A System For Monitoring Overloaded Vehicles

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ABSTRACT

Although road management and maintenance management systems are commonly used, less attention has been given to monitoring overloaded vehicles, despite the fact that the greatest damage to the pavement is caused by overloading. In many cases, vehicle weighing is not under the control of the road authority. This paper describes a vehicle overloading management system and its implementation since 1988 in the province of KwaZulu-Natal, South Africa. The benefits accruing to the road authority through its introduction are many: its use as a management tool; the ability to identify problem vehicle configurations, problem loads and problem hauliers who have a deliberate policy of overloading their vehicles; the ability to monitor trends of average and maximum overloads over time; and so on. The monitoring system has proved to be very successful - average overloads have reduced significantly over the past seven years. The system has been introduced to all nine provinces in South Africa and has recently been installed in Malawi. By reducing overloading, the haulage industry has benefitted and is now able to tender more fairly for contracts. The paper also describes major problems facing the road authorities in South Africa with regards control of vehicle overloading and highlights some of the important factors that should be addressed in order to achieve an effective enforcement programme.

INTRODUCTION

The deterioration of the road pavement is largely a function of the traffic loads acting on the pavement. Between fifteen and twenty per cent of all heavy vehicles on South Africa's roads are overloaded and these vehicles contribute approximately sixty per cent of the damage to the road infrastructure. The aim of vehicle overloading enforcement is to minimise this damage, thereby optimising the funds available for road construction and maintenance, and to improve safety for the road user.

In the light of the significant reduction in funds available for construction and maintenance of urban roads in South Africa, the preservation of this huge investment has become a priority for road authorities there.

The control of overloading of heavy vehicles has been a problem in South Africa for many years. Increased traffic volumes and the competitive haulage market have resulted in increased numbers of overloaded vehicles. Overloaded vehicles significantly reduce the life of the road network, and severely damage the road pavement and, to a lesser extent, bridges. The present deregulation of the transport industry is likely to aggravate this situation.

CONTROL OF VEHICLE OVERLOADING

The provincial road authorities in South Africa weigh vehicles statically on a regular basis throughout the year. During 1993, almost 95 000 vehicles were weighed at weighbridges throughout the country, of which 40 per cent were overloaded. This is 45 per cent higher than the number of vehicles weighed in 1992.

A Vehicle Overloading Management System has been developed by the Division of Roads and Transport Technology, initially in conjunction with the KwaZulu-Natal Department of Transport, for the analysis of weighbridge data. During 1991 the system was implemented in the other provinces in South Africa, so that currently all data is collected in a uniform manner for compilation into a national database. The program is able to perform various analyses which assist the provinces in identifying problem areas. The output sheet gives detailed information on all vehicles weighed at a specific weighbridge site during a specific period. Another report sheet lists a number of transport companies which operate in each province, together with the number of vehicles weighed from each company and the number that were overloaded. Transport companies guilty of regular overloading can thus be identified. A monthly or annual breakdown of overloading statistics at each weighbridge site can help authorities identify problem routes and thus plan their enforcement strategy.

Other reports can assist the Road Traffic Inspectorate. For example, sugar cane is a troublesome commodity to transport because of its variable moisture content. This crop is harvested during the summer months along the coastal plain of KwaZulu-Natal and the traffic officers would

concentrate their efforts there during summer. In the winter months more attention is given to companies transporting coal to the provinces inland which experience severe winters. Other commodities that are often overloaded include granite blocks, timber, sand and stone, lime and cement.

PROBLEMS RELATED TO VEHICLE OVERLOADING

There are a number of problems related to vehicle overloading and law enforcement. These problems, although inter-related, can be divided into six areas as follows:

- hauliers
- traffic police
- magistrates' courts
- level tolerances
- penalties
- alternative routes

HAULIERS

Transport companies operating in South Africa today work in a highly competitive market. One of the ways of maintaining a competitive edge is to adopt a policy of loading vehicles to maximum capacity, which usually results in overloading. This policy pays because of the relatively low fines for overloading and the low level of enforcement in many parts of the country. Furthermore, many vehicles operating on South African roads are designed to accommodate higher axle loads than are permitted in this country. In the light of the level of enforcement and fine structure, it is obviously tempting for operators to use the full capacity of vehicles without causing them damage.

Thus a situation exists where some hauliers have been forced out of business because of the policies of their competitors. It is solely the responsibility of the state's traffic authorities to ensure that the deterrents against overloading are severe enough to make a policy of deliberate overloading unattractive.

TRAFFIC POLICE

It appears that the major problem facing the traffic police regarding law enforcement is a lack of funds and staff. Most of the provinces simply do not have the necessary facilities and staff to ensure a satisfactory level of enforcement.

Furthermore, many of the traffic officials seem to evaluate the seriousness of a traffic violation solely in terms of road traffic safety rather than, for example, cost of damage to the road network. Thus a speed violation is seen to be far more serious than an overload violation. Although an overloaded vehicle is, generally speaking, less safe than a legal vehicle, the main concern to the road authorities and the taxpayer is the cost of damage to the road infrastructure. In the long term, pavement deterioration reduces road traffic safety in any event.

In short, the traffic authorities should be allocated sufficient funds to ensure not only a satisfactory level of law enforcement but also widespread prevention of vehicle overloading.

MAGISTRATES' COURTS

For various reasons, many traffic authorities are of the opinion that magistrates tend to favour the case of the haulier. One possible reason is that the magistrate, and to some extent the haulier, see the regulations concerning maximum permissible axle and axle unit loads and the concentration of load on a group of axles, Regulations 365 and 365A respectively, as contradictory. The most common example illustrating this view is that of a vehicle which is legal according to Regulation 365 but illegal according to Regulation 365A, the bridge formula. The question is frequently asked: How can a vehicle be legal according to part 365 of the regulation and yet be illegal according to part 365A? Surely the haulier must be given the benefit of the doubt? This line of reasoning is of course invalid. Travelling through a red traffic light is obviously not legal simply because one travels at less than the speed limit.

It is important to understand that the two regulations exist for two completely different reasons which are unrelated. Regulation 365 is intended to protect the road pavements while Regulation 365A is for the protection of bridges and culverts. It is perhaps unfortunate that the regulations are implicitly related merely because they are numbered 365 and 365A.

Another problem relating to the courts concerns the intention of the law. In many court cases it would seem that the focus of the deliberations is on the technicalities regarding vehicle weighing and measurement of the distance between axles, rather than the underlying principles of vehicle overloading. For example, if there is doubt as to the accuracy of a mass measurement, to the nearest 250 or 500 kg, the fine is reduced or the case withdrawn, irrespective of the fact the axle in question may have been 50 or 100 per cent overloaded. The net result is that in some areas, the traffic authorities have all but given up contesting cases in court because of the high percentage of acquittals.

In order to try and solve the above problems, it is essential that a number of issues be addressed. The prosecutor and witnesses (traffic officials) must have a thorough knowledge of the sections in the Road Traffic Act dealing with vehicle overloading, as well as which part of the law is being applied in a particular prosecution. Sufficient information must be provided, and the equipment used for weighing must be calibrated at the required intervals. If the technicalities are incorrect, or the information incomplete, the magistrate is powerless to judge in favour of the State because he cannot deviate from the law.

It is also important that the magistrate be made fully aware of the seriousness of the offence of vehicle overloading and of the practical problems involved with vehicle weighing. The KwaZulu-Natal Department of Transport has gone a long way to solving this problem by adopting a policy of inviting magistrates to a weighbridge site and demonstrating the weighing of vehicles. Most of the provinces now also make use of prosecutors who have had specific experience in vehicle overloading cases.

LEVEL TOLERANCES

Unacceptably high level tolerances on the concrete approach slabs of single axle scales has been a particular problem in the province of the Western Cape. Inconsistent mass readings from different weighbridges due to a variation in the levels of approach slabs has resulted in the Attorney-General of that province terminating all weighing activities for overloading enforcement until the approach slabs of the problematic weighbridges have been upgraded. In some cases the single axle scales have been replaced with 4 x 3 metre axle unit scales which are able to weigh tandems and tridems as single units.

Experimental research conducted at a multi-deck weighbridge during 1994 by the Division of Roads and Transport Technology, CSIR, has highlighted the tridem axle unit as being very sensitive to the level tolerances of the approach slabs of single axle scales. Steel plates were used to simulate a range of 'bump heights' of adjacent axles, axle units or groups of axles during the weighing process. It was found that in general, the bump height of axles or axle units of adjacent groups of axles has a negligible effect on the mass accuracy of the axle or axle unit being weighed. However the bump height under an axle *within* an axle unit (tandem or tridem) has a significant effect on the load distribution within the axle unit being weighed. A bump height of 20 mm under one axle of a tridem unit may cause a load variation of up to 40 per cent. This reduces to approximately 10 per cent for a bump height of 5 mm. Tandem axle units were found to be less sensitive and a bump height of 20 mm may cause a load variation of up to six per cent.

PENALTIES

The maximum fine that can be imposed by a traffic officer for admission of guilt for overloading was increased from R300 (US$ 85) to R1 000 (US$ 280) per vehicle on 1 July 1992, according to the Criminal Procedure Act. This means, for example, that an articulated vehicle can be given a maximum fine of R2 000 (US$ 560) if both the truck tractor and the semi-trailer are severely overloaded. In practice, however, fines for overloading seldom exceed R1 000 (US$ 280) per vehicle combination.

These fines are negligible compared with the damage done by the vehicle on the road and the higher profit made by the haulier in transporting a heavier load. In fact it makes sense, from an economic point of view, for the haulier to make additional profits by carrying a heavier load and running the risk of a R200 (US$ 55) to R1 000 (US$ 280) fine!

Although the maximum fine for vehicle overloading that can be imposed in a court of law was increased from R2 000 (US$ 560) to R8 000 (US$ 2 220) in June 1990, and from R8 000 to R24 000 (US$ 6 670) in July 1992, fines above R1 000 (US$ 280) are seldom imposed by the magistrate, and it seems unlikely that the change in legislation will affect the actual fines imposed in court. Although the traffic officer also has the authority to issue a ticket to appear in court, instead of an admission of guilt fine, this is seldom done because of the high percentage of acquittals as described in the section on magistrates' courts.

In the present scenario, the major deterrent to vehicle overloading in South Africa is the possibility of an overloaded vehicle being prevented from proceeding until it complies with the regulations. This may involve a significant time loss to the haulier because the load must either be redistributed on the same vehicle (in cases where the load is incorrectly distributed) or transferred to another vehicle (in cases where the vehicle is grossly overloaded). In the former instance, the haulier will normally have to hire a crane to shift the load and in the latter instance, another vehicle must be sent to the weighbridge site to carry the excess load. Depending on the distance between the weighbridge site and the nearest haulier depot, this may prove very expensive.

In the past, hauliers were allowed to stockpile excess load in the parking-off areas and have it collected at a later stage either by the same vehicle or another vehicle from the same company. However, the parking-off areas became cluttered with unclaimed sugar cane, timber, granite etc. which had to be cleared at the expense of the traffic authorities. This led to the present situation where cargo is not allowed to touch the ground and must be transferred directly from one vehicle to another.

Compared with fines for overloading in many other countries, fines in South Africa are very low. A more effective method of imposing penalties is to have a schedule of fines relating an overload to a fine either by a formula or a table. Thus a penalty commensurate with the degree of overloading can be imposed without the violation having to go to court. For example, in Sweden, a vehicle which is 20 tons overweight (a situation which is not uncommon in South Africa) would automatically be fined the equivalent of R61 000 (US$ 17 000) in Sweden. The haulier would probably get away with a R2 000 (US$ 560) fine in South Africa. In California, the fine would be approximately US$ 9 000.

ALTERNATIVE ROUTES

If a driver of a heavy vehicle is aware that the vehicle he is driving is overloaded, he will obviously try to avoid any operational weighbridges by using a feasible alternative route. With the widespread use of CB radios by drivers of heavy vehicles, it does not take long for the news to spread that the traffic police have started a weighing exercise at a particular weighbridge. This poses a great problem to the traffic authorities in situations where one or more feasible alternative routes exist. In some cases extra manpower is used to monitor the alternative routes with portable vehicle screeners such as the vehicle load monitor, so that overloaded vehicles taking these routes can be escorted to the weighbridge for accurate weighing and subsequent prosecution.

The strategic location of new weighbridges on a road network is thus critical to ensure an effective enforcement programme. In metropolitan areas alternative routes are numerous and the only way of achieving effective enforcement in these areas is through the use of portable weighing equipment in conjunction with a permanent weighbridge.

THE VEHICLE OVERLOADING MANAGEMENT SYSTEM

In order to carry out satisfactory analyses of vehicle overloading data, computerisation of a vehicle weighing management system is essential. Because the KwaZulu-Natal Department of Transport was interested in obtaining more detailed analyses of their vehicle weighing data, a project was started in 1987 to provide the Roads Branch with a database system for the analysis of weigh data from their 11 permanent and 11 mini weighbridge sites. It is important to note that the statistics in this paper are based only on vehicles weighed at weighbridges, and that, because of the vehicle screening process used at some weighbridges, the samples analyzed are not representative of the total vehicle population. Furthermore, in determining the average load of overloaded axles or axle groups, legally loaded axles are not included in the calculations.

Initially, all information was input manually by a data assistant, using the monthly return sheets from each weighbridge site. Subsequently a programme for upgrading the permanent weigh sites was started, which included the computerisation of the weighbridges. This involved the storage of vehicle weighing data on the hard disk of the computer at the weigh site. At the end of each month, all the data was loaded onto floppy disks for transfer to the main database system at the head office in Pietermaritzburg. The number of vehicles weighed at the permanent weigh sites represents approximately 90 per cent of all vehicles weighed during the period 1988 to 1994. Thus, on the average, only 10 per cent of vehicles weighed per month are entered into the system manually.

As weighbridges have been upgraded and computerised, modems have been installed at each weigh site, so that the weigh data can be sent directly from the weigh site to the head office via modem. This obviates the inevitable delay in obtaining the information at the end of each month, as well as the occasional loss of floppy disks. The system is illustrated diagrammatically in Figure 1. In each province, a proportion of the weighbridges has been computerised and the rest require the manual filling in of forms after which the data is fed into a computer, either at a regional office or at the provincial head office.

OVERLOADING STATISTICS IN KWAZULU-NATAL

Vehicle weighing statistics were computerised in the province of KwaZulu-Natal at the end of 1987. Table 1 and Figure 2 show the number of vehicles weighed, overloaded and charged during the period from 1988 to 1994. There has been a significant increase in vehicle weighing since 1989 (16 000 vehicles weighed) to 1993 and 1994 when over 47 000 and 39 000 vehicles were weighed respectively.

The increase in the percentage of overloaded vehicles from 1988 to 1989 can largely attributed to the introduction of vehicle screening at the larger weighbridge sites. Table 2 shows the average overloads in KwaZulu-Natal for the same period for different axle units and the bridge formula. Figures 3 and 4 show that from 1988 to 1993 there has been a steady decline in average overloads which can largely be attributed to the efforts of the province in their overloading enforcement programme. However there were significant increases in average axle and axle unit overloads in 1994.

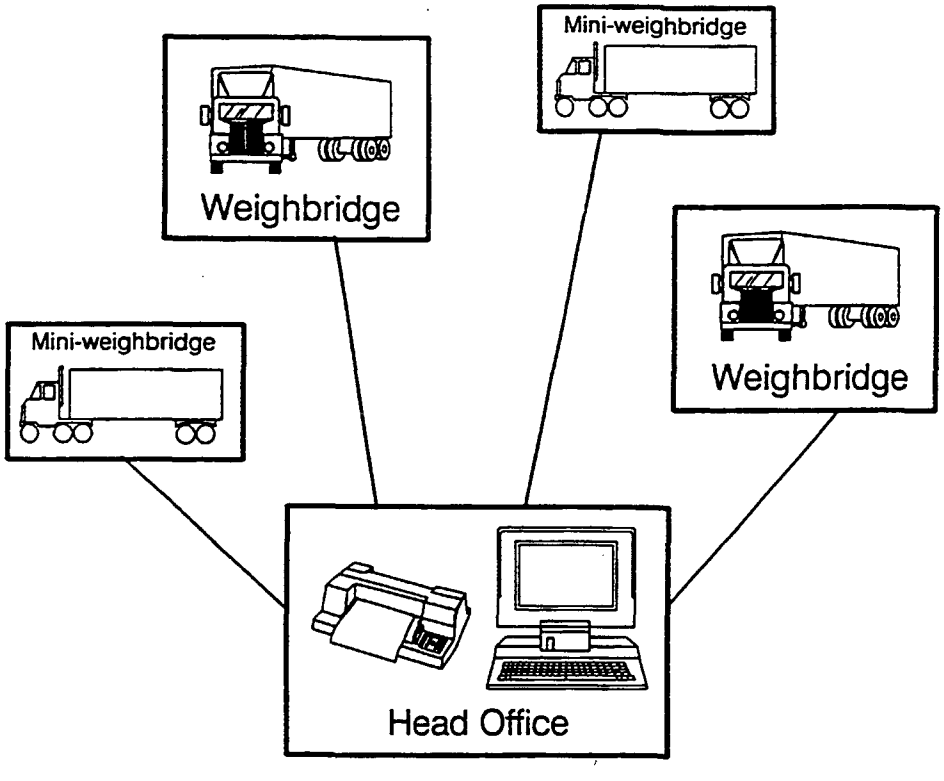

Figure 1. Diagrammatic representation of the Vehicle Overloading Management System

Table 1 : Number of vehicles weighed and overloaded in KwaZulu-Natal from 1988 to 1994

Year	Vehicles weighed	Vehicles overloaded (total)	Vehicles charged (total)	Vehicles overloaded (Reg 365)	Vehicles overloaded (Reg 365A)	Percentage overloaded	Percentage charged
1988	27 284	7 323	7 139	7 071	874	27	26
1989	15 950	8 102	6 820	7 985	976	51	43
1990	15 472	9 280	7 085	9 126	1 336	60	46
1991	31 725	16 195	11 927	15 663	3 356	51	38
1992	33 108	13 897	10 057	13 722	1 309	42	30
1993	47 395	17 673	12 175	17 651	312	37	26
1994	39 230	13 643	6 803	13 579	1 620	35	17

Note: The 'Vehicles charged' and 'Percentage charged' columns reflect the change in tolerance levels from 5 to 15 per cent.

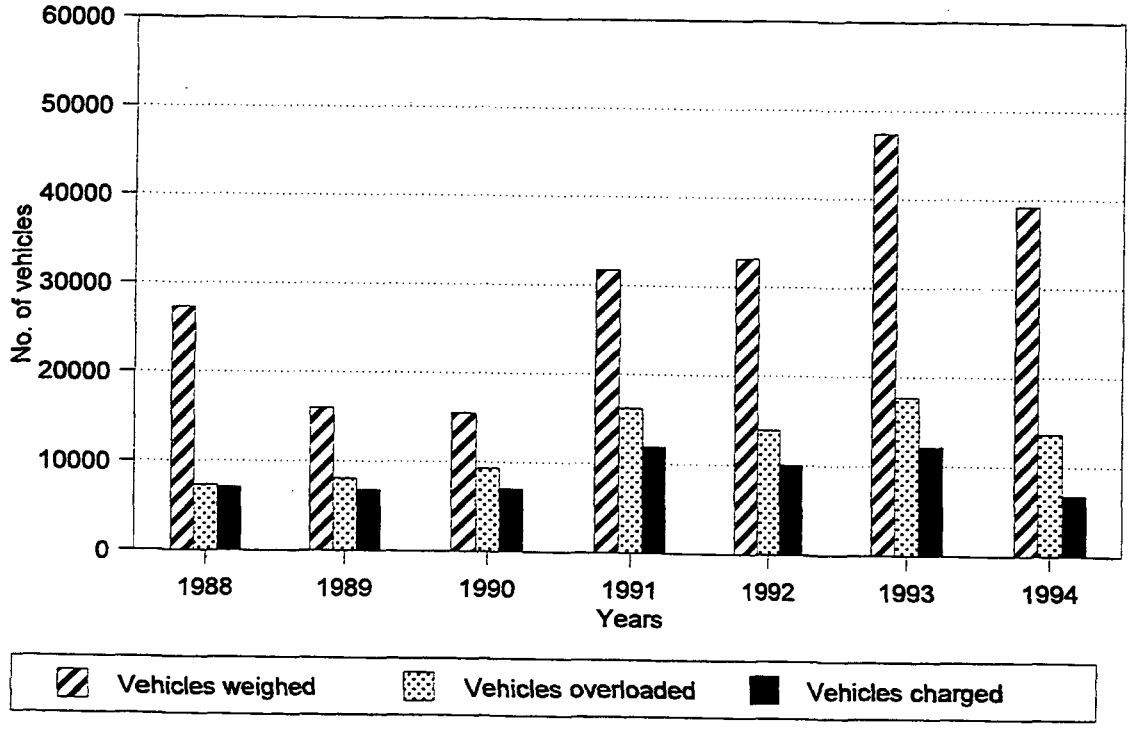

Figure 2. Vehicles weighed, overloaded and charged per year in KwaZulu-Natal: 1988 to 1994

Table 2. Average overloads in kilograms of overloaded vehicles in KwaZulu-Natal from 1988 to 1994

Year	Reg 365 (axles)	Reg 365A (Bridge formula)	8 200 kg axles	16 400 kg axle units	21 000 kg axle units
1988	2 424	4 942	1 779	1 923	2 107
1989	2 161	4 664	1 695	1 752	1 936
1990	1 894	4 145	1 550	1 576	2 044
1991	1 682	3 918	1 394	1 378	1 803
1992	1 496	3 169	1 337	1 282	1 503
1993	1 378	3 121	1 181	1 163	1 504
1994	1 644	2 973	1 299	1 334	1 722

Note: Average overloads are calculated in terms of the legal limits

The average overload in contravention of Regulation 365 (axle loading) increased by 19,3 per cent from 1 378 kg in 1993 to 1 644 kg in 1994. The reason for this sharp increase is primarily due to the change in allowable tolerance on single axles (other than steering axles) and axle units from 5 to 15 per cent in March 1994. Although the tolerance on Regulation 365A (bridge formula) and the gross combination mass has remained at 5 per cent, the net result has been an increase in average overloads in the Province. This increase in allowable tolerance on axles and axle units does not allow fully loaded legal vehicles to carry more load, but does allow a greater degree of flexibility in terms of load distribution. However, vehicles that are not loaded to their legal capacity, are not prosecuted if an axle or axle unit is up to 15 per cent overloaded.

This trend can also be seen in Figure 4 where the average overloads on 8 200 kg axles, tandem and tridem axle units increased from 1993 to 1994 by 10,0 14,7 and 14,5 per cent respectively.

General statistics for vehicle weighing in KwaZulu-Natal during 1994 are shown in Figure 5. This forms one of the reports generated by the vehicle overloading management system both on a monthly and on an annual basis.

COMPANY STATISTICS

The Vehicle Overloading Management System has a facility whereby transport companies can be monitored in terms of their frequency and degree of overloading. Vehicle overloading statistics of selected companies are studied by the Department of Transport on a regular basis and, if necessary, interaction with the management of specific companies is initiated to discuss overloading patterns.

UNITRANS is one of the largest transport operators in South Africa. Figure 6 shows the number of UNITRANS vehicles weighed, overloaded and charged per month in KwaZulu-Natal during the period September 1991 to December 1994. Figure 7 shows the average monthly overloads during the same period. It is significant to note that although the average overload decreased from around 3 000 kg to 1 000 kg from the end of 1991 to the end of 1993, there was a marked increase in the annual average overload of 74 per cent from 1 192 kg in 1993 to 2 071 kg in 1994. Despite this increase in average overload, the percentage of vehicles charged decreased from 25 per cent in 1993 to 16 per cent in 1994 (see Figure 7). This change in trend is largely due to the change in tolerance from 5 to 15 per cent on axle units as described previously.

CONCLUSIONS

Overloaded vehicles significantly reduce the life of a road network. Although a large portion the road authorities' budgets are allocated to road maintenance, relatively little effort is spent on controlling the primary source of road damage - overloaded vehicles. It is essential that all relevant parties - the road authorities, traffic police and magistrates - appreciate the seriousness of the problem in order to achieve satisfactory control.

Adequate weighing facilities and correct weighing procedures are necessary if overloading violations are to be successfully prosecuted in court. A policy of park and redistribute as well as other appropriate penalties for overloading have been found to have a positive effect on the degree of overloading in the province of KwaZulu-Natal during the past seven years.

The Vehicle Overloading Management System has proved to be a useful source of information for monitoring long- and short-term trends in overloading and for identifying and monitoring transport companies that are guilty of blatant or regular overloading.

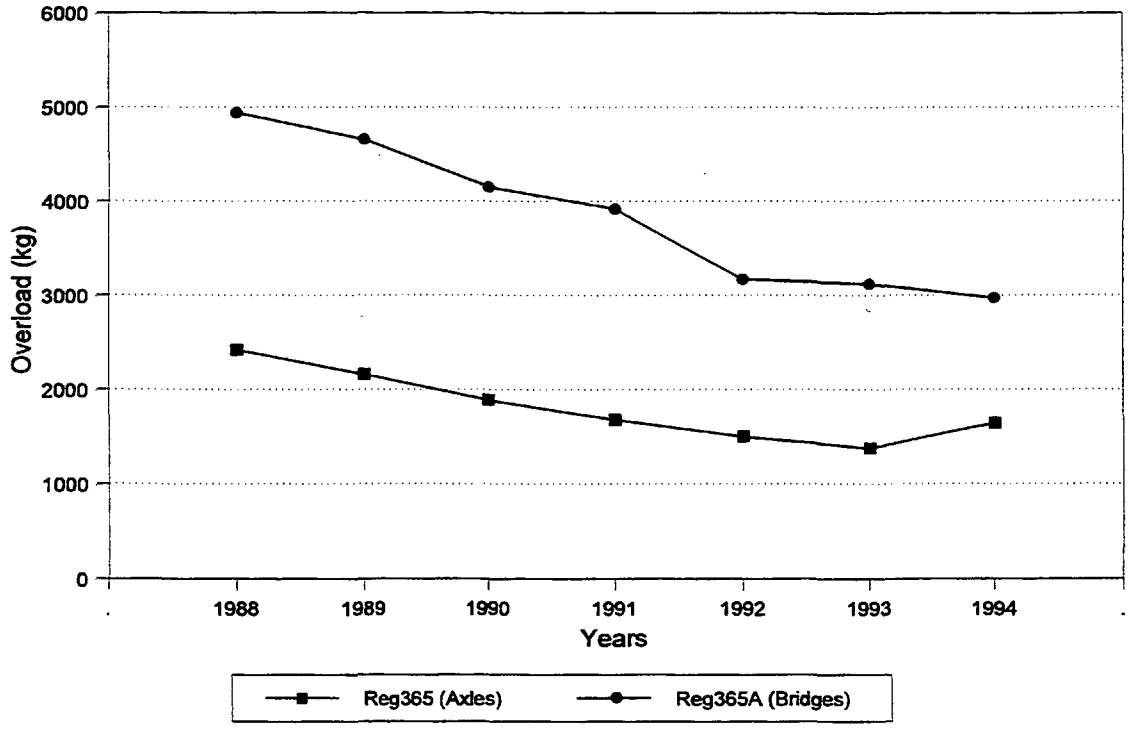

Figure 3. Average overloads in KwaZulu-Natal: Regulations 365 and 365A: 1988 to 1994

