

DEVELOPMENT OF AN OVERLOAD CONTROL STRATEGY FOR THE REPUBLIC OF SENEGAL

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ABSTRACT

The Republic of Senegal has approximately 15 000 km of roads of which 4 300 km are paved. Senegal's road network is considered to be one of the best in West Africa. One of the threats to the Senegal road network is overloaded heavy vehicles, particularly because there are currently no weighbridges in the country being used for overload control law enforcement. Recognising the need for an effective overload strategy for Senegal, the Ministry of Public Works and Transport decided to initiate a study in respect of the Management of Overload Control in Senegal. The project, which was funded by the European Union, was carried out during 2005 and is currently being evaluated by the Ministry for implementation.

Five sites were identified to carry out traffic counts and weigh-in-motion surveys to assess the current status of heavy vehicle overloading in Senegal. These sites enabled the assessment of 90% of the heavy vehicle traffic in Senegal. The results of the surveys found that 31% of heavy vehicles are overloaded and that the average degree of overloading per vehicle is 25%. The annual cost of overloading, based on an estimate of additional E80-km due to overloaded vehicles was estimated at US\$ 53.5 million p.a. Because of the importance of the Port of Dakar in terms of imports and exports, it was found that four weighbridges constructed on national routes linking Dakar to the rest of the country (and neighbouring countries) could effectively monitor and control more than 80 per cent of heavy vehicle traffic in Senegal. An assessment of the commodities transported during the surveys found that cement; sand, steel and general goods are the cargoes that contribute most significantly to overloading of heavy vehicles.

The overload control strategy that was developed addresses operational issues relating to the proposed overload control facilities and includes recommendations on the use of public-private partnerships in overload control and the introduction of fees and penalties for overloading.

1 INTRODUCTION

1.1 Background

The Republic of Senegal has approximately 15 000 km of roads of which 4 300 km are paved. Senegal's road network is considered to be one of the best in West Africa. One of the threats to this network is overloaded heavy vehicles, particularly because there are currently no weighbridges in the country being used for overload control law enforcement. Recognising the need for an effective overload control strategy for Senegal, the Ministry of Public Works and Transport decided to initiate a study in respect of the Management of Overload Control in Senegal. The project, which was funded by the European Union, was carried out during 2005 and is currently being evaluated by the Ministry for implementation

1.2 Scope of project

The activities carried out within the framework of this project included the following:

- Evaluation of the effect of overloading on the roads in Senegal;
- Evaluation of the current policies and acts that regulate axle loads at a national and regional level;
- Development of a strategy for overload control in Senegal, including the identification of the number and location of overload control facilities and the required equipment and operations;
- Development of an integrated action plan to implement the overload control strategy; and
- Identification and analysis of various sources of funding for the implementation of overload control;

2 TRAFFIC STUDY

As part of the project a traffic study consisting of traffic counts and weigh-in-motion surveys was conducted. Traffic counts from a traffic survey that was done for the national roads agency (1) (Agence Autonome des Travaux Routiers (AATR)) were used to identify heavy vehicle routes in Senegal. The 2002 traffic survey included counts for 135 stations throughout Senegal. Based on these counts, the following eight major heavy vehicle routes were identified:

1. N1 from Dakar through Diam Niadia; Mbour; Fatick; Kaolack; Kaffrine; and Tambacounda to Kidira.
2. N2 from Diam Niadia through Thies; Tivaouane; Louga; Saint Louis; Dagana; and Haere Lao to Matam.
3. N3 from Thies through Bambey; Diourbel; Mbake; and Touba to Dara.
4. N4 from Diourbel through Gossas; and Kaolack to Keur Ayip; then through the Gambia to Senoba; through Bignona to Ziguinchor.
5. N6 from Tambacounda through Velingara; Kolda; and Tanaf to Ziguinchor.
6. R10/R70 from Rufisque on the N1 through Bayak to Mboro.
7. R60 from Mbake through Mbar to Kaffrine.
8. R30/R31 from Louga to Touba.

These eight major heavy routes are shown in Figure 1.

