A COMPREHENSIVE ANALYSIS OF THE EFFECTIVENESS OF SPEED CAMERA ENFORCEMENT IN DECREASING THE ACCIDENT RATE IN THE JOHANNESBURG METROPOLITAN AREA

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ABSTRACT

A comprehensive analysis of the effectiveness of speed enforcement by camera as a tool in decreasing the accident rate on high accident risk roads in the City of Johannesburg. The analysis indicates a significant reduction in accident rates on roads where speed enforcement by camera operations was conducted. A more in-depth analysis determined that, of all the factors playing a role in the reduction of the accident rate, a reduction in the average infringement vehicle speed is the fundamental factor that is most effective in reducing the accident rate.

1 BACKGROUND

For the purpose of this paper, the accident rate was referred to as the total number of accidents (fatal injury + serious injury +damage only accidents) per month that happened on the 12 specific roads or road sections as identified for this study. Accident data covering the entire City of Johannesburg Metropolitan area were obtained from the JMPD (Johannesburg Metropolitan Police Department) Accident Bureau and analysed over a period of two years (01 January 2008 to 31 December 2009).

Scientists in Adelaide estimated that the relative risk of a vehicle travelling at or above 60km/h, becoming involved in a casualty crash – a vehicle crash in which people are killed or hospitalized – double for every 5km/h above 60km/h. One reason for this increased risk is reaction time – the time it takes between a person perceiving a danger and reacting to it. The braking distance is proportional to the square of the speed – which means that the breaking distance increases considerably as speed increases. Kloeden, C.N, A.J. McLean, V.M. Moore and G. Ponte. 1997.

In 2008, TMT Services & Supplies was awarded a Speed Enforcement by Camera tender for the City of Johannesburg under the jurisdiction of the Johannesburg Metropolitan Police (JMPD). TMT supplied JMPD with a comprehensive Accident Analysis Database paid for by TMT from funds generated from the above Speed Enforcement by Camera project. Statistical data on speed enforcement were recorded on the iForce database which was first used in the Ventersdorp TMT branch in 2000. This contract was similar to the current JMPD contract. The accident data was combined with the speed enforcement data and analysed. This paper form part of a long term, in-depth study to be completed in the next 3 to 5 years and would also include municipalities in other provinces.

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2 THE PURPOSE OF THIS PAPER

A comprehensive analysis of enforcement effort in order to determine the effectiveness of speed enforcement by camera as a tool in decreasing the accident rate on high accident risk roads in the City of Johannesburg and a determination of the most effect means of reducing the accident rate.

3 SCOPE OF THIS REPORT

Accident Statistical Data – JMPD Accident Database – 01/01/2008 to 31/12/2009

Accident data covering the entire City of Johannesburg Metropolitan area were obtained from the JMPD (Johannesburg Metropolitan Police Department) Accident Bureau and analysed over a period of two years (01 January 2008 to 31 December 2009). The JMPD Accident Bureau is based on the best practice module in South Africa. It is a complete set of programs that provides for the capture, validation, scanning, display, storage by location, sale and export of accident data to the National Traffic Information System (E-Natis).The software allows for fast digital capturing of the accident report forms to provide a person involved in an accident with a case number within four hours of its occurrence. It identifies accident locations as described by the average man on the street. The software includes a Global Information System (GIS) module allowing for accident map viewing.

A total of 72916 accidents was reported and captured on this system for the duration of the two year period (01 January 2008 to 31 December 2009).