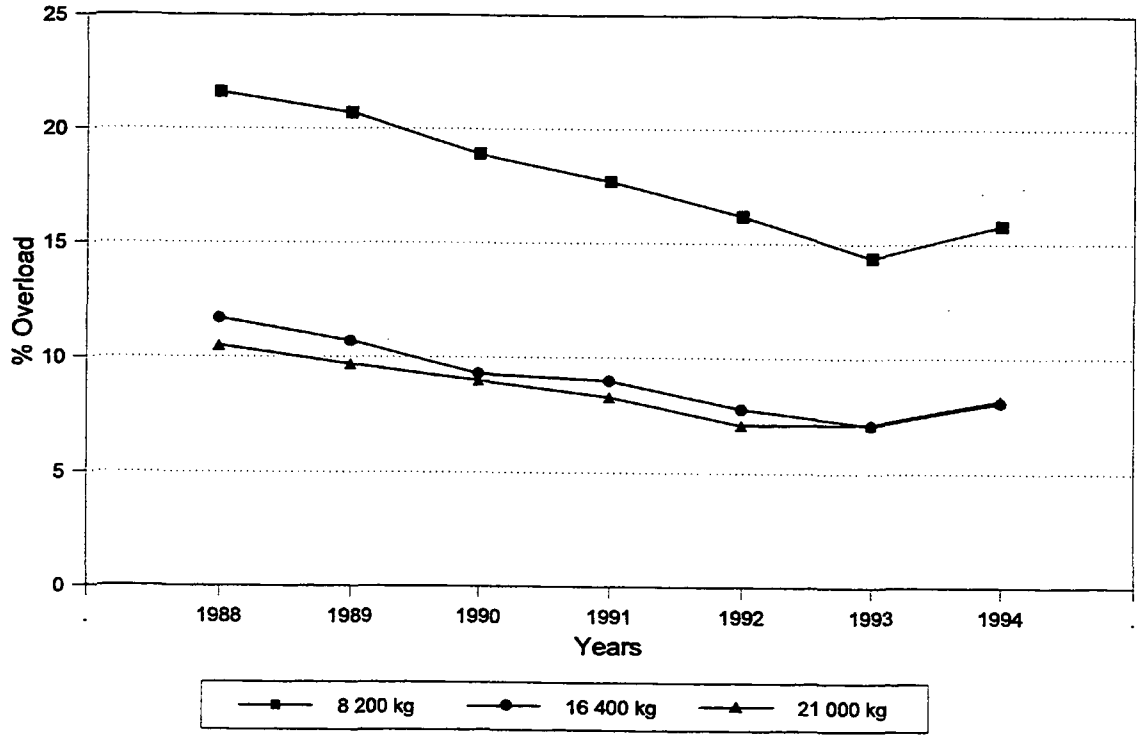

Figure 4. Average overloads in KwaZulu-Natal: Single axles, tandems and tridems: 1988 to 1994

PROVINCE OF KWAZULU-NATAL
DEPARTMENT OF TRANSPORT

VEHICLE WEIGHING STATISTICS ANNUAL REPORT 1994

All Weighbridges

a) All Vehicles

Number of vehicles weighed	:	39230
Number of vehicles overloaded	:	13643 (35%)
Number of vehicles charged	:	6792 (17%)

b) Regulation 365 - Axle Loading

Total number over legal limit	:	13579 (35%)
Average mass over legal limit	:	1644 kg
Maximum overload	:	15340 kg
Maximum % overload	:	98 %

c) Regulation 365A - Bridge Loading

Total number over legal limit	:	1619 (4%)
Average mass over legal limit	:	2971 kg
Maximum overload	:	29500 kg
Maximum % overload	:	79 %

d) Maximum Axle Group Overloading

Permis. Mass	Actual Mass	Percent. Overload	Company	Cargo	Locality
6000	8880	48	NISSAN TRUCK	MIXED GOODS	ROSSBURGH
6500	9580	47	K M C PLANT H	SAND	EMPANGENI
8200	15100	84	V CHETTY	CEMENT	WESTMEAD
16400	29540	80	ROMATRANS	STEEL	ROSSBURGH
21000	36340	73	ROMATRANS	STEEL	ROSSBURGH
-----365A-----					
57420	86920	51	B.V.B. TRANSP	ANDALUSITE	LADYSMITH

Permissible Mass (kg)	Average Overload (kg)	Number Overloaded	Percentage Overloaded
6000	521	449	21
6500	333	1399	18
8200	1299	3557	50
16400	1334	9571	36
21000	1722	1413	34

Figure 5. Vehicle weighing statistics in KwaZulu-Natal: Annual report 1994

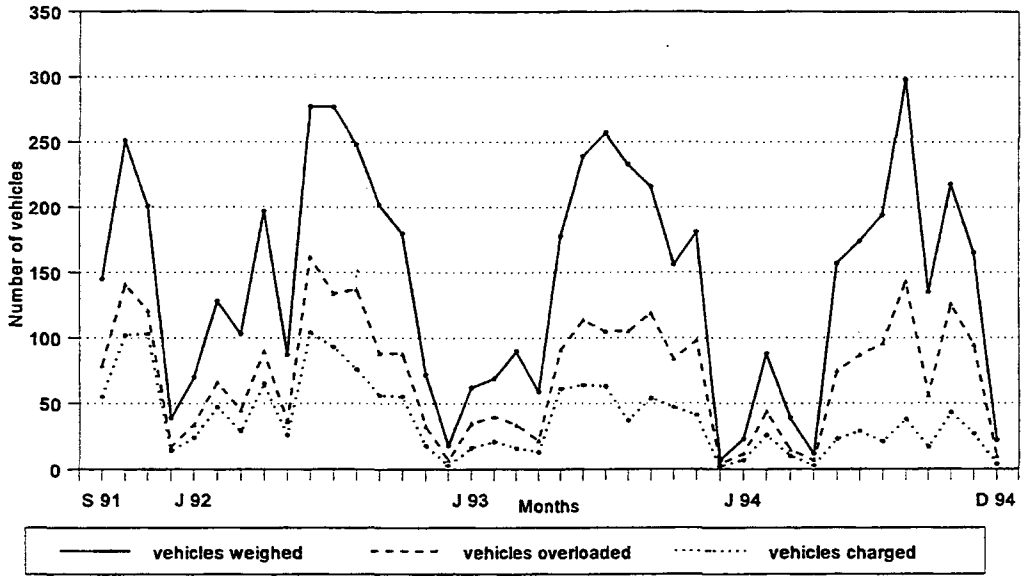

Figure 6. Vehicles weighed, overloaded and charged per month of UNITRANS: September 1991 to December 1994

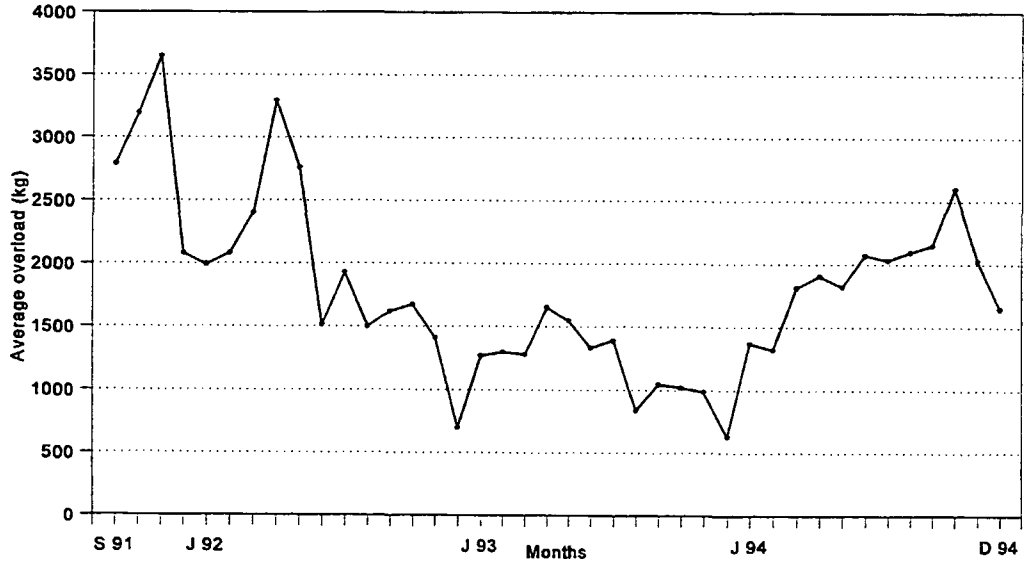

Figure 7. Average monthly overloads of UNITRANS: September 1991 to December 1994