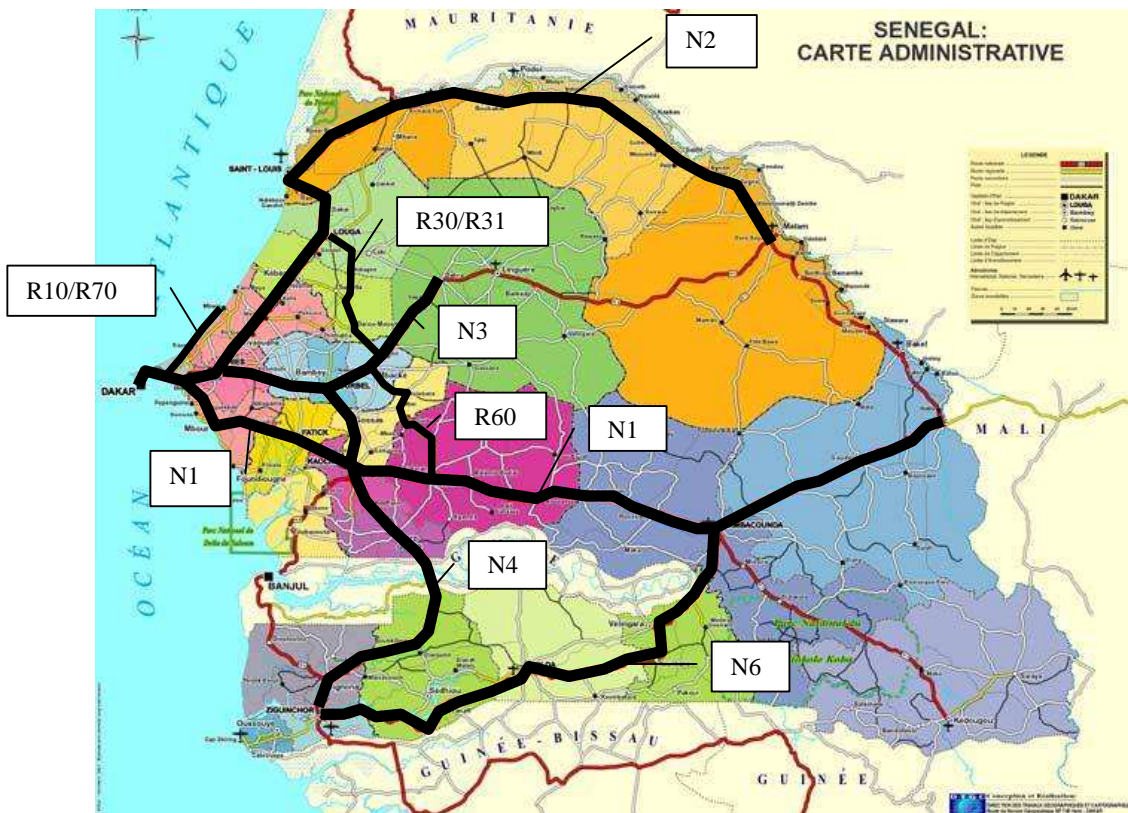


Figure 1: Major heavy vehicle routes in Senegal

The 2002 traffic counts and the eight heavy vehicle routes clearly indicate that Dakar is the origin and destination of the majority of the heavy vehicles and the number of heavy vehicles reduces as one moves away from Dakar. Five sites were identified to carry out traffic counts and weigh-in-motion surveys to assess the current status of heavy vehicle overloading in Senegal. These sites formed a cordon around Dakar and enabled the assessment of 90% of the heavy vehicle traffic in Senegal. The five sites identified were the following:

- Station 182 on the N1 west of Diam Niadia;
- Station 180 on the N3 east of Thies;
- Station 181 on the N2 north of Thies;
- Station 184 on the N1 north of Mbour;
- Station 183 on the P101 north of the N1.

2.1 Seasonal variation

The traffic study was carried out in two phases. The first phase took place during the first two weeks in September 2005 (during the rainy season). During this phase, 7-day counts were done at the five stations with 12-hour weigh-in-motion surveys. The second phase was a calibration survey during the second two weeks of November 2005 (after the rainy season). During this phase random traffic counts were done at four of the stations and weigh-in-motion surveys at three sites. Because the project had to be completed within a period of seven months, there was limited flexibility in terms of selecting the two survey dates.

Comparing the traffic counts for the two phases a significant increase in traffic volumes from September 2005 to November 2005 was evident. The average increase for the three stations on the national roads was 29% in terms of Average Daily Traffic (ADT) and 24% in terms of Average Daily Truck Traffic (ADTT). This indicates a significant seasonal variation in traffic volumes.

3 STATUS OF HEAVY VEHICLE OVERLOADING IN SENEGAL

3.1 Introduction

The weigh-in-motion surveys were done using portable low speed weigh-in-motion (LSWIM) axle scales, the MASS-5000L supplied by Mikros Systems in South Africa. The equipment weighs individual axles while the vehicle is driven over the load sensors at approximately 5km/h. The MASS-5000L is equipped with a low profile load cell weigh sensor that is generally accurate to within 3%.

In order to evaluate the level of overloading in Senegal, the loads as measured during the WIM surveys were compared with the legal axle and vehicle loads in Senegal. The legal axle and axle unit loads are presented in Table 1.