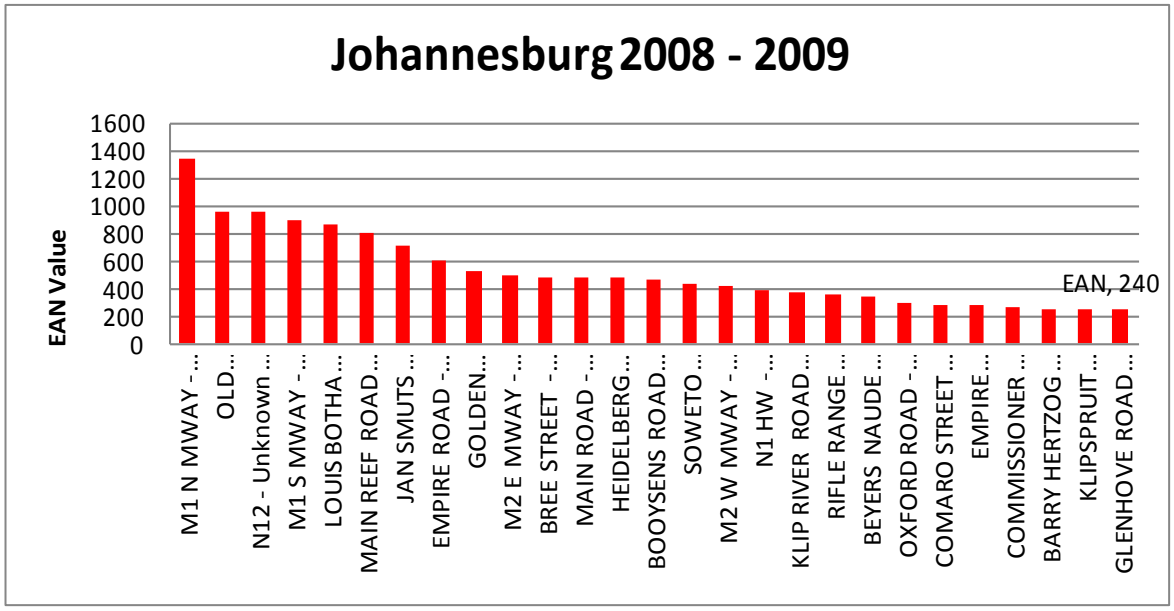
Fig. 1: Monthly combined accident per month, per severity – City of Johannesburg, 2008 &2009 combined

JOHANNESBURG
Date Range: 01/01/2008 to 31/12/2009

	Number of Incidents by Injury Classification					Casualties by Injury Classification			
Month of Year	**Total**	**Fatal**	**Serious**	**Slight**	**Damage Only**	**Total**	**Deaths**	**Serious**	**Slight**
January	7306	11	80	633	6582	1098	11	146	941
February	8316	4	83	566	7663	884	4	102	778
March	8811	19	127	714	7951	1133	20	168	945
April	7307	25	117	698	6467	1217	28	179	1010
May	8170	21	107	620	7422	1008	27	170	811
June	4142	13	69	297	3763	463	13	80	370
July	4203	17	44	308	3834	453	21	53	379
August	5036	21	86	466	4463	807	24	133	650
September	5302	20	97	495	4690	857	21	134	702
October	5490	30	98	481	4881	765	30	120	615
November	5080	10	75	440	4555	749	10	102	637
December	3753	7	51	227	3468	368	7	77	284
Total for 2008/2009	**72916**	**198**	**1034**	**5945**	**65739**	**9802**	**216**	**1464**	**8122**

These accident data were analysed according to the roads/locations with the highest EAN (Equivalent Accident Number). The EAN system allocates 12 points per fatal injury accident, 8 points per serious injury accident, 3 points per slight injury accident and 1 point per damage only accident. Gearts, K & Wots G(2), “Black Spot Analysis Methods: Literature Review, 2003.

Fig. 2: Road per EAN value, Johannesburg, 2008-2009

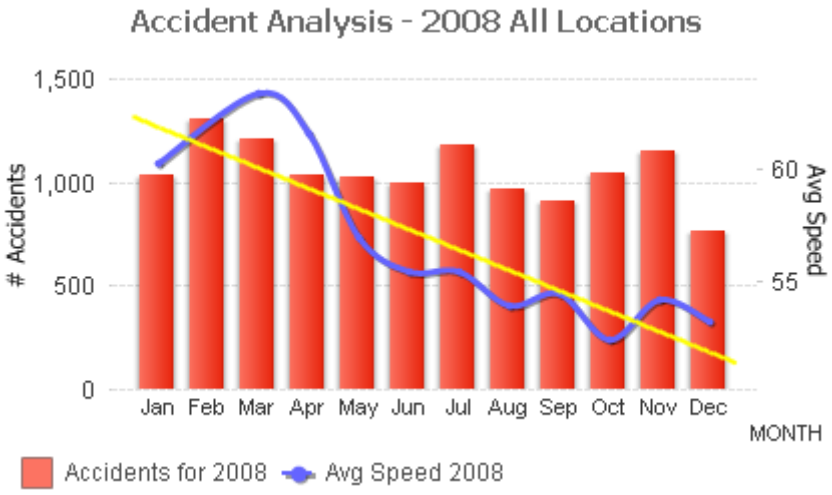


Speed Enforcement by Camera Statistical Data

Speed Camera statistical data was obtained from TMT Services and Supply iForceDatabase (an Intelligent Offence Processing Application capable of generating management reports on a daily basis indicating, among others, the offence status, equipment utilization, average speed and infringement rates) as well as from the AVPC (AARTO Violation Processing Centre) that successfully handles all requirements of the AARTO Act (Administrative Adjudication of Road Traffic Offences).

For the purpose of this paper, the speed of a total of 24 620 942 vehicles was recorded over a period of 2 years on 12 roads with a speed limit of 60km/h over the entire length of the road, where speed enforcement by camera operations were conducted. A total of 815 226 of these vehicles infringed the law by exceeding the speed limit with more than the tolerance allowed for. Although the traffic volumes on these roads were not recorded the number of vehicles' speed measured was in direct relation to the traffic volume. The average speed of vehicles at different locations on each of these roads was recorded and the average for each entire road was used in this study. All speed enforcement recording were obtained by using mobile speed cameras only.

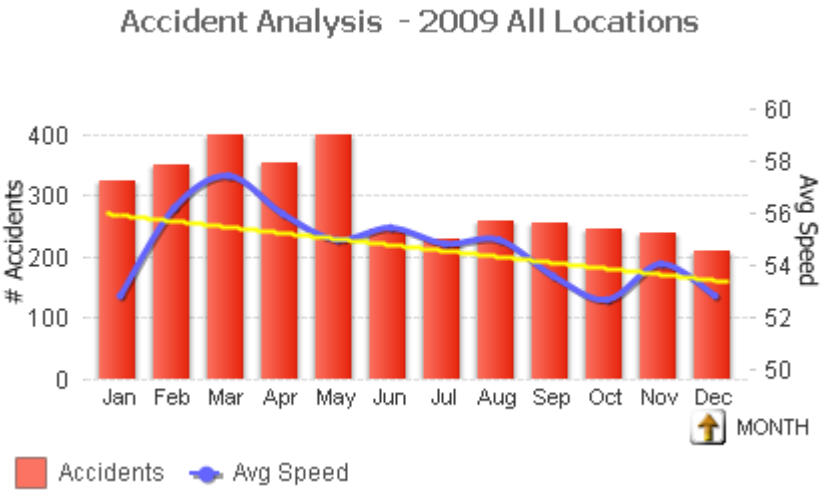
Fig 3: Accident/Average Speed Analysis 2008



4 ACCIDENT, INFRINGEMENT AND AVERAGE SPEED ANALYSIS

The average speed and the number of accidents on the 12 above-mentioned roads for 2008 were analysed and plotted on fig 3. The trend line indicates an overall reduction in the accident rate over the 12 moth period. It also indicates a significant reduction in the average vehicle speed.
The trend line in the average vehicle speed was determined by using the following expression: Y= -0.9338X + 61.649, where X = month -1 (1)

Fig 4: Accident/Average Speed Analysis 2009



The Average speed and number of accidents on the twelve roads in 2009 were analysed and plotted on fig 4. The trend line indicates a significant overall reduction in the accident rate for the 12 month period in 2009. There was also a significant reduction in the average vehicle speed over the 12 months of 2009. The accident data for 2008 and 2009 was verified by JMPD as being credible. All accidents reported, either at the JMPD or at the various police stations in the Johannesburg Metropolitan area, were captured on the Accident Database. Accidents in unknown locations were regarded as invalid and not reflected in the accident statistical reports. Of a total number of 78356 accidents reported and captured by the JMPD Accident Database during the period of 2008 to 2009, 5440 occurred at unknown locations. The reports generated therefore covered only72916 valid accidents. This presents 93% credibility in the accident data. The average number of accidents per month for the 7 months for November 2008 to May 2009 was 286 accidents per month compared to an average of 160 accidents per month for the following 7 months from June 2009 to December 2009. This was a decline of 44% in the average number of accidents per month.

*ARPM = Accident rate per month

% decline in accident rate = $\frac{ARPM_{2008} - ARPM_{2009}}{ARPM_{2008}} = \frac{286-160}{286}$ = 44% (2)

The significant decrease in the number of accidents, especially in the second halve of 2009 can be attributed to the following:

- From February 2008 to March 2008 (2 months) no speed enforcement by camera was allowed by the Director: Public Prosecutions for the entire Johannesburg

Metropolitan Area. This led to an increase in the average vehicle speed on all roads and resulted in a significant increase in the overall accident rate.

- After speed enforcement by camera commenced in April 2008, the effect of being caught speeding only affected motorