanda	Uganda
2010	1,489,980	800,125	265,586	232,301	1,078,025
2011	1,534,679	824,129	273,553	239,270	1,110,366
2012	1,580,720	848,853	281,760	246,448	1,143,677
2013	1,628,141	874,318	290,213	253,841	1,177,987
2014	1,676,985	900,548	298,919	261,456	1,213,327
2015	1,727,295	927,564	307,887	269,300	1,249,726
2016	1,779,114	955,391	317,123	277,379	1,287,218
2017	1,832,487	984,053	326,637	285,701	1,325,835
2018	1,887,462	1,013,574	336,436	294,272	1,365,610
2019	1,944,086	1,043,982	346,529	303,100	1,406,578
2020	2,002,408	1,075,301	356,925	312,193	1,448,775
2021	2,062,481	1,107,560	367,633	321,558	1,492,239
2022	2,124,355	1,140,787	378,662	331,205	1,537,006
2023	2,188,086	1,175,011	390,022	341,141	1,583,116
2024	2,253,728	1,210,261	401,722	351,376	1,630,609

Year	Total ESALs for 20 Years				
	Kenya	**Tanzania**	**Burundi**	**Rwanda**	**Uganda**
2025	2,321,340	1,246,569	413,774	361,917	1,679,528
2026	2,390,980	1,283,966	426,187	372,774	1,729,914
2027	2,462,710	1,322,485	438,973	383,958	1,781,811
2028	2,536,591	1,362,159	452,142	395,476	1,835,265
2029	2,612,689	1,403,024	465,706	407,341	1,890,323
Total (20 years)	**40,036,315**	**21,499,660**	**7,136,390**	**6,242,006**	**28,966,934**

Responsibility of a Vehicle Axle per ESAL for Road Maintenance Cost

Country	M. Cost ($) ('10-'30)	Road Length (km)	M. Cost (US$)/km ('10-'30)	ESALs*km/day (2010)	Total ESALs/ day (2010)	Total ESALs ('10-'30) with 3% annual traffic growth	M. Cost (US$)/ ESAL/km)	M. Cost (US$)/ ESAL/100km
Kenya	1,266,200,000	1,915	661201.04	7,817,291	4,082	40,036,315	0.0165	1.65
Tanzania	1,163,000,000	2,506	464086.19	5,493,461	2,192	21,499,660	0.0216	2.16
Burundi	20,200,000	115	175835.65	83,590	728	7,136,390	0.0246	2.46
Rwanda	64,800,000	539	120235.35	343,005	636	6,242,006	0.0193	1.93
Uganda	451,600,000	834	541364.78	2,463,768	2,953	28,966,934	0.0187	1.87
Average	**-**	**-**	**392,544.60**	**3,240,223**	**2,118**	**20,776,261**	**0.0201**	**2.01**

F.2 Estimation Using the Results of the Analysis With/Without Overloading

For both Types T (low rate of overloading) and UB (high rate overloading), overloaded axles were extracted from the axles of all vehicles weighed at sample weighbridge stations, and the sum of the overloaded proportion of ESALs of those overloaded axles (i.e., the sum of the difference between the ESALs of overloaded axles and ESALs at the axle load limits) by number of axles by vehicle type were calculated. Then, adapting the sum of the overloaded proportion of ESALs to the number of vehicles weighed, the sum of the overloaded proportion of ESALs per day under the assumptions of with/without HDM-4 analysis, described in Section 4.4 and Appendix D.2, was estimated. Converting the total overloaded proportion of ESALs per day to a 20-year period with 3% annual traffic growth, the overloaded proportion of ESALs of the "target" section of 124 km in the analysis period was calculated. Finally, the level of responsibility of an overloaded axle for road maintenance cost per overloaded proportion of ESAL per km was estimated from the difference of the road maintenance cost between the with and without cases, and the total overloaded proportion of ESALs of overloaded axles described above.

The data used for this calculation and calculation results for both Types T and UB are as follows.

F.2.1 Type T

Sum of Overloaded Portion of ESALs of Overloaded Axles (Actual Data from Tanzania)

Vehicle	Configuration	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Total	# of Vehicles Weighted
2 Axle	1*2	5.88	116.81	-	-	-	-	122.69	194
3 Axle	1*22	7.03	14.39	14.39	-	-	-	35.80	75
4 Axle	11*22	1.94	3.63	0.00	0.00	-	-	5.58	19
5 Axle	1*2-222	0.00	0.00	1.53	7.78	7.78		17.10	6
6 Axle	1*22-222	2.04	32.29	32.29	49.40	48.26	48.26	212.55	145
Total	-	-	-	-	-	-	-	**393.71**	**439**

Sum of Overloaded Proportion of ESALs of Overloaded Axles per Day (2010) under the Assumption of With/Without Analysis

Vehicle	Configuration	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Total	ADT by Vehicle Category
2 Axle	1*2	0.65	56.33	-	-	-	-	56.98	380
3 Axle	1*22	1.11	12.13	12.13	-	-	-	25.37	150
4 Axle	11*22	0.96	3.75	0.00	0.00	-	-	4.72	38
5 Axle	1*2-222	0.00	0.00	1.21	10.02	10.02	-	21.25	12
6 Axle	1*22-222	0.43	30.45	30.45	15.14	14.67	14.67	105.80	320
Total	-	-	-	-	-	-	-	**214.11**	**900**

Sum of Overloaded Proportion of ESALs of Overloaded Axles for 20 years (2010-2029) under the Assumption of With/Without Analysis

Year	Overloaded ESALs (with 3% annual traffic growth)
2010	78,150
2011	80,494
2012	82,909
2013	85,397
2014	87,958
2015	90,597
2016	93,315
2017	96,115
2018	98,998
2019	101,968
2020	105,027
2021	108,178
2022	111,423
2023	114,766
2024	118,209
2025	121,755
2026	125,408
2027	129,170
2028	133,045
2029	137,036
Total (20 years)	**2,099,919**

Responsibility of Overloaded Proportion of ESALs for Road Maintenance Cost

Maintenance Cost for 20 years (US$)			Responsibility per Overloaded Axle	
With Case	**Without Case**	**With - Without**	**(US$/124km/ESAL)**	**(US$/km/ESAL)**
111,160,000	91,560,000	19,600,000	9.333694095	0.075271727

F.2.2 Type UB

Sum of Overloaded Proportion of ESALs of Overloaded Axles (Actual Data from Mbarara and Masaka Weighbridges)

Vehicle	Configuration	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Total	# of Vehicles Weighted
2 Axle	1*2	275.48	7,852.28	-	-	-	-	8,127.76	2,271
3 Axle	1*22	712.55	10,503.30	4,213.53	-	-	-	15,429.38	3,293
4 Axle	11*22	35.71	110.22	213.42	107.25	-	-	466.60	276
5 Axle	1*2-222	22.24	1,271.12	290.47	166.69	189.23	-	1,939.75	539
6 Axle	1*22-222	238.58	3,444.38	5,694.74	2,957.85	2,363.29	2,491.09	17,189.93	4,699
Total	-	-	-	-	-	-	-	**43,153.42**	**11,078**

Sum of Overloaded Proportion of ESAL of Overloaded Axles per Day (2010) under the Assumption of With/Without Analysis

Vehicle	Configuration	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Total	ADT by Vehicle Category
2 Axle	1*2	12.53	368.45	-	-	-	-	380.98	180
3 Axle	1*22	21.72	715.97	252.80	-	-	-	990.50	260
4 Axle	11*22	1.19	7.40	8.56	2.65	-	-	19.81	20
5 Axle	1*2-222	0.41	54.52	13.28	5.94	6.92	-	81.07	40
6 Axle	1*22-222	7.95	188.11	320.95	186.21	117.97	129.48	950.67	400
Total	-	-	-	-	-	-	-	**2,423.02**	**900**

Sum of Overloaded Proportion of ESALs of Overloaded Axles for 20 years (2010–2029) under the Assumption of With/Without Analysis

Year	Overloaded ESAL (with 3% annual traffic growth)
2010	884,403
2011	910,936
2012	938,264
2013	966,412
2014	995,404
2015	1,025,266
2016	1,056,024
2017	1,087,705
2018	1,120,336
2019	1,153,946
2020	1,188,564
2021	1,224,221
2022	1,260,948
2023	1,298,776
2024	1,337,740
2025	1,377,872
2026	1,419,208
2027	1,461,784
2028	1,505,638
2029	1,550,807
Total (20 years)	**23,764,253**

Responsibility of Overloaded Proportion of ESALs for Road Maintenance Cost

Maintenance Cost for 20 years (US$)			Responsibility per Overloaded Axle	
With Case	Without Case	With - Without	(US$/ 124km/ ESAL)	(US$/ km/ ESAL)
124,040,000	111,160,000	12,880,000	0.541990535	0.004370891

Appendix G Axle Load Limit Analysis, Input Data, and Modelling Results

(1) Axle Load and GVM Specifications of an "Ideal" Vehicle for a Various ESALs

1) ESAL=6

Vehicle	Configurati	No.1	No.2	No.3	No.4	No.5	No.6	No.7	GVW	ESAL	GVM	ESAL	total carryin	vehicle number		ratio
2 Axle	1*2	6000	8000						14000	1.22	12908	1.025008	3195350	248	2axle	41.5%
3 Axle	1*22	6000	6000	6000					18000	0.88	16596	0.739101	1684200	101	3axle	17.0%
4 Axle	11*22	4000	4000	6000	6000				20000	0.70	18440	0.590064	510750	28	4-5axle	6.0%
5 Axle	1*2-222	6000	8000	6000	6000	6000			32000	2.10	29504	1.764108	231000	8	6axle	35.5%
6 Axle	1*22-222	6000	6000	6000	6000	6000	6000		36000	1.76	33192	1.478201	6384900	192		
7 Axle	1*22+22*2	6000	6000	6000	6000	6000	6000	6000	42000	2.05	38724	1.724568	745350	19		

2) ESAL=8

Vehicle	Configurati	No.1	No.2	No.3	No.4	No.5	No.6	No.7	GVW	ESAL	GVM	ESAL	total carryin	vehicle number		ratio
2 Axle	1*2	8000	10000						18000	3.18	16596	2.67962	3195350	193	2axle	42.5%
3 Axle	1*22	8000	8000	8000					24000	2.77	22128	2.335923	1684200	76	3axle	16.8%
4 Axle	11*22	6000	6000	8000	8000				28000	2.43	25816	2.050016	510750	20	4-5axle	5.7%
5 Axle	1*2-222	8000	10000	8000	8000	8000			42000	5.96	38724	5.015543	231000	6	6axle	35.0%
6 Axle	1*22-222	8000	8000	8000	8000	8000	8000		48000	5.55	44256	4.671846	6384900	144		
7 Axle	1*22+22*2	8000	8000	8000	8000	8000	8000	8000	56000	6.47	51632	5.450487	745350	14		

3) ESAL=10

Vehicle	Configurati	No.1	No.2	No.3	No.4	No.5	No.6	No.7	GVW	ESAL	GVM	ESAL	total carryin	vehicle number		ratio
2 Axle	1*2	10000	12000						22000	6.94	20284	5.842849	3195350	158	2axle	43.1%
3 Axle	1*22	10000	10000	10000					30000	6.77	27660	5.702937	1684200	61	3axle	16.7%
4 Axle	11*22	8000	8000	10000	10000				36000	6.36	33192	5.35924	510750	15	4-5axle	5.5%
5 Axle	1*2-222	10000	12000	10000	10000	10000			52000	13.71	47944	11.54579	231000	5	6axle	34.7%
6 Axle	1*22-222	10000	10000	10000	10000	10000	10000		60000	13.55	55320	11.40587	6384900	115		
7 Axle	1*22+22*2	10000	10000	10000	10000	10000	10000	10000	70000	15.80	64540	13.30685	745350	12		

4) ESAL=12

Vehicle	Configurati	No.1	No.2	No.3	No.4	No.5	No.6	No.7	GVW	ESAL	GVM	ESAL	total carryin	vehicle number		ratio
2 Axle	1*2	12000	14000						26000	13.35	23972	11.24467	3195350	133	2axle	43.5%
3 Axle	1*22	12000	12000	12000					36000	14.04	33192	11.82561	1684200	51	3axle	16.6%
4 Axle	11*22	10000	10000	12000	12000				44000	13.88	40568	11.6857	510750	13	4-5axle	5.4%
5 Axle	1*2-222	12000	14000	12000	12000	12000			62000	27.40	57164	23.07028	231000	4	6axle	34.5%
6 Axle	1*22-222	12000	12000	12000	12000	12000	12000		72000	28.09	66384	23.65122	6384900	96		
7 Axle	1*22+22*2	12000	12000	12000	12000	12000	12000	12000	84000	32.77	77448	27.59309	745350	10		

5) ESAL=14

Vehicle	Configurati	No.1	No.2	No.3	No.4	No.5	No.6	No.7	GVW	ESAL	GVM	ESAL	total carryin	vehicle number		ratio
2 Axle	1*2	14000	16000						30000	23.47	27660	19.76106	3195350	116	2axle	43.8%
3 Axle	1*22	14000	14000	14000					42000	26.02	38724	21.9084	1684200	43	3axle	16.5%
4 Axle	11*22	12000	12000	14000	14000				52000	26.71	47944	22.48934	510750	11	4-5axle	5.4%
5 Axle	1*2-222	14000	16000	14000	14000	14000			72000	49.49	66384	41.66946	231000	3	6axle	34.4%
6 Axle	1*22-222	14000	14000	14000	14000	14000	14000		84000	52.04	77448	43.8168	6384900	82		
7 Axle	1*22+22*2	14000	14000	14000	14000	14000	14000	14000	98000	60.71	90356	51.1196	745350	8		

(2) HDM Results for the ADT 10,000 Case

1. IRI 4 ESAL 6 case
2. IRI 4 ESAL 8 case
3. IRI 4 ESAL 10 case
4. IRI 4 ESAL 12 case
5. IRI 4 ESAL 14 case
6. IRI 7 ESAL 6 case
7. IRI 7 ESAL 8 case
8. IRI 7 ESAL 10 case
9. IRI 7 ESAL 12 case
10. IRI 7 ESAL 14 case

(3) HDM Results for the ADT 10,000 Case

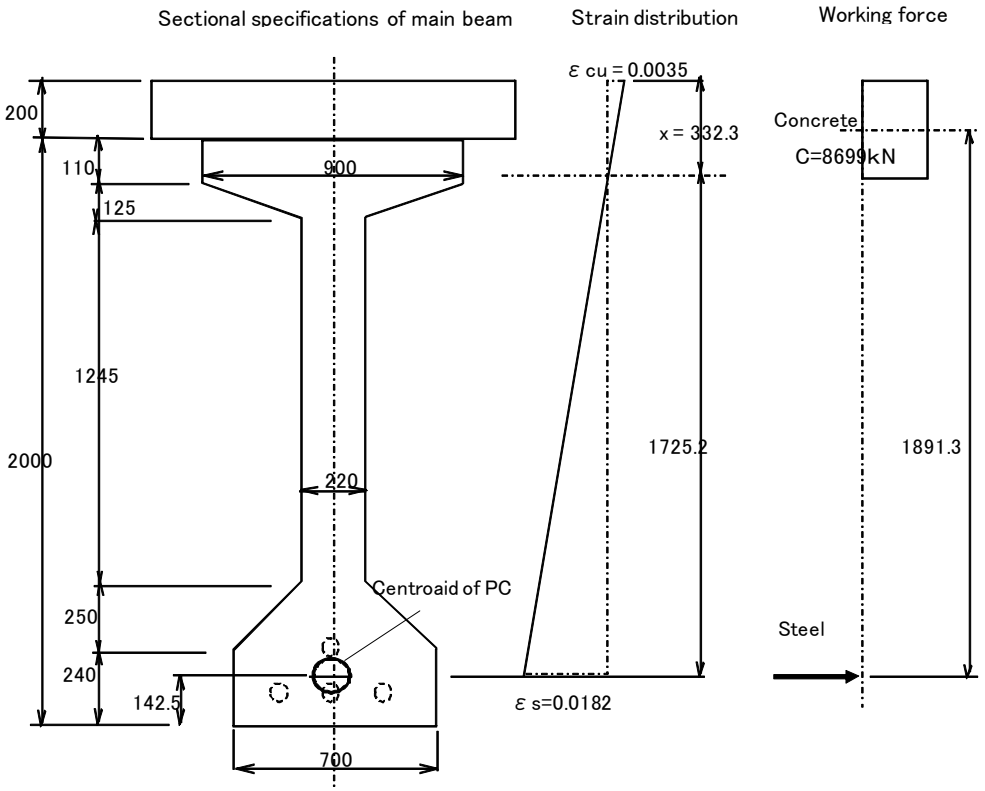
1. IRI 4 ESAL 6 case
2. IRI 4 ESAL 8 case
3. IRI 4 ESAL 10 case
4. IRI 4 ESAL 12 case
5. IRI 4 ESAL 14 case
6. IRI 7 ESAL 6 case
7. IRI 7 ESAL 8 case
8. IRI 7 ESAL 10 case
9. IRI 7 ESAL 12 case
10. IRI 7 ESAL 14 case

(4) HDM Results for the ADT 10,000 Case

1. IRI 4 ESAL 6 case
2. IRI 4 ESAL 8 case
3. IRI 4 ESAL 10 case
4. IRI 4 ESAL 12 case
5. IRI 4 ESAL 14 case
6. IRI 7 ESAL 6 case
7. IRI 7 ESAL 8 case
8. IRI 7 ESAL 10 case
9. IRI 7 ESAL 12 case
10. IRI 7 ESAL 14 case

Appendix H Bridge Strength Evaluation Data

Consideration on the ultimate limit state (main beam at the center of bridge span) was based on the following:



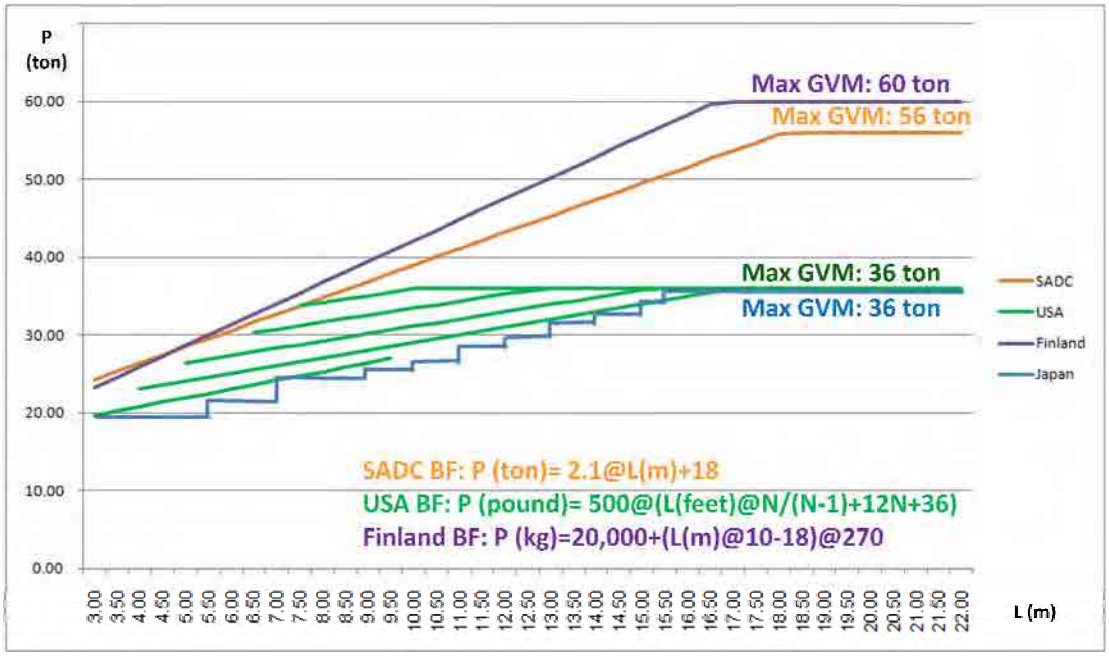
Calculation of resisting bending moment

d	Effective Hight	mm	2057.5
W1	Compression Flunge	mm	2450
t1	Thickness of Slab	mm	200
W2	Thickness of Web	mm	220
x	Neutral Axis from Top	mm	332.3
σck	Concrete Slab	N/mm2	30
σck	Concrete Beam	N/mm2	40
εcu	Stress Limitation of Conc		0.0035
A	Resistance area	mm2	609070
C=0.67/1.5*fcu*A			
=0.447fcu*A		kN	8699.9
Ep	Young Modulous Steel	N/mm2	200000
Ap	Area of PC tendon	mm2	5376
εs	(Traial calculation)		0.182
	σpu	N/mm2	1860
T	T=0.87σpu*Ap	kN	8699.44
	Z=d-0.5x	mm	1891.35
Mr	Mrc=C*Z	kNm	16454.6
	Mrt=T*Z	kNm	16453.7

Appendix I Comparison of Bridges Formulas in the World and Historical Course of Events Leading to SADC Axle Load Limits

I.1 Comparison of Bridge Formulas in the World

Figure I-1 presents a comparison of bridge formulas in the world.



P: GVM limit; L: extreme axle spacing; N: number of axles
* Japan does not have a bridge formula but stipulates GVM limits for ranges of max wheelbase.

Figure I-1: Comparison of Bridge Formulas in the World

I.2 Historical Course of Events Leading to SADC Axle Load Limits and the Bridge Formula

Generally axle mass limits in Africa are low in relation to international practice, while gross vehicle/combination mass limits are higher. The historical development of these limits is set out in this appendix.

(1) Origins of Single, Tandem, and Tridem Axle Mass Limits

For many years in South Africa, the single axle mass limit for an axle with dual tyres was set at 8.2 tonnes,[1] while limit for a tandem axle unit was set at 16.4 tonnes (i.e., 8.2 tonnes × 2). Also, historically (i.e., prior to the introduction of a bridge formula in South Africa in the early 1970s), the tridem axle unit was 24.6 tonnes (i.e., 8.2 tonnes × 3). With the application of the bridge formula, the axle load limit for the tridem axle unit with an extreme axle spacing of 2.72 m was set at 20.9 tonnes.[2]

[1] The limit for the rear axle of a bus was set higher at 10.2 tonnes, perhaps because the government owned railway buses.
[2] However, in many parts of South Africa, the bridge formula was not applied and a load limit of 24.6 tonnes was applied for the tridem axle unit.

Early international studies showed that an axle with air suspension caused 15% less road wear than an axle with a steel suspension, presupposing (of course) that the shock absorbers in the air suspension were working efficiently. Furthermore, on average, under dynamic conditions, single axle loadings varied by plus or minus 25% of the static load, while axles in tandem axle units varied by 15%. Axles in tridem axle units generally caused less road deterioration than axles in tandem axle units. In fact, it was shown that axles in a well-designed tridem axle unit caused less road wear than single axles.[3]

A number of significant studies, working group reports, and symposia relating to axle mass limits were undertaken in Africa and globally between 1986 and 1993 as summarized below:

C.R. Freeme, Simplification of Regulations, June[4] 1986

High tyre pressures (around 1,000 kilopascals) can reduce pavement life by 60%–70%.

Canadian Vehicle Weights and Dimensions Study, 1986

Recommendations were limits of 10 tonnes for single, 17 tonnes for tandem, and 24 tonnes for tridem axle units.

Council of Ministers, Canada, 1988

Noted the following existing regulations:

(i) steering 5.5 tonnes (long nose);
(ii) single with duals, 9.1 tonnes;
(iii) tandem with duals, 17.0 tonnes (1.2–1.85 m spacing); and
(iv) tridem with duals, 21.0 tonnes (2.4–3.0 m) spacing, 23.0 tonnes (3.0–3.6m), and 24.0 tonnes (3.6–3.7m).

South African Technical Working Group, May 1991

The recommendations from this Working Group were to:

(i) increase the articulated vehicle length from 17.0 to 18.5 m, for increased efficiency without causing any real detriment; and
(ii) increase the vehicle combination length from 20 m to 22 m, for increased efficiency without causing any real detriment.

Van Wyk & Louw Inc., Consequences in the Increases of Legal Axle Loads, September 1991

Recommendations from this study were as follows:

(i) There was economic justification to increase the legal load limits.
(ii) Although limits of 10.2 tonnes (single), 20.4 tonnes (tandem), and 24 tonnes (tridem) offered the highest benefit/cost ratios, load limits of 10 tonnes, 18 tonnes, and 21 tonnes, respectively, were recommended.

South African Department of Transport Working Group on Dimensions and Loads, February 1992

The road transport industry recommended load limits of 10 tonnes (single), 18 tonnes (tandem), 24 tonnes (tridem), and 56 tonnes (gross vehicle/combination mass), as it could be shown that

[3] NITRR Technical Note TP/39/86, Council for Scientific and Industrial Research (CSIR), 1986.
[4] Months cited where available.

there would be a financial net benefit to the country if mass limits were increased. A regulation was drafted that would increase axle mass limits on the condition that overloading was being reduced and additional funds were being appropriated for increased road maintenance. The increases agreed were 9, 18 and 21 tonnes, respectively. The Working Group agreed that these limits would be reviewed with long-term application the ultimate goal.

Third International Symposium on Heavy Vehicle Weights, United Kingdom, August 1992

Most delegates at this symposium spoke of 24 tonnes as the optimum for a tridem axle unit, irrespective of other axle limitations. The United Kingdom was undertaking a bridge strengthening program to allow for a 24-tonne tridem.

Carl Bro International, Axle Load Study for Southern Africa, May 1993

The objective was to harmonize load limits in Southern Africa. The main outcome was an estimated optimum mass limit for the single axle with dual tyres of 13 tonnes; however, allowing a safety margin, 12 tonnes was recommended. Since the Highway Design and Maintenance Standards Model (HDM-III) assumed that 15.1 tonnes on a tandem axle was equivalent to 2 equivalent standard axles (ESAs)[5] for road wear, 24/15.1 for a tandem axle unit was found to be roughly equal to 13/8.16 for a single axle. Hence, 24 tonnes was estimated as the correct loading for a tandem axle unit. The optimum single, tandem, and tridem limits varied from 12, 17, and 24 tonnes, to 12, 22, and 33 tonnes. The consultants recommended a compromise between the two, presumably 12, 19.5, and 28.5 tonnes, although no figures were given.

(2) Origins of the SADC Bridge Formula

The origins of the bridge formula may be traced from the 1970s to the 1990s, as below. It is on this basis that SADC has been guiding the region forward, as also described at the end of this subsection.

Origin of the 1.8 × L + 16,000 Bridge Formula, 1970–71

In 1970–71 the South African Department of Transport formed a committee chaired by E.B. Cloete to update existing load regulations to protect the nation's bridges. While the committee found that South Africa needed to follow act to protect its bridges as did overseas countries, the committee also found that the overseas systems were very complex. For example, the United States formula was $W = 500 \times (L \times N/(N - 1) + 12N + 36)$, where L was the spacing in feet, N being the number of axles, and W the weight in pounds. Therefore, a simpler formula was required and N.O. Marriott of the Cape Provincial Administration and a member of the committee came up with a solution. He placed two reference points on a graph of allowable mass (y axis) against distance between axles (x axis). A tandem axle unit was allowed to be loaded to 16 tonnes and so he placed the first reference point at zero distance and 16 tonnes.

At the other end of the scale, a 20 m long vehicle combination should be allowed a gross combination mass (GCM) of 50 tonnes. Since the extreme axle spacing for a 20 m vehicle combination was about 18.5 m, he placed the reference point at 18.5 m extreme axle spacing, with a GCM of 50 tonnes. A straight line was drawn between the two reference points and this line was defined by the equation $1.8 \times L + 16$. This formula was subsequently introduced into South Africa's regulations as the bridge formula. Figure I-2 illustrates this derivation of the South African bridge formula graphically.

[5] An ESA refers to the number of standard axle loads that are equivalent in damaging effect on a pavement to a given vehicle or axle loading.

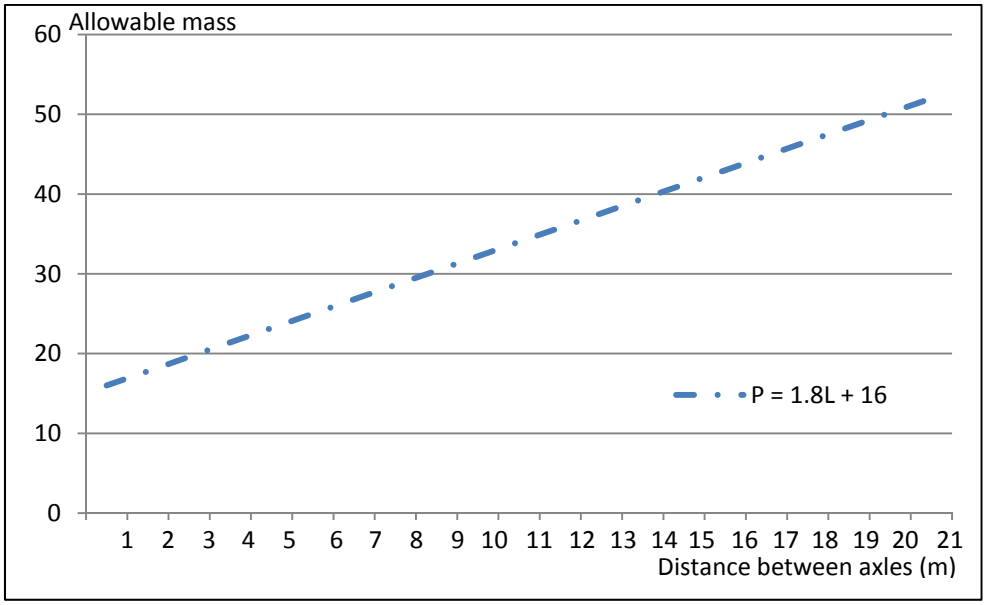


Figure I-2: Derivation of the South African Bridge Formula

Canadian Vehicle Weights and Dimensions Study, 1986, and Council of Ministers Decision, Canada, 1988

Based on the 1986 study,[6] in 1988 the Canadian Council of Ministers of Transportation agreed on certain vehicle configurations and mass limits. Included was a B-double or B-Train double (equivalent to the interlink), with a GCM limit of 62.5 tonnes. The minimum extreme axle spacing was set at 18.75 m. Applying the 1.8 L + 16 bridge formula, the 18.75 m extreme axle spacing gives a GCM limit of 49.75 tonnes. Using the 2.1 L + 18 bridge formula proposed for East and Southern Africa, the 18.75 m extreme axle spacing gives a GCM limit of 57.4 tonnes, less than the Canadian limit of 62.5 tonnes.

South African Technical Working Group. May 1991

The recommendations from this Working Group were to (i) increase the articulated vehicle length from 17.0 to 18.5 m, for increased efficiency without any detriment; and (ii) increase the vehicle combination length from 20 m to 22 m, for increased efficiency and again with no detriment. The increased length of a vehicle combination meant an increase in the GCM to around 52 tonnes.

Peter Buckland, North American and British Long-Span Bridge Mass, Journal of Structural Engineering, October 1991[7]

Buckland showed that the British Standard BS5400 1978 (to which many of the bridges in East and Southern Africa were designed) allowed higher loadings than the American AASHTO 1983 and the Canadian CAN/CSA-S6-88 1988 standards. Yet, as indicated above, the Canadians allowed their B-Double a higher bridge loading than what is being proposed for East and Southern Africa even though there bridges were designed for a lesser loading.

[6] The study found that "[a]mong the B-doubles [i.e., interlinks], the eight-axle variety, with tridem centre-group, offers the greatest productivity advantages while suffering no significant loss in dynamic performance relative to the five-axle truck tractor semi-trailer. Recognizing the safety benefits of the reduced exposure which accompanies increased payload capacity plus high performance, yet simplicity, of this vehicle combination, the eight-axle B-doubles (interlink) is looked upon as the closest to ideal configuration of the overall group of vehicles."
[7] http://cedb.asce.org/cgi/WWWdisplay.cgi?73321.

For a tandem axle unit in South Africa, using the original bridge formula of 1.8L + 16 and an axle spacing of 1.36 m, the mass limit would be 18.5 tonnes, which is in excess of the original 16 tonnes and the proposed 18 tonnes. However, the 1.8L + 16 bridge formula limited the tridem axle unit (spacing 2.72 m) to 20.9 tonnes. Retaining this formula meant that the transporters and trailer manufactures would spread the tridem axle unit out to over 4 m to achieve the 24-tonne mass limit (i.e., the sum of 3 × 8 tonne axles). Such a wide-spaced axle unit would be legal (as it was not considered an axle unit), but it would not be desirable because: (i) it would create considerable scuffing unless expensive and complex steering axles were included; and (ii) it would be very difficult to retain equal massing on the three axles. This was one justification to upgrade the original bridge formula.

Technical Methods for Highways (TMH) 7 Code of Practice, 1981, assumes a constant limiting value of 3.6 tonnes per m (36 kN/m).[8] As shown in Figure I-3 below, with an extreme axle spacing of around 9.5 m, the original bridge formula gave higher mass limits, while the gross vehicle mass/gross combination mass was controlled by the sum of the axle mass limits. Above an extreme axle spacing of around 9.5 m, and for the heavy vehicle combinations, the original bridge formula reduced the bridge loading below that of TMH7.

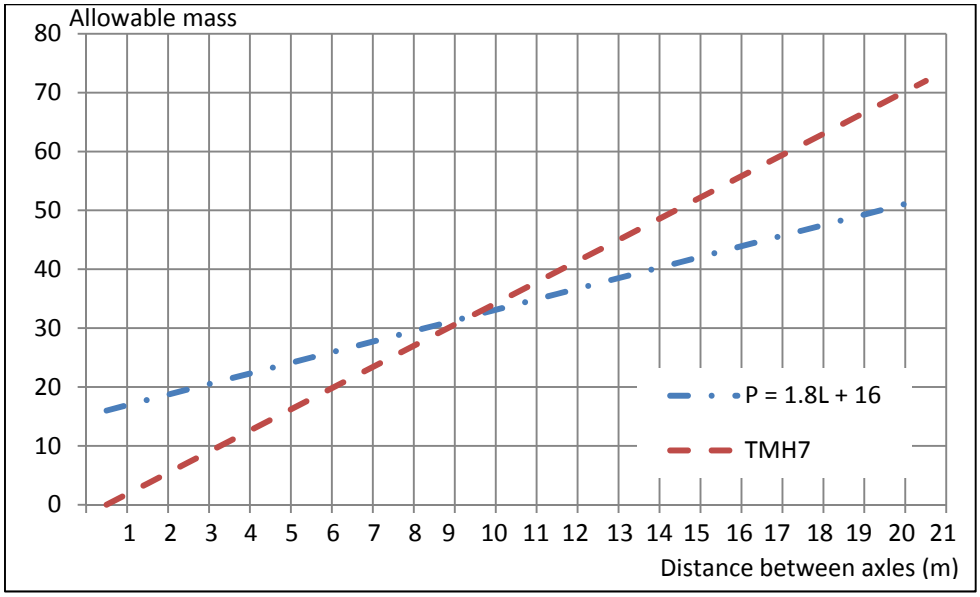


Figure I-3: Comparison of TMH 7 and the Original Bridge Formula

It can be shown that a line of jam-packed 4 × 2 trucks results in a bridge loading of around 4.2 tonnes per m while a line of jam-packed 6 × 4 trucks results in a bridge loading of around 3.6 tonnes per m. However, this does not consider the practical situation where: (i) other vehicle types of vehicles are interspersed, (ii) vehicles are partly laden or empty, and (iii) there is a reasonable distance between moving vehicles. It can be seen from Figure I-3 above that a 7-axle vehicle combination (truck and trailer, or interlink) of 20 m length is controlled by the bridge formula and therefore causes considerably less wear to the roads than does smaller heavy vehicles.

[8] BS5400 takes into consideration high mass per unit length. It also considers impact massing.

Van Wyk & Louw Inc, Consequences of Increases in the Legal Axle Mass Limits, September 1991

Three studies were carried out as inputs to this document. Study 1 showed that increased axle masses would give net gains to South Africa, but that no increases should be given until additional maintenance funds were made available. Study 2 recommended the bridge formula 2L + 15 and limits of 10.2 tonnes for a single axle, 20.4 tonnes for a tandem axle unit, and 24 tonnes for a tridem axle unit. Study 3 recommended limits of 10 tonnes for a single axle and 18.5 tonnes for a tandem axle unit. (A limit of 11 tonnes could be considered for a single air-suspended axle.)

South African Department of Transport Working Group on Dimensions and Loads, February 1992

This Working Group was set up after the conclusion of the previous studies outlined above. Existing mass limits were 8.2 tonnes (single), 16.4 tonnes (tandem), and 21 tonnes (tridem). The summation of axles in a 7-axle vehicle combination resulted in a GCM of: $6.5 + (6 \times 8.2) = 55.7$ tonnes. The existing bridge formula of $1.8 \times L + 16$ did not allow a 20 m vehicle combination to realize its full potential. Using the extreme axle spacing of 18.5 m, the bridge formula gave a GCM limit of $1.8 \times 18.5 + 16 = 49.3$ tonnes. Although there was no upper GCM limit set in the regulations, the bridge formula effectively determined this limit to be 49.3 tonnes.

The Working Group agreed on an interim bridge formula of $2.1 \times L + 15$ tonnes, which would give 53.9 tonnes for a 20 m vehicle combination, and the Minister endorsed this recommendation. There was to be an immediate overloading monitoring program and a bridge strengthening program. Also, extra budgets were to be made available for road maintenance.

Van Niekerk Kleyn & Edwards, Van Wyk & Louw, The Effect of an Increase in Loads, March 1993

This study showed that the theoretical strengths of bridges were less than the forecast traffic loads that would result from the proposed increase in mass limits. However, field tests showed that the actual stiffness of the bridges exceeded the theoretical stiffness.

Carl Bro International, Axle Mass Study for Southern Africa, May 1993

The objective of this study was to harmonize mass limits in Southern Africa. Dimensions had been previously agreed at 12.5 m for a rigid vehicle, 17 m for an articulated vehicle, and 22 m for a vehicle combination. The HDM-III model was used in the calculations. The study recommended a 63-tonne GCM limit, although consideration had to be given to the strength of bridges and some bridges may have required some restriction.

Developments since 1993 and Comments

Following the 1993 Carl Bro study, various investigations were undertaken by the road transport and freight forwarding industry. One of the submissions found a gain in efficiency for the region by loading 3 × 6 m TEU, or 1 × 6 m TEU and 1 × 12 m ISO container on a vehicle combination. To achieve this gain, the length of the vehicle combination needed to be increased to 22 m.[9] It was found that the GCM over 2 additional meters would cause no more road wear and less stress on bridges.

[9] Generally, this was not seen as presenting a safety problem since the time required to overtake such a vehicle would be increased by less than one second.

Applying the upgraded 2L + 15 bridge formula to a 22 m vehicle combination with an extreme axle spacing of about 19.7 m would give a 54.4-tonne GCM limit. While the 1993 Carl Bro study had recommended a GCM limit of 63 tonnes, this limit was considered too high and therefore SADC recommended a 56-tonne limit (7 axles × 8 tonnes per axle). In South Africa, this recommendation meant that the upgraded bridge formula of 2L + 15, with an extreme axle spacing of 19.7 m, could not achieve the recommended limit.

SADC also agreed with the road transport industry's recommendation of limits of 10 (single), 18 (tandem), and 24 (tridem) tonnes. However, in South Africa the upgraded bridge formula of 2 L + 15 when applied to a tridem axle unit with a 2.72 m extreme axle spacing only gave a 20.4-tonne limit for the tridem, which was well below the 24-tonne limit recommended by SADC.

With the two shortcomings in the 2 L + 15 bridge formula described above, South Africa agreed to revise the formula for a second time, to 2.1 L + 18. This gave a 23.7-tonne limit for a tridem axle unit (considered to be close enough to the agreed 24-tonne limit) and a GCM limit of over 59 tonnes. However, it was agreed that the new formula was not too generous (at 59 tonnes for the extreme axle spacing) because it restricted the limits on the tandem and tridem axle units in a 6-axle articulated vehicle. The extreme axle spacing for the 18-tonne tandem axle unit and the 24-tonne tridem axle unit in the articulated vehicle would have to be at least 11.4 m apart for them to achieve full loading. Since this was in fact not possible, these two axle units have not been able to realize their full potential until recently.

Against this background, all parties in the context of SADC cooperation agreed that the 56-tonne limit was adequate and the new bridge formula gave the tandem and tridem axle units in a 6-axle articulated vehicle combination reasonable mass limits.

Appendix J Examples of Vehicle and Vehicle Combination Drawings to Assist with the Regulations of Member States

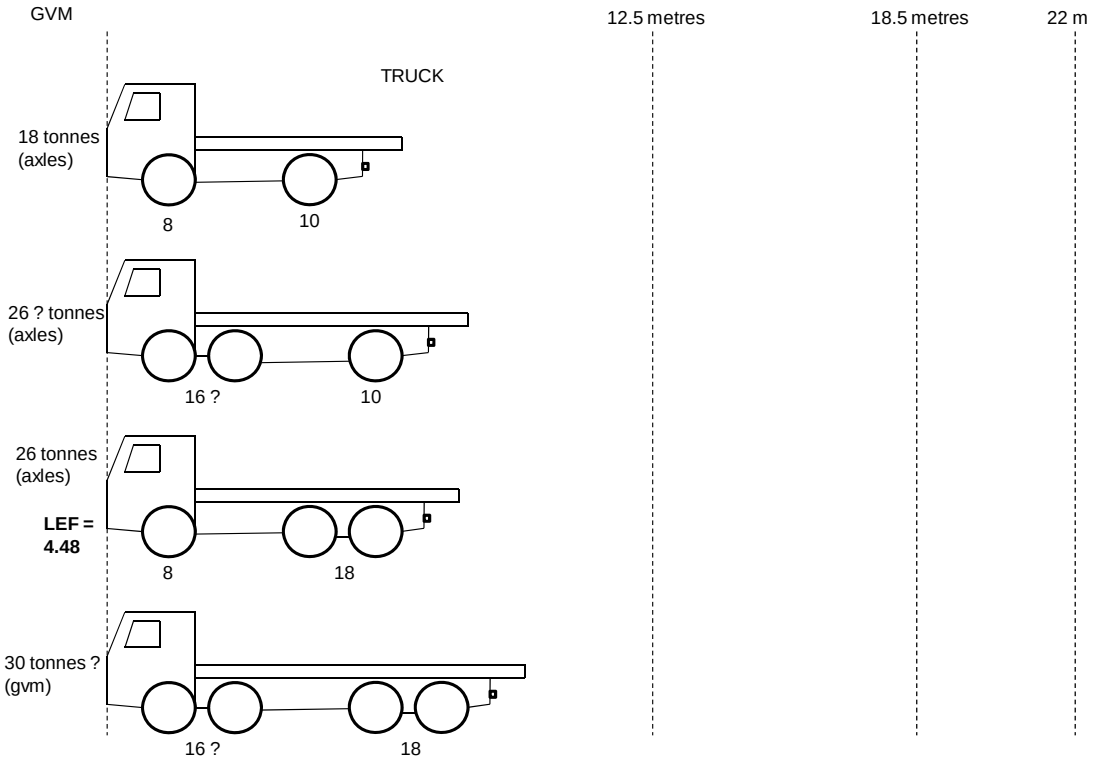
The following drawings of vehicles and vehicle combinations show many of the vehicles and vehicle combinations on the region's roads today. Not every vehicle or vehicle combination is shown. No more than 7 axles per vehicle combination are shown. While 8-axle vehicle combinations will be limited to 56 tonnes and do appear on regional roads, it is not considered desirable to show them since it may encourage overloading.

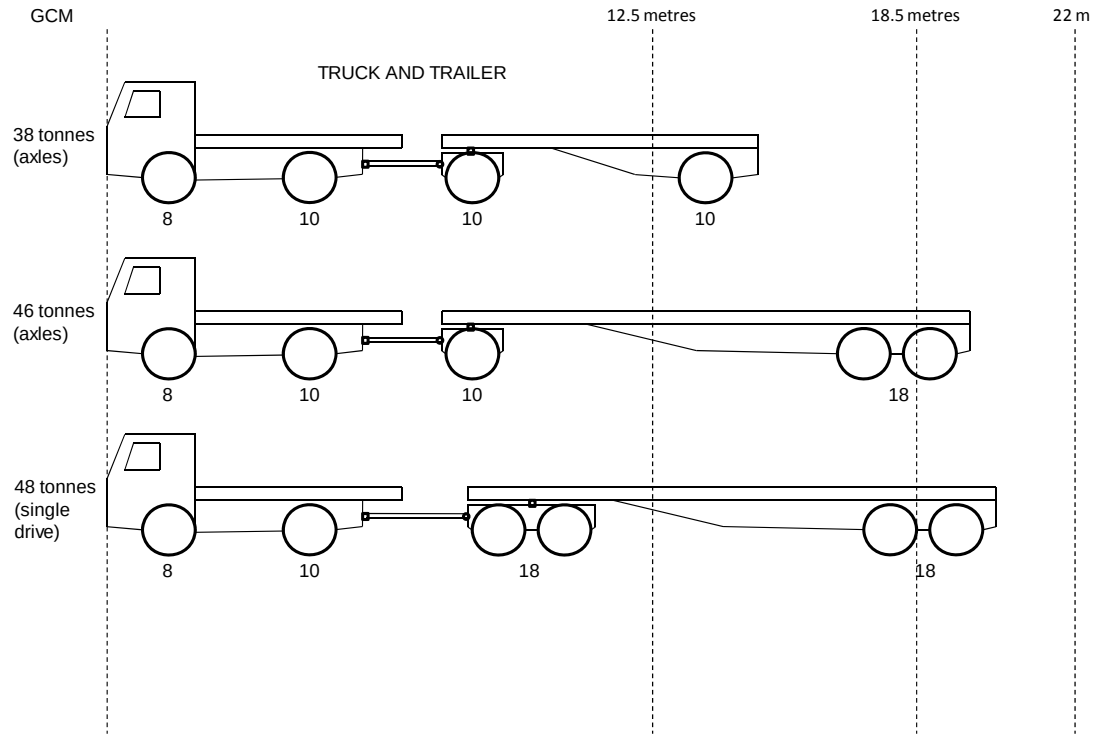
All vehicles and vehicle combinations are covered by the Bridge Formula:
Load (tonnes) = 2.1 × Distance between any two axles (meters) + 18

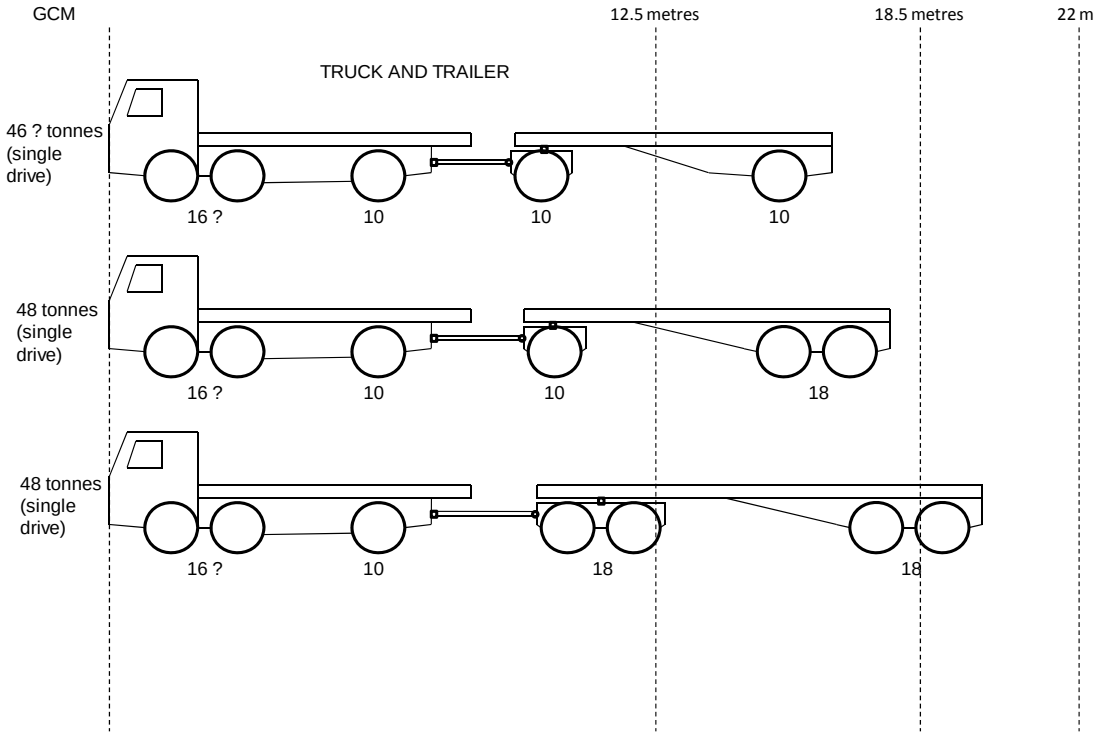
The heavier vehicle combinations comply with the Bridge Formula and are limited to 56 tonnes. For simplicity and apart from the front axle, no axles with single tyres are shown. In most cases, the inclusion of single tyres will reduce the allowable load limits.

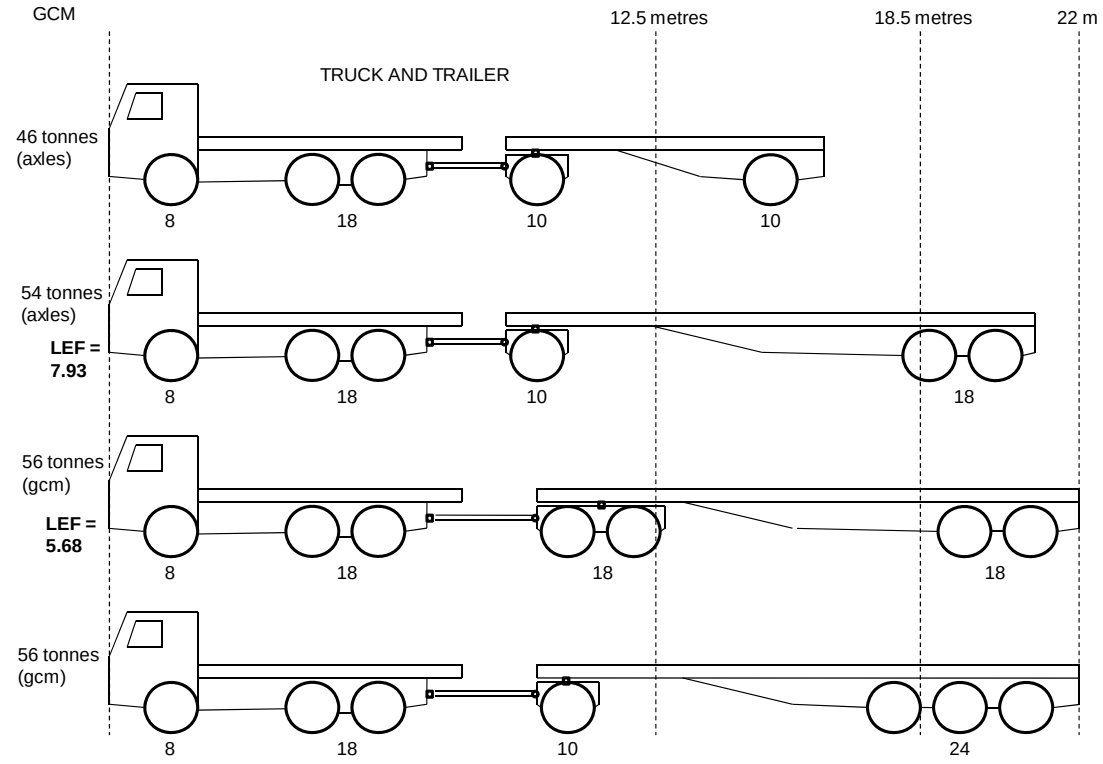
The regional recommendations for single tyre limits in an axle unit still have to be finalized. The load limits shown in the left hand column wee determined by the sum of the axles (axles), or by the single drive axle (single drive), or by the gross combination mass limit (GCM).

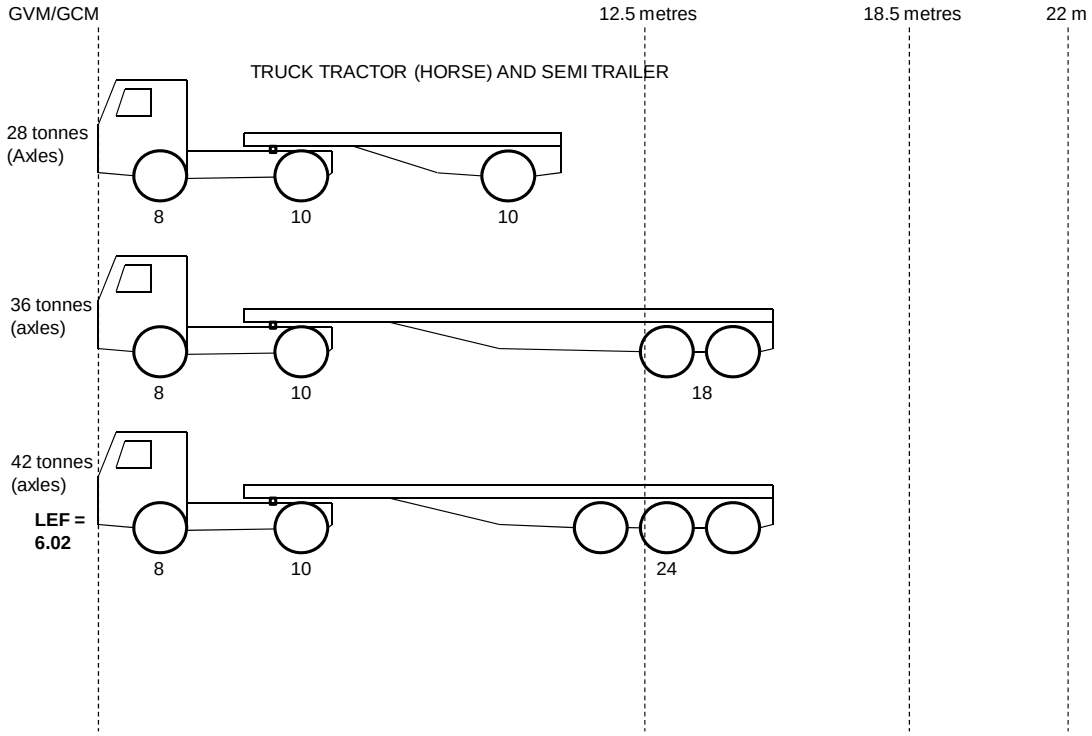
LEF = the Load Equivalency Factor for the seven common vehicle combinations shown, as calculated in the Council of Scientific and Industrial Research (CSIR) study of August 2010.

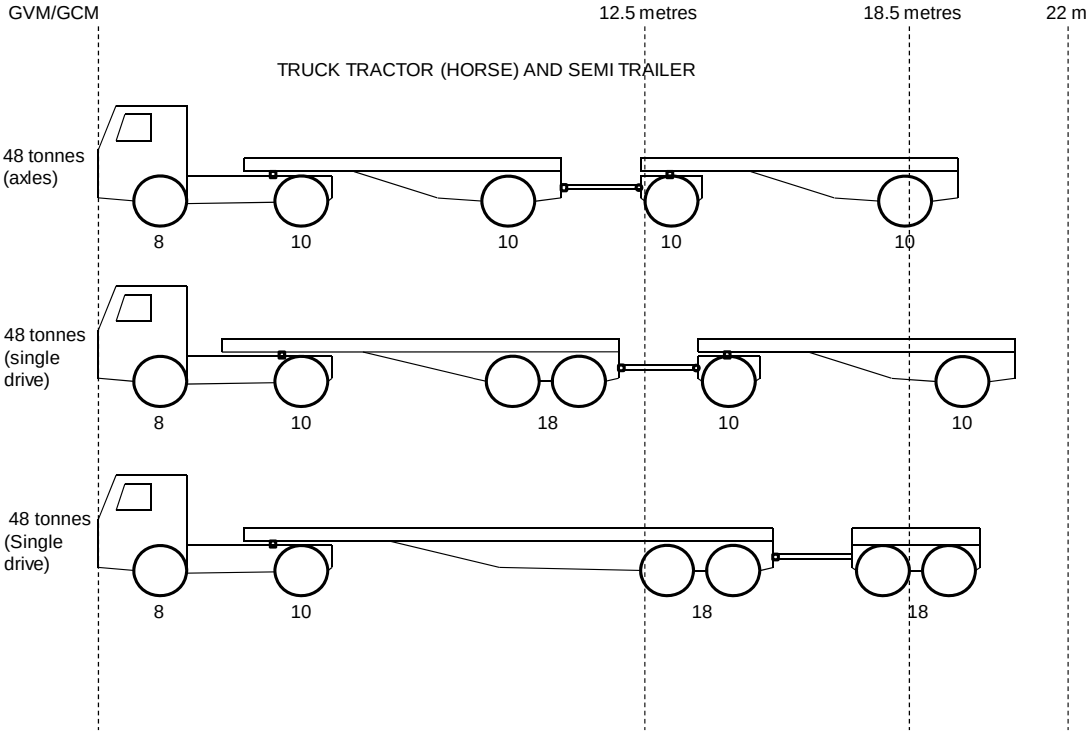

GVM
12.5 metres
18.5 metres
22 m
TRUCK
18 tonnes (axles)
8
10
26 ? tonnes (axles)
16 ?
10
26 tonnes (axles)
LEF = 4.48
8
18
30 tonnes ? (gvm)
16 ?
18

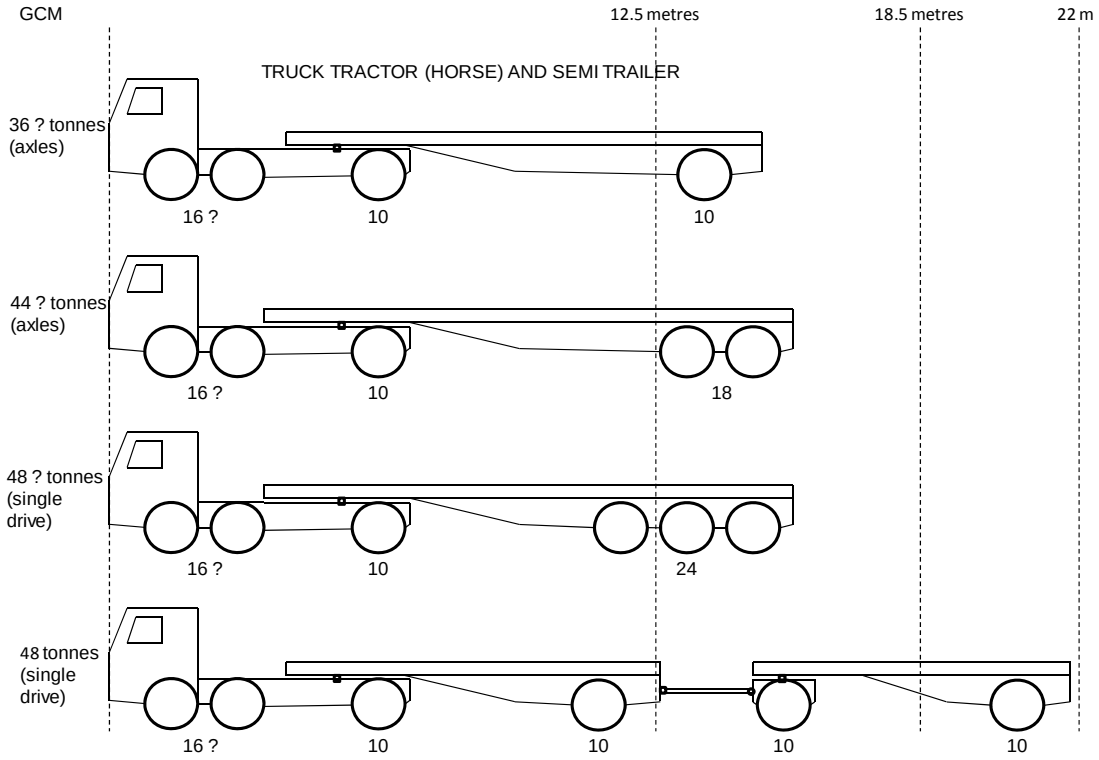

GCM
12.5 metres
18.5 metres
22 m
TRUCK AND TRAILER
38 tonnes (axles)
8
10
10
10
46 tonnes (axles)
8
10
10
18
48 tonnes (single drive)
8
10
18
18

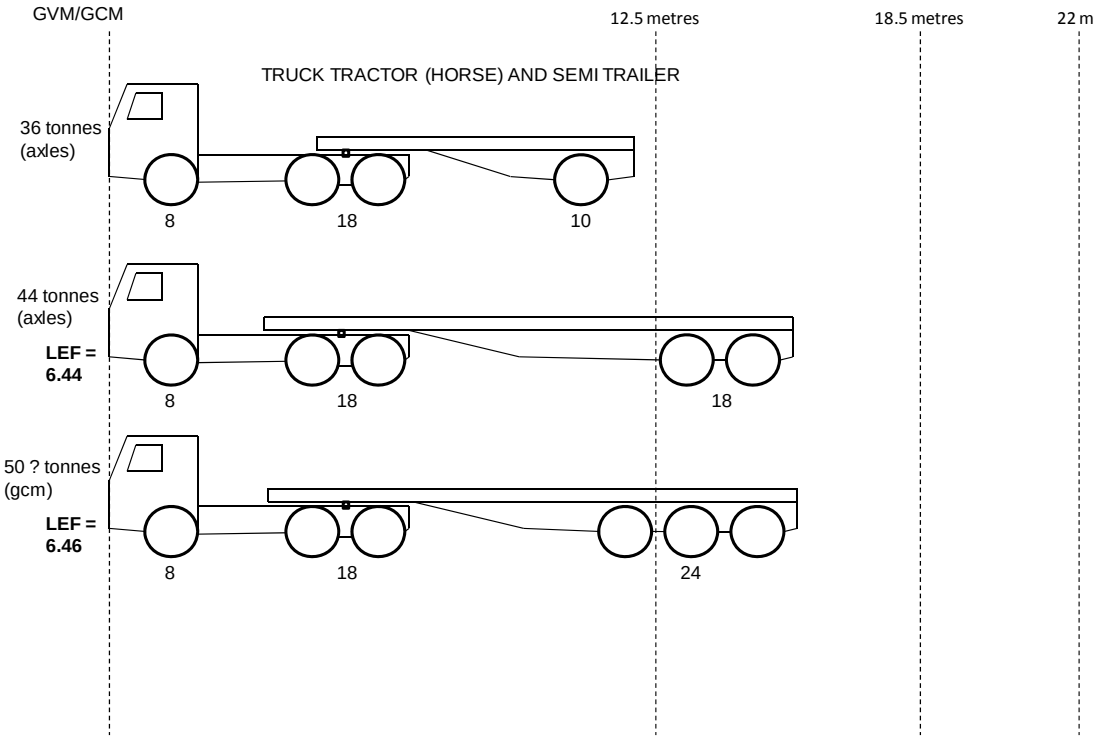

GCM
12.5 metres
18.5 metres
22 m
TRUCK AND TRAILER
46 ? tonnes (single drive)
16 ?
10
10
10
48 tonnes (single drive)
16 ?
10
10
18
48 tonnes (single drive)
16 ?
10
18
18

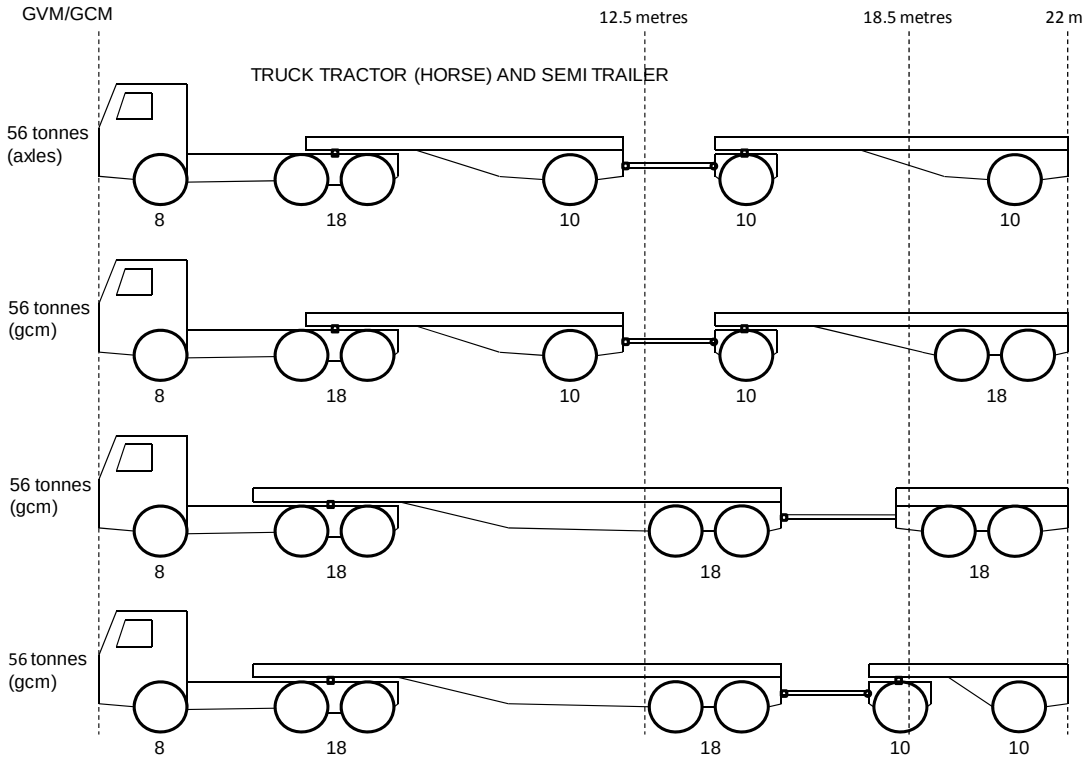

GCM
12.5 metres
18.5 metres
22 m
TRUCK AND TRAILER
46 tonnes (axles)
8
18
10
10
54 tonnes (axles)
LEF = 7.93
8
18
10
18
56 tonnes (gcm)
LEF = 5.68
8
18
18
18
56 tonnes (gcm)
8
18
10
24

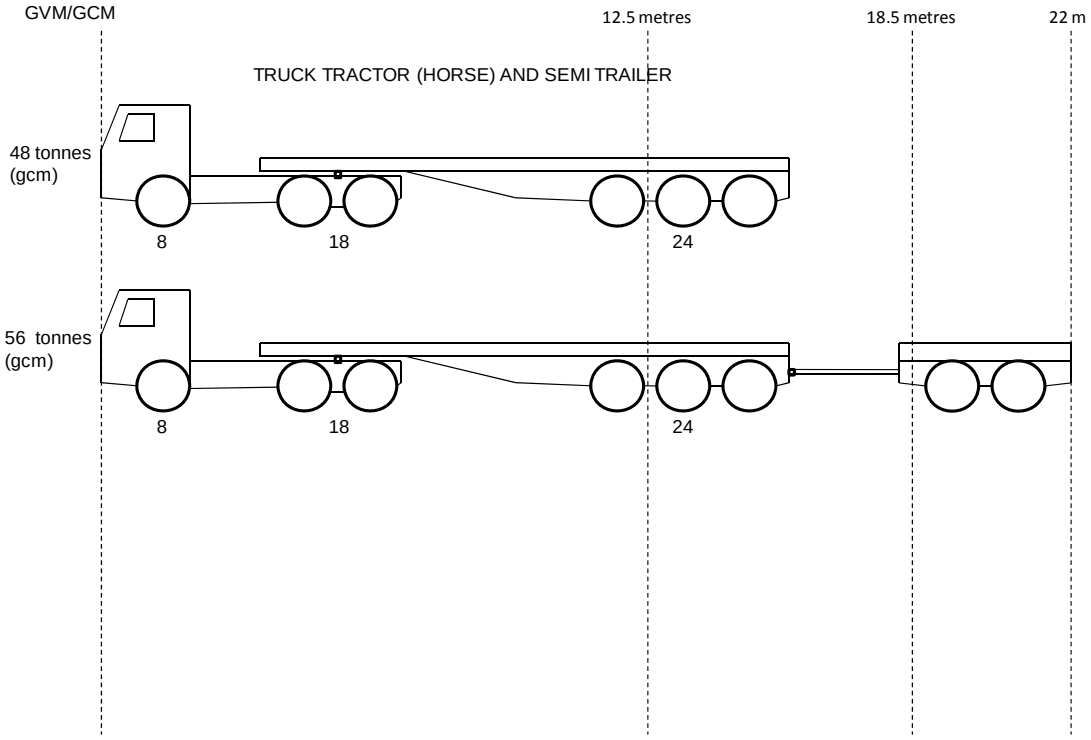

GVM/GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
28 tonnes (Axles)
8
10
10
36 tonnes (axles)
8
10
18
42 tonnes (axles)
LEF = 6.02
8
10
24

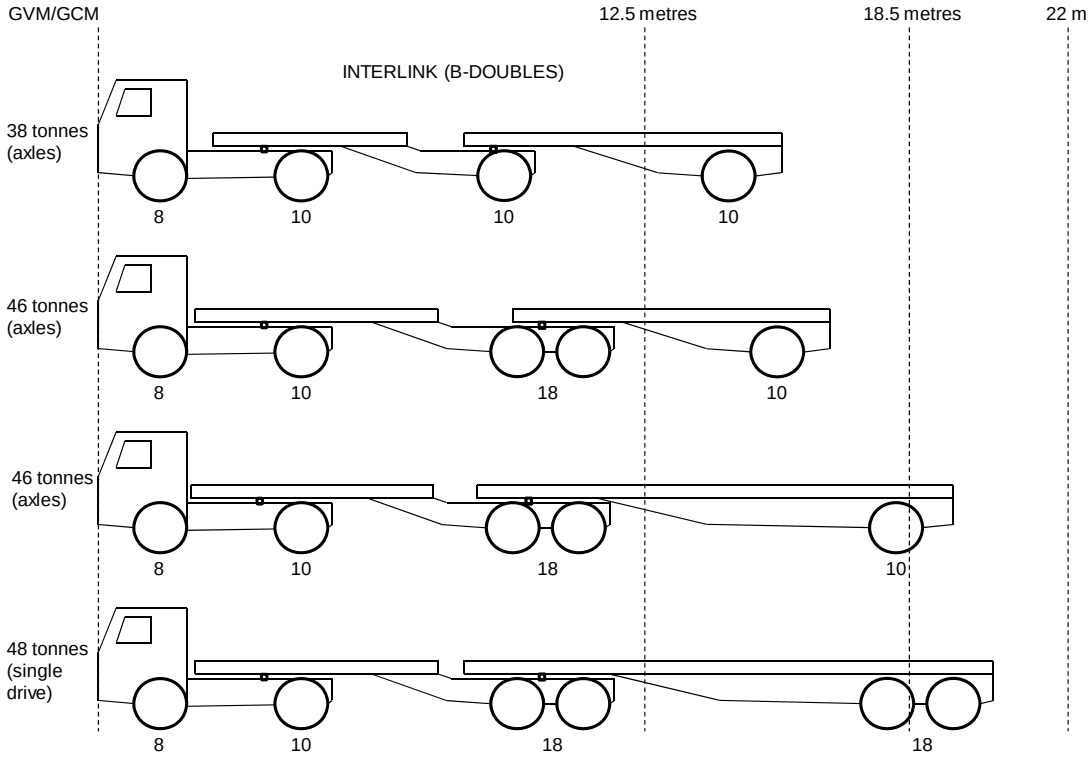

GVM/GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
48 tonnes (axles)
8
10
10
10
10
48 tonnes (single drive)
8
10
18
10
10
48 tonnes (Single drive)
8
10
18
18

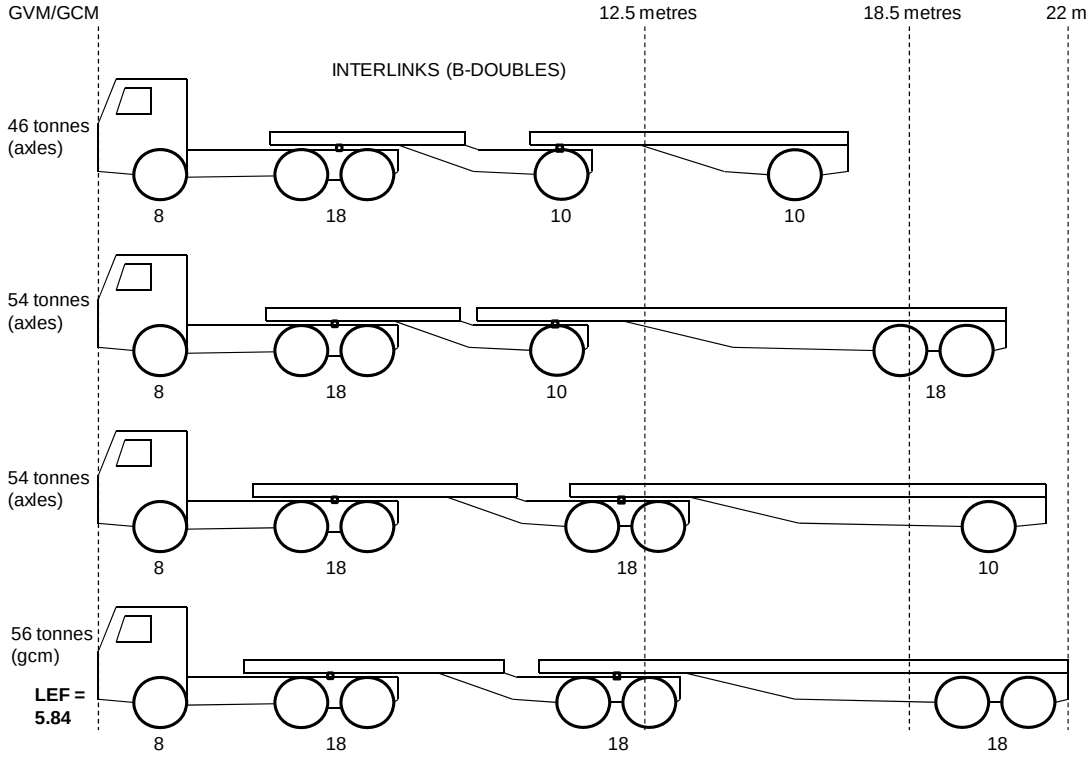

GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
36 ? tonnes (axles)
16 ?
10
10
44 ? tonnes (axles)
16 ?
10
18
48 ? tonnes (single drive)
16 ?
10
24
48 tonnes (single drive)
16 ?
10
10
10
10


GVM/GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
36 tonnes (axles)
8
18
10
44 tonnes (axles)
LEF = 6.44
8
18
18
50 ? tonnes (gcm)
LEF = 6.46
8
18
24


GVM/GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
56 tonnes (axles)
8 18 10 10 10
56 tonnes (gcm)
8 18 10 10 18
56 tonnes (gcm)
8 18 18 18
56 tonnes (gcm)
8 18 18 10 10


GVM/GCM
12.5 metres
18.5 metres
22 m
TRUCK TRACTOR (HORSE) AND SEMI TRAILER
48 tonnes (gcm)
8 18 24
56 tonnes (gcm)
8 18 24


GVM/GCM
12.5 metres
18.5 metres
22 m
INTERLINK (B-DOUBLES)
38 tonnes (axles)
8 10 10 10
46 tonnes (axles)
8 10 18 10
46 tonnes (axles)
8 10 18 10
48 tonnes (single drive)
8 10 18 18


GVM/GCM
12.5 metres
18.5 metres
22 m
INTERLINKS (B-DOUBLES)
46 tonnes (axles)
8 18 10 10
54 tonnes (axles)
8 18 10 18
54 tonnes (axles)
8 18 18 10
56 tonnes (gcm)
LEF = 5.84
8 18 18 18

Appendix K EAC Act or Protocol

K.1 An EAC Act or Protocol?

An EAC Act is preferred to an EAC Protocol because:

- it provides an integrated approach to vehicle overload control with legal effect;
- this approach has been effectively applied before;
- the steps required for adoption of a Protocol are lengthy, making it inappropriate for the required fast tracking of the issue; and
- a Protocol would just provide a general framework and would therefore need to be accompanied by a number of laws and regulations.

K.2 Integrated Approach to Vehicle Overload Control

An EAC Act (pursuant to Article 62 of the EAC Treaty) would provide an integrated approach to vehicle overload control in the EAC with legal effect in the Partner States. It would override contrary national laws and regulations as per subparagraphs (4) and (5) of Article 8 of the EAC Treaty.

Alternatively, if a Protocol is adopted and the Partner States have their own laws/regulations, they will not meet the mandate of Article 90(l) of the EAC Treaty for the Partners States to "adopt common rules and regulations" on "gross weight and load per axle".

K.3 EAC Acts Have Been Effectively Applied Before

EAC Acts have been applied effectively before (e.g., the EAC Customs Management Act, 2004; the EAC Standardisation, Quality Assurance, Metrology and Testing Act, 2006; the EAC One-Stop Border Posts Act, in process).

There are no convincing reasons to abandon this approach.

K.4 The Steps Required for a Protocol are Lengthy

A Protocol would take longer to adopt than an Act, making it inappropriate for the required fast tracking of the issue.

It would require many steps: (i) submission of the draft to the sectoral council and then to workshops in the Partner States, (ii) preparation of a final report with a revised draft Protocol as an official document, (iii) submission of the final report to the Council of Ministers for approval, (iv) article-by-article review by the Attorneys Generals of the Partner States and the Legal Department of the Secretariat, and (v) submission of the resulting draft to the Council of Ministers for signing.

K.5 A Protocol Would Only Provide a General Framework

A Protocol would only provide a general framework and therefore would not meet the mandate of Article 90(l) for "common rules and regulations".

Pursuant to Article 151(l) of the EAC Treaty, a Protocol is an annex of the EAC Treaty to "spell out the objectives and scope of, and institutional mechanisms for co-operation and integration". Therefore, many of the required details could not be specified in a Protocol. It would be unprecedented.

Additional laws and regulations would be required, and if enacted at the Partner State level would result in a fragmented, non-harmonized approach.

Appendix L Dynamic Stability of Interlinks

In response to a request for a comparison of interlinks (B-doubles) and truck-trailers, a brief discussion of existing work is presented. The National Transport Commission (NTC, previously NTRC) of Australia developed performance-based standards (PBS) for heavy vehicles as an alternative means of regulating heavy vehicles. It is the latest edition of these standards that South Africa is using for its PBS initiative. During the process of recommending and reviewing potential performance standards, the NTC conducted an evaluation of the Australian heavy vehicle fleet against these standards.[1] At the time, the range of selected potential standards was as suggested by previous work by the same organization[2] and this list remains essentially unchanged.

In the NTC's evaluation of the Australian vehicle fleet, 139 generic vehicles were chosen to represent the range of typical vehicle combinations including rigid trucks, truck-trailers, truck-semitrailers, and road trains. Numerical computer simulations of these vehicle combinations were conducted (using *Adams* and *AutoSim* multi-body/vehicle dynamics software packages) and the performance statistics of each combination compared against the respective performance standards. The subsequent report from that study is lengthy and detailed and a summary may be downloaded from the NTC's website.[3] A description of the various performance measures may also be obtained from the website.[4]

In support of the safety of interlinks over truck-trailers (more specifically, based on the illustrations provided, *truck and dog trailer*), some overall results of the study are presented in Tables L-1, L-2, and L-3. The tables show the percentage of vehicles simulated in each vehicle group (e.g., B-double, rigid truck) that pass the required performance criteria at the required level. In the right-most column the percentage of vehicles in each group that pass *all* of the standards is given. Hence, a higher quoted percentage of one vehicle group over another gives an indication of the statistically superior performance of that particular vehicle combination over the other in each performance measure. The limiting values for the PBS measures are relaxed for more limited road access – urban road access has the most stringent requirements, major freight routes slightly less stringent and road train routes the least stringent. The tables show the results for each of these access levels respectively.

Arguably, the most safety-critical PBS measures are those pertaining to dynamic characteristics of the vehicle and are: Static Rollover Threshold, Rearward Amplification, High Speed Transient Offtracking, Yaw Damping, and Tracking Ability on a Straight Path. The results show the B-double to be the superior performer in all these standards except rollover threshold and the difference here is not considerable. It can be seen from the performance in low-speed standards that the B-double is not, in general, ideally suited for urban access but performs notably overall. From these results and other research results it may be said that *in general* B-doubles are dynamically safer than truck-dog-trailer equivalents. It should be emphasized however that it is possible to produce an unsafe vehicle in either configuration, even within legal constraints, and as such this deduction is not all-encompassing.

[1] NTRC, *Performance Characteristics of the Australian Heavy Vehicle Fleet*, Melbourne: National Road Transport Commission, 2002.
[2] NTRC, *Definition of Potential Performance Measures and Initial Standards*, Melbourne: National Road Transport Commission, 2001.
[3] http://www.ntc.gov.au/docview.aspx?documentid=255.
[4] http://www.ntc.gov.au/filemedia/Reports/PBSSchemeStandsVehAssRule24Nov08.pdf.

Table L-1: Australian Heavy Vehicle Fleet Performance (Access to Entire Road Network) [1]

#	Vehicle Class	Performance Measures																
		Startability (%)	Gradeability (Max. Grade) (%)	Gradeability (Max. Speed on 1%Grade) (km/h)	Acceleration Capability (s)	Tracking Ability (m)	Low-Speed Offtracking (m)	Frontal Swing (m)	Tail Swing (m)	Steer Tyre Friction Demand (%)	Static Rollover Threshold (g)	Rearward Amplification (-)	High-Speed Transient Offtracking (m)	Yaw Damping Coefficient (-)	Gross Mass per SAR (t/SAR)	Horizontal Tyres Forces (-)	Max. Effect Relative to Ref. Vehicle (%)	OVERALL (%)
		Performance Levels																
		15	25	70	12	3.1	7.4	1.5	0.35	80	0.35	5.7	0.80	0.15	8.4	1.8	95	-
17	rigid trucks	100	100	100	100	100	100	100	100	100	71	100	100	100	18	29	100	18
6	buses/coaches	100	100	100	100	100	100	100	100	100	100	100	100	100	-	83	100	-
43	prime-mover and semi-trailer	100	67	100	98	100	95	100	100	100	79	100	100	100	72	93	100	47
23	B-double	100	-	100	35	100	4	100	100	100	78	100	100	100	78	100	100	-
1	B-triple	100	-	100	-	100	-	100	100	100	100	100	100	100	100	100	100	-
9	truck and pig/tag-trailer	100	78	100	100	100	100	100	100	100	56	56	56	100	22	89	100	22
14	truck and dog trailer	100	79	100	93	100	100	100	100	100	86	50	71	93	71	79	93	21
12	A-double	100	-	100	-	100	8	100	100	100	92	92	83	100	100	100	92	-
12	A-triple road train	-	-	25	-	100	-	100	100	100	75	17	8	83	100	92	100	-
2	AAB-quad road train	-	-	-	-	100	-	100	100	100	100	50	-	100	100	50	-	-
139	**entire fleet**	**90**	**50**	**92**	**68**	**100**	**64**	**100**	**100**	**100**	**79**	**83**	**83**	**98**	**65**	**84**	**97**	**20**

Notes: *Acceleration Capability* shown in the Table is based on a 25 m cleared-distance intersection clearance time.

Table L-2: Australian Heavy Vehicle Fleet Performance (Access to Major Freight Routes) [1]

#	Vehicle Class	Performance Measures																
		Startability (%)	Gradeability (Max. Grade) (%)	Gradeability (Max. Speed on 1%Grade) (km/h)	Acceleration Capability (s)	Tracking Ability (m)	Low-Speed Offtracking (m)	Frontal Swing (m)	Tail Swing (m)	Steer Tyre Friction Demand (%)	Static Rollover Threshold (g)	Rearward Amplification (-)	High-Speed Transient Offtracking (m)	Yaw Damping Coefficient (-)	Gross Mass per SAR (t/SAR)	Horizontal Tyres Forces (-)	Max. Effect Relative to Ref. Vehicle (%)	OVERALL (%)
		Performance Levels																
		10	20	70	15	3.5	10.1	1.5	0.35	80	0.35	5.7	0.80	0.15	8.4	1.8	80	-
17	rigid trucks	100	100	100	100	100	100	100	100	100	71	100	100	100	18	29	100	18
6	buses/coaches	100	100	100	100	100	100	100	100	100	100	100	100	100	-	83	100	-
43	prime-mover and semi-trailer	100	86	100	100	100	100	100	100	100	79	100	100	100	72	93	100	53
23	B-double	100	39	100	100	100	100	100	100	100	78	100	100	100	78	100	100	30
1	B-triple	100	-	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
9	truck and pig/tag-trailer	100	100	100	100	100	100	100	100	100	56	56	56	100	22	89	100	22
14	truck and dog trailer	100	93	100	100	100	100	100	100	100	86	50	71	93	71	79	93	21
12	A-double	100	-	100	100	100	100	100	100	100	92	92	83	100	100	100	92	-
12	A-triple road train	100	-	25	-	100	8	100	100	100	75	17	8	83	100	92	100	-
2	AAB-quad road train	50	-	-	-	100	-	100	100	100	100	50	-	100	100	50	100	-
139	**entire fleet**	**99**	**65**	**92**	**90**	**100**	**91**	**100**	**100**	**100**	**79**	**83**	**83**	**98**	**65**	**84**	**99**	**27**

Notes: *Acceleration Capability* shown in the Table is based on a 25 m cleared-distance intersection clearance time.

Table L-3: Australian Heavy Vehicle Fleet Performance (Access to Road Train Routes) [1]

#	Vehicle Class	Performance Measures																
		Startability (%)	Gradeability (Max. Grade) (%)	Gradeability (Max. Speed on 1%Grade) (km/h)	Acceleration Capability (s)	Tracking Ability (m)	Low-Speed Offtracking (m)	Frontal Swing (m)	Tail Swing (m)	Steer Tyre Friction Demand (%)	Static Rollover Threshold (g)	Rearward Amplification (-)	High-Speed Transient Offtracking (m)	Yaw Damping Coefficient (-)	Gross Mass per SAR (t/SAR)	Horizontal Tyres Forces (-)	Max. Effect Relative to Ref. Vehicle (%)	OVERALL (%)
		Performance Levels																
		5	8	60	25	3.7	13.7	1.5	0.35	80	0.35	5.7	0.80	0.15	8.4	1.8	75	-
17	rigid trucks	100	100	100	100	100	100	100	100	100	71	100	100	100	18	29	100	**18**
6	buses/coaches	100	100	100	100	100	100	100	100	100	100	100	100	100	-	83	100	-
43	prime-mover and semi-trailer	100	100	100	100	100	100	100	100	100	79	100	100	100	72	93	100	**53**
23	B-double	100	100	100	100	100	100	100	100	100	78	100	100	100	78	100	100	**70**
1	B-triple	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**
9	truck and pig/tag-trailer	100	100	100	100	100	100	100	100	100	56	56	56	100	22	89	100	**22**
14	truck and dog trailer	100	100	100	100	100	100	100	100	100	86	50	71	93	71	79	93	**21**
12	A-double	100	100	100	100	100	100	100	100	100	92	92	83	100	100	100	92	**83**
12	A-triple road train	100	100	100	100	100	100	100	100	100	75	17	8	83	100	92	100	-
2	AAB-quad road train	100	100	100	100	100	100	100	100	100	100	50	-	100	100	50	100	-
139	entire fleet	100	100	100	100	100	100	100	100	100	79	83	83	98	65	84	99	**42**

Notes: *Acceleration Capability* shown in the Table is based on a 25 m cleared-distance intersection clearance time.

Source of all Tables: NTRC, *Performance Characteristics of the Australian Heavy Vehicle Fleet*, Melbourne: National Road Transport Commission, 2002

Appendix M List of Participants in Task Force Meetings and Stakeholders Workshops

M.1 List of Participants, 1st Task Force Meeting on 18 January 2011

No.	Country	Name	Position	Organization	Email	Telephone
1	-	Eng. Hosea Nyangweso	Principal Civil Engineer	EAC Secretariat	nyangweso@eachq.org	255 784 239 997
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7	Uganda	Mr. Ssebbugga-Kimeze	Director of operations	Uganda National Roads Authority	Ssebbugga.KIMEZE@unra.go.ug	256 772 477 042
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21	-	Ms. Masako Hatta	Transport Economist	JICA Study Team	mhatta@padeco.co.jp	81 3 5812 1091
22	-	Mr. Barney M W Curtis	Consensus Building Expert	JICA Study Team	fesarta@iafrica.com	27 83 386 8202
23	-	Mr. Seiji Kadooka	Coordinator/ Highway Engineer	JICA Study Team	skadooka@padeco.co.jp	81 3 5812 1091

M.2 List of Participants, 1st Stakeholders' Workshop on 7–8 February 2011

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