Table 1: Legal axle and axle unit loads in Senegal

Description	Maximum load (tons)	
	Steering	Non-steering
Single axle	6	12
Double axle unit (tandem)	10	20
Triple axle unit (tridem)	-	25

3.2 Level of overloading of heavy vehicles in Senegal

When evaluating the level of overloading, two factors have to be considered, namely the extent of overloading and the degree of overloading. The extent of overloading refers to the number of vehicles that are overloaded and is usually expressed as a percentage of the total number of vehicles. The degree of overloading refers to the amount by which an individual vehicle is overloaded. The degree of overloading can be expressed as the actual value by which the vehicle is overloaded in kilogramme or as a percentage of the legal load of the vehicle. An average overload value can also be determined for a population of overloaded vehicles.

Based on the results of the 5 WIM surveys, it is clear that overloading is a serious problem in Senegal. The extent of overloading is on average 16.3% for all heavy vehicles, while the average degree of overloading is very high at approximately 7 t per overloaded vehicle i.e. 25%.

The most problematic vehicle classes are Class 12 (extent of 41% and degree of 20%); Class 112 (extent of 46% and degree of 27%); Class 113 (extent of 38% and degree of 21%); Class 122 (extent of 43% and degree of 36%); and Class 123 (extent of 27% and degree of 46%).

In terms of axles and axle units, 15% of all vehicles' steering axles were found to be overloaded by an average of 1 137kg or 19%; 16% of all drive axles/axle units overloaded by an average of 4 318kg or 33%; and 40% of all axle units on semi-trailers overloaded by an average of 6 485kg or 31%.

Forty percent of the Class 11 vehicles weighed were midi-buses that can be classified as light heavy vehicles that generally do not cause significant road damage. The presence of these vehicles in the Class 11 sample had the effect that the level of overloading of Class 11 vehicles appeared to be low. If these midi-buses are excluded from the Class 11 sample, the extent of overloading of the remaining Class 11 vehicles is also very high (22%).

3.3 Problem cargoes

In order to establish for what type of cargo the level of overloading is the highest, an analysis of the WIM data was done in terms of cargo. During the survey, 8 classes of cargo were identified, namely containers; tankers; timber; steel; general goods; sand; cement; and passengers (buses). The analysis showed that the most problematic types of cargo are cement and sand. Cement is particularly severe with an extent of overloading of 91% and an average degree of overloading of 32%. Steel and general goods are also problematic. It was also identified that 32% of all tanker vehicles weighed were overloaded. This could be symptomatic of a fault in the design of these vehicles, i.e. the size of the tank being too large for the number of axles on the vehicle. The same problem, although to a lesser extent, appears to exist with vehicles carrying containers.

4 ROAD DAMAGE (COST)

4.1 Introduction

Axle overloading primarily affects the durability of a road. It reduces pavement life and over stresses bridges and culverts. Because of the exponential relationship between an axle load and the resultant pavement wear (or damage), overloaded vehicles generally cause pavement damage well in excess of what legally loaded vehicles cause. By eliminating overloading, a significant saving in road infrastructure maintenance can be realised. The results of the weigh-in-motion surveys were used to quantify additional pavement damage caused by overloaded vehicles in Senegal.

In all calculations the equivalent standard axle loads (ESALs)¹ or E80s are calculated using the following formula:

$$ESALs (E80s) = \left(\frac{P}{Ps} \right)^a$$

Where P = axle load
Ps = standard axle load, taken as 8 200kg
a = damage coefficient, taken as 4.

The calculation of the additional road damage caused by overloaded vehicles was done in the following way:

- Step 1 The WIM data was analysed to determine the average extent of overloading per class and the average E80s for overloaded vehicles per class.
- Step 2 The legal axle loads in Senegal were used to calculate the legal E80s per vehicle class.
- Step 3 The difference between the average overloaded E80s and the legal E80s per class was calculated to determine the average overloaded E80s per class.
- Step 4 The average extent of overloading per class and the average overloaded E80s per class were then applied to the available vehicle counts from the 2002 traffic counts to determine the

¹ ESAL: Equivalent Standard Axle Load, a standard axle load originally defined as 18,000 lb (now normally taken as 8,200 kg or 80 kN) on dual wheels used as the measurement unit in road structural design and damage evaluation.

- additional E80s due to overloaded vehicles per road section for which traffic counts are available.
- Step 5 The additional E80s due to overloaded vehicles per road section were then multiplied by the length of the road section to determine the additional E80-km due to overloaded vehicles per road section and the total for all road sections.
- Step 6 The total additional E80-kms due to overloaded vehicles was then multiplied by a road damage cost per E80-km to determine the additional road damage caused by overloaded vehicles.

In the calculations of the average extent and degree of overloading, the data from the Keur Mbaye Fall site was not included as this site covered traffic of a local nature not representative of the overall road network. Buses were also excluded from the road damage calculations. The reason is that the majority of buses are midi-buses that can be classified as light heavy vehicles that generally do not cause significant road damage. It is important to note that although buses may not be overloaded in terms of the legal loads and therefore do not cause significant road damage, they may be loaded beyond the manufacturer's specifications for the vehicle and/or tyres and may therefore be a safety risk.

The 2002 traffic counts used the following heavy vehicle classes:

Passenger vehicles:	Buses
Goods vehicles:	Single truck with 2 axles
	Single trucks with more than two axles
	Articulated vehicles

In order to use the 2002 traffic counting data, the WIM data was converted to the 2002 vehicle classes, as follows:

<u>2002 class</u>	<u>WIM class</u>
Goods vehicles:	
Single truck with 2 axles	Class 11
Single trucks with more than two axles	Class 12
Articulated vehicles	Weighted average of classes 112; 113; 122; and 123

Using the average overloaded E80s per vehicle per class and the average extent of overloading per vehicle class, and applying this to the traffic counts from the 2002 traffic counting survey, the additional E80s from overloaded vehicles and the additional E80-km were calculated. The 2002 traffic counting survey contained 126 sites. The length of road represented by these 126 sites is 5 169km. The result of these calculations was that overloaded vehicles causes an additional 4,3 million E80-km on this 5 169km of the road network per day.

To determine the additional road damage caused by overloaded vehicles, it is necessary to multiply the estimated E80-km with a cost per E80-km. A road pavement maintenance cost of US\$0.04/E80-km was used. This value is based on a Southern Africa Transport and Communications Commission (SATCC) study (2) that was done in 1994, and subsequent studies in South Africa.

The total additional road damage caused by overloaded vehicles was thus estimated at US\$171 500/day. Assuming the additional E80-km occur on average 6 days per week, this translates to an estimated additional road damage cost caused by overloaded vehicles of US\$ 53,5 million per annum.

5 OVERLOAD STRATEGY

5.1 Introduction

The long-term goal of an overload control strategy should be to reduce the number of overloaded heavy vehicles to an acceptable level and thereafter to contain overloading at this level. It is not practically possible to eliminate overloading completely, but it should be possible to reduce the number of overloaded vehicles to between 5 and 10% of all vehicles on the road and then to maintain it at this level.

5.2 Objectives of an overload control strategy (3)

The objectives of an overload control strategy should be to:

- Preserve the road infrastructure assets cost effectively;
- Ensure a high apprehension rate, sufficiently deterring penalties and successful prosecution of overloaded heavy vehicles;
- Ensure that transport costs to the national economy are kept to a minimum;
- Improve road safety; and
- Encourage consultation and liaison between all the role players.

5.3 Integrated and holistic overload control (3)

An overload control strategy should be approached in an integrated, holistic and comprehensive manner. By integrated it is meant that the overload control strategy should be an integral part of the country's broader road management and safety strategies. A holistic approach would mean that all the aspects of the overload problem should be addressed. This means that it would not be sufficient simply to supply infrastructure for overload control (such as weighbridges) without addressing other aspects, such as manpower; operations; maintenance; and legal and judicial aspects of overload control.

A comprehensive overload control strategy should involve all, or as many as possible, of the role players of the various disciplines that are involved in the road freight industry

5.4 Different overload control options

Two overload control options can be considered: an area approach and a corridor approach. An area approach is applicable where a high volume of heavy vehicles travel on a number of roads in an area, such as a metropolitan or industrial area. In this case, one or more fixed weighbridges should be located in such a position that they are easily accessible from the roads in the surrounding area. Heavy vehicles are then taken from the roads in the area to these weighbridges to be weighed.

A corridor approach is applicable when there are one or more a well defined corridors that are used by heavy vehicles. A corridor can consist of a main road and a number of alternative (escape) routes that run more or less parallel to the main road. In this case a fixed weighbridge is usually placed next to the main road to intercept all heavy vehicles travelling on the main road and to weigh these vehicles at the weighbridge. Depending on the volume of heavy vehicles, it may be necessary to carry out screening of heavy vehicles on the main road to identify those vehicles that are probably overloaded. Depending on the length of the corridor, it may be necessary to provide more than one fixed weighbridge.

As part of the corridor approach, it would also be necessary to intercept potentially overloaded heavy vehicles on the alternative routes and to send these to the fixed weighbridge to be weighed. Once again the volume of heavy vehicles on the alternative routes would dictate how potentially overloaded vehicles are identified. The simplest way would be to use visual screening. The next level of screening would be to use portable scales, either dynamic or static type of scales. On alternative routes with high heavy vehicle volumes it could even be necessary to install fixed screeners, such as high-speed weigh-in-motion (HSWIM) scales or slow-speed weigh-in-motion (SSWIM) scales. HSWIM scales are installed in the road where the heavy vehicles normally travel, while SSWIM scales would require the construction of a lay-by where the scale is installed and the heavy vehicles can be weighed at slow speed.

5.5 Recommended overload control option for Senegal

Eight heavy vehicle routes were identified in Senegal. The majority of the heavy vehicle traffic in Senegal travels on these eight routes and the most appropriate overload control option for Senegal would therefore be a corridor approach. The corridor approach can however be modified taking into account that the majority of heavy vehicles in Senegal travel to and from Dakar and have to travel on the N1 between Dakar and Diam Niadia. At Diam Niadia the traffic splits onto the N1 and N2 with a further major split at Thies where the N3 splits off from the N2.

The most cost effective option for Senegal would therefore be a cordon approach, whereby all heavy vehicles entering or leaving the Dakar region should be checked, and if overloaded, apprehended. This approach would require a number of fixed weighbridges to be constructed on the major routes leaving and entering the Dakar region, while screening would be done on alternative routes.

6 PROPOSED WEIGHBRIDGES

6.1 Locations

In order to give effect to the cordon approach, it was recommended that weighbridges be established at the following sites:

- N1 west of Diam Niadia (before the N1 and N2 split);
- R10 north of Rufisque (north of the R10/N1 intersection);

These two sites can be supported by two further sites, namely:

- N2 north of Thies; and
- N3 east of Thies.

These four sites will form an effective cordon around the Dakar region.

Apart from these four sites there are three other sites that should be given consideration in future. The first site is on the N1 between Dakar and Rufisque. There are approximately 1 200 heavy vehicles per day on this section of the N1 that only travel between Dakar and Rufisque. These vehicles form part of the local traffic and would not pass the proposed N1-Diam Niadia site. Consideration could therefore be given to establishing a weighbridge on the N1 between Dakar and Rufisque. It is however anticipated that the heavy traffic congestion experienced on this section of the N1 could make it difficult to conduct overload control operations.

There are two further road sections that carry a significant number of local heavy vehicles traffic, namely the N3 between Mbake and Touba in the Diourbel region and the N4 between Ziguinchor and Bignona in the Ziguinchor region. Weighbridges on these two sections of road should be considered in the future.

6.2 Priority

The average daily truck traffic (ADTT) and the expected number of overloaded heavy vehicles past each of the four proposed weighbridge sites (both directions) are presented in Table 2.

Table 2: ADTT and number of overloaded heavy vehicles at each proposed weighbridge site

Proposed weighbridge	ADTT	% overloaded heavy vehicles	Number of overloaded heavy vehicles per day
N1–Diam Niadia	4 600	31%	1 426
R10-Rufisque	1 300	25%	325
N2-Thies	1 200	17%	204
N3-Thies	1 600	23%	368

In terms of number of heavy vehicles and strategic location in relation to the major heavy vehicle routes, the N1-Diam Niadia site has the highest priority.

The site with the second highest priority is the R10-Rufisque site. The first reason is that the R10 carries a high number of heavy vehicles that do not pass the Diam Niadia site. The second reason is that the R10 between Rufisque and Bayakh could become part of an alternative route for heavy vehicles wanting to avoid the proposed N1-Diam Niadia weighbridge once constructed. Two alternative routes are possible. One is the R10 from the N1 at Rufisque to Bayakh and from there on the D700 to the N2. The second alternative route is the R10 from the N1 at Rufisque to Bayakh continuing on the R70 through Mboro to Lompoul on to the R30 to the N2 close to Kebemer.

The site with the third highest priority is the N3-Thies site due to the higher volume of heavy vehicles on this section, making the N2-Thies site the site with the fourth highest priority.

In summary, the priority list is as follows:

1. N1-Diam Niadia

2. R10-Rufisque
3. N3-Thies
4. N2-Thies

The location and priority of the proposed sites are shown in Figure 2.

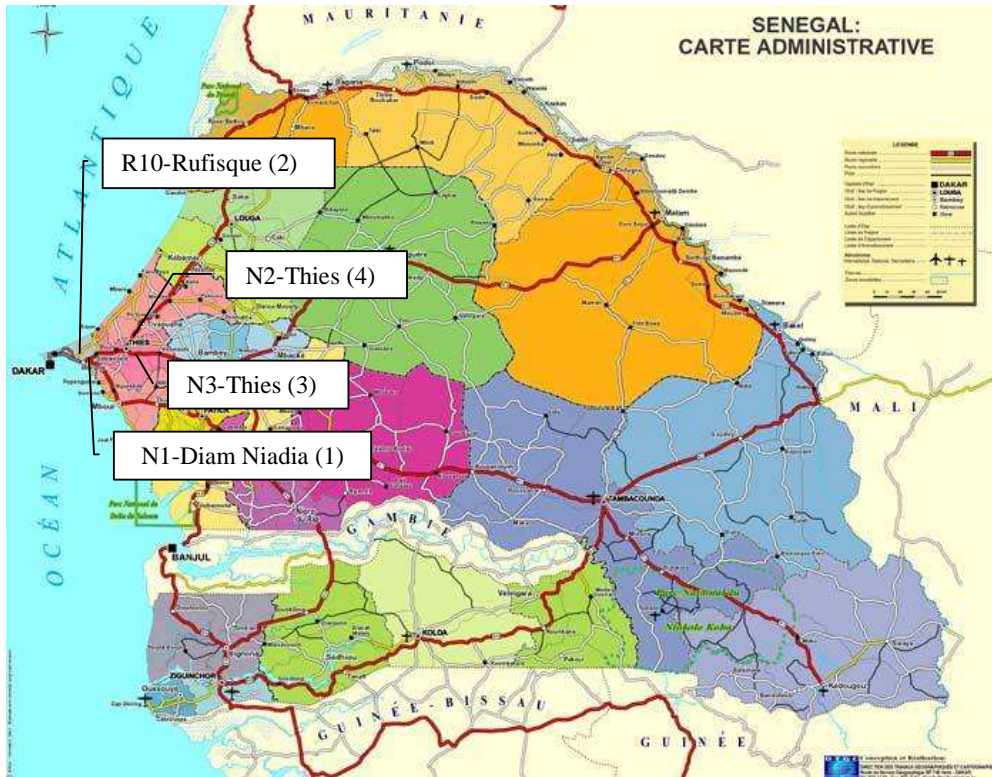


Figure 2: Location and priority of proposed weighbridge sites

6.3 Size/Lay-out of proposed weighbridges

Based on the heavy vehicle volumes at the four identified sites, the recommended size and lay-out of the four proposed weighbridges are as follows:

N1-Diam Niadia site: A dual facility with one weighbridge for the eastbound traffic and a second weighbridge for the westbound traffic. The two weighbridges should be equipped with a three deck scale. These two weighbridges should be operated on a 24-hour basis. For screening purposes it is recommended that HSWIM scales be installed on the N1 in both directions.

R10-Rufisque site: A single facility, equipped with a three deck scale is proposed for this site. For screening, it is recommended that HSWIM scales be installed on the R10 in both directions. This weighbridge should be operated on a 24-hour basis if possible, but a 16-hour basis could be considered.

N3-Thies site: A single facility, equipped with a three deck scale is proposed for this site. For screening, it is recommended that HSWIM scales be installed on the N3 in both directions. This weighbridge should be operated on a 24-hour basis.

N2-Thies site: A single facility, equipped with a three deck scale is proposed for this site. For screening, it is recommended that HSWIM scales be installed on the N2 in both directions. This weighbridge should be operated on a 24-hour basis.

If the long term goal of reducing the extent of overloading to a maximum of 10% is achieved, the estimated number of heavy vehicles at each of the proposed weighbridge sites would be as follows:

- N1-Diam Niadia: 460
- R10-Rufisque: 120
- N3-Thies: 130
- N2-Thies: 160

Although the number of overloaded vehicles should reduce, the recommended size and lay-out of the four proposed weighbridges are still appropriate. Screening can never be one hundred percent accurate and the sample of trucks weighed at a weighbridge would always include non-overloaded vehicles. The growth in traffic would also result in an increase in the number of vehicles to be weighed.

The dual facility recommended at N1-Diam Niadia is warranted due to the high volume of traffic on this section of road (ADT of 17 300 in November 2005) and because a large number of the heavy vehicles travel at night on this section of the N1. A single facility would require heavy vehicles to cross the oncoming traffic and this would create an unsafe situation.

6.4 Weighbridge at the Port of Dakar

As the majority of heavy vehicle traffic in Senegal has its origin and destination in Dakar, and more specifically the Port of Dakar, an effective way to control overloading would be to weigh all heavy vehicles leaving and entering the Port of Dakar. It was therefore recommended that negotiations be entered into with the Port Authority to establish weighbridges at the main entrances to the port. These weighbridges would be used for overload law enforcement and should comply with all the requirements in terms of facilities, equipment, type of scale, computer equipment, software, and holding facilities. The existing weighbridge at one of the port entrances, which is currently used for commercial purposes, could be upgraded to a multi-deck scale and be used for law enforcement in addition to its current function. However, the logistics of the weighing activities would have to be analysed to ensure that undue delays are not caused.

7 OPERATIONAL ISSUES

7.1 Manpower

In terms of operating the proposed weighbridges, experienced and well trained personnel are a key element to an efficiently operated weighbridge. The number of personnel at a weighbridge is a function of the operational hours as well as the number of heavy vehicles passing through the weighbridge. (3) It was recommended that 13 persons are required per shift to operate a weighbridge. Of the 13, 4 would be performing administrative and operational tasks and need not be traffic police.

7.2 Operational hours

It was recommended that all the proposed weighbridges be operated on a 24-hour basis. This would require three 8-hour shifts. If a weighbridge cannot be operated for 24 hours due to manpower constraints, it should be operated for a minimum of 16 hours per day. In these cases, the starting time of the shifts should be changed from day to day so that the operators and drivers of the heavy vehicles cannot establish an operational pattern for these weighbridges.

7.3 Calibration and maintenance of equipment

Calibration and maintenance of equipment is very important. Failure to maintain and calibrate the scale could lead to the withdrawal of cases in court. The calibration interval required by the relevant state department must be adhered to. (3)

7.4 Computerisation

All weighbridges should be equipped with an integrated computer and management information system. The computer system should be connected to all weighing equipment installed at the weighbridge to record automatically the data produced by this equipment. (3) A software package should be installed that can process the scale readings and the data from the vehicle and driver, which would be manually entered, to determine whether the vehicle is overloaded. Data collected should be forwarded to the Ministry's office on a monthly basis for analysis.

7.5 Cooperation with the judiciary

An important part of the overload control strategy is the court system. This could be a major obstacle to effective overload control if the cooperation of the judiciary is not obtained. Court officials should be educated on the importance of the prosecution of overload cases to reduce road damage and to promote road safety.

7.6 Detaining overloaded vehicles

An effective deterrent in the combating of overloading is to detain an overloaded vehicle until the load on the vehicle has been brought to within legal limits. (3) If a vehicle is only overloaded on axles all that would be required is a shifting of the load. If the vehicle is overloaded on total permissible vehicle mass, it would require that some of the load be off-loaded. In these cases the portion of the load that has to be off-loaded must be transferred to another vehicle and may not be off-loaded onto the ground.

7.7 Alternative routes

Screening of heavy vehicles on alternative routes is very important to ensure that these routes are not used by overloaded heavy vehicles to avoid weighbridges on the main roads. Visual screening only can be done and could be sufficient if the volume of heavy vehicles is low and the traffic police are experienced. In cases where the distance from the point of screening to the weighbridge is long, it is recommended that portable scales be used for screening purposes.

7.8 Public-Private Partnerships

The structuring of sound contracts with private partners is an important way in which government can improve public service delivery. In this way the state can complement its budgetary capacity with the wealth of innovative and specialist skills available in the private sector. Furthermore, available state resources must be used to leverage much-needed private sector investment in public infrastructure and services.

The involvement of the private sector in public service delivery is usually referred to as public-private partnerships (PPP). A PPP can be defined as a contractual arrangement between the public sector and a private entity where the private sector performs a departmental function or uses state property in accordance with output specifications for a significant period of time, in return for a benefit. It involves a substantial transfer of all forms of project life cycle risk (financial, technical, and operational) to the private sector and the private sector contracts to undertake the functions which it is better equipped to manage. The public sector retains a major role either as main purchaser of the service or as main enabler of the project continue to manage the areas it is best able to control and for which it has the staff, skills and resources

The main benefit of a PPP is usually seen as the delivery of a better or more services for the same price that can be delivered by the public sector, or delivering the same service at a lower price. Other benefits, which are sometimes the most important, are budget-planning (the public sector has a fixed price contract to deliver the service), delivery of the service on time and on budget and sustainability. An additional benefit is the sharing of skills, knowledge and competencies amongst the parties involved in the PPP.

It was recommended that consideration be given in involving the private sector in the construction, operation and maintenance of the four proposed facilities. A proposed allocation of the various functions that are performed at a weighbridge to either the public sector or private sector partners are presented in Table 3.

Table 3: Allocation of Weighbridge Operation Functions

Function	Public Sector	Private Sector
Construction of facility	X	X
Supply of computer and office equipment		X
Maintenance of infrastructure		X
Day-to-day cleaning of premises		X
Cleaning of site and garden services		X
Calibration of scale		X
Maintenance and replacement of computer and office equipment		X
Supply of equipment		X
Operating equipment		X
Maintenance and replacement of equipment		X
Stopping vehicles	X	
Directing vehicles to weighbridge	X	
Escorting of vehicles to weighbridge	X	X
Maintenance and replacement of equipment		X
Directing vehicles at scale		X
Collecting information from driver and vehicle	X	X
Measuring axle distances	X	X

Entering information into computer		X
Printing weigh ticket		X
Directing overloaded vehicle to holding area	X	
Verifying information of overloaded vehicles	X	
Issuing charge notices	X	
Re-weighing vehicles once load has been corrected		X
Releasing vehicles once load has been corrected	X	
Testifying in court	X	X
Issuing warrants of arrest	X	
Collection of fines	X	X
Collection of data		X
Reporting		X

Important issues pertaining to PPPs in overload control that should be considered are the type of PPP contract; payment for services rendered by the private partner; the availability of traffic police on a continuous basis; a performance contract for the private partner; the involvement and support of the court system; traffic measuring points to evaluate the effectiveness of overload control undertaken at a weighbridge; and reporting to evaluate the performance of the private sector partner.

8 FEES AND PENALTIES FOR OVERLOADING

Vehicle overload control, the level of penalties, and the judicial/administrative mechanisms to deal with the problem, have received considerable attention during the past three decades throughout the world. Problems associated with heavy vehicle overloading are exacerbated by numerous factors, chief amongst which are the enforcement and penalty aspects.

The fines imposed for overloading remain, in most cases, unrealistically low compared with the damage done by the vehicle on the road and the higher profit made by the hauler in transporting a heavier load. Such fines obviously do not have a significant effect on discouraging overloading and the income derived from these fines is insignificant compared to the road damage. The income from fines is in many cases paid into a "central account" and is usually not directly available for road maintenance purposes.

A need therefore exists for the introduction of some form of user charges or fees to recover costs from the operators of overloaded vehicles in order to carry out timeous road maintenance.

Shortcomings in the legal frameworks for dealing with overloading concern the time-consuming, expensive, and often tardy (possibly due to relatively low priority), prosecution process when cases are taken to court (presumably when fines are unpaid). The practice in many industrialised countries is therefore to remove the burden to the courts created by mass-violations, by treating such offences administratively. This is achieved by way of a system with administrative "on-the-spot" fees for overloading. The cases then going to court should only be appeals contesting that the law was not applied correctly rather than to appeal the size of the administrative fee. Thus the move is towards an "infringement system", decriminalising the offences as opposed to the traditional criminal approach.

The underlying principle is that the user charges should act as a deterrent for potential offenders while having a rational basis to reflect broadly the damage to the road infrastructure, and should certainly outweigh any commercial benefits of overloading for the operator. It is a cost recovery method for an infringement that, apart from damage to the road infrastructure, can have negative impacts on road traffic flow and capacity, traffic safety, and the environment. Although these three factors are extremely difficult to quantify it is clear, nonetheless, that the user charge should also be considered as providing some recompense towards these. It was recommended that the concept of user charges be implemented in Senegal and that a schedule of user charges be developed.

9 CONCLUSIONS

A study was carried out to address a need identified by the Senegal Ministry of Public Works and Transport to control overloading of heavy vehicles on the Senegal road network. The results of a 2002 traffic survey were used to identify eight major heavy vehicle routes. Seven-day traffic counts (including slow-speed WIM surveys) were carried out as five strategic locations in order to quantify the extent and degree of overloading in Senegal. Two set of traffic counts were conducted to account for seasonal variations in traffic volumes. The results of the WIM surveys indicate that approximately 16 percent of heavy vehicles are overloaded and that the average

degree of overloading (per vehicle) is 25% or 7 tons. In terms of axles and axle units, 16% of all drive axles/axle units were overloaded by an average of 33% and 40% of all semi-trailer axle units were overloaded by an average of 31%. Cement was found to be the most problematic commodity with an extent of overloading of 91% and average degree of overloading of 32%. It was estimated that the additional pavement damage caused by the overloaded portion of overloaded vehicles amounts to US\$ 53.5 million per annum.

It was recommended that the proposed overload control strategy be based on an integrated and holistic approach, addressing various aspects such as infrastructure for overload control, manpower, operations, maintenance, sustainable funding, overload penalties and legal and judicial aspects. In terms of proposed infrastructure, a corridor approach is recommended involving the establishment of four weighbridges on the N1 (west of Diam Niadia), N2 (north of Thies), N3 (east of Thies) and R10 (north of Rufisque). These weighbridges should ideally be operated on a 24-hour a day basis. An additional weighbridge on the N1 between Dakar and Rufisque should be considered in the future to control overloading of local heavy vehicles travelling in the Dakar region, but frequent traffic congestion on this section of road could be a problem. Three-deck scales are recommended for all the proposed facilities, with a dual facility (for eastbound and westbound vehicles) at Diam Niadia. Weighbridge facilities at the Port of Dakar are also recommended, which could, in co-operation with the Port Authorities and the Chamber of Commerce, serve a dual purpose of law enforcement and commerce.

It was further recommended that consideration be given to entering into a public-private partnership with the private sector for the construction and operation of the proposed weighbridges. The various functions at the weighbridge that should be fulfilled by the public and private sector personnel were identified. Finally, it was recommended that an infringement system be developed and implemented in order to introduce user charges for overloading, which are related to the cost of infrastructure damage caused by overloaded vehicles.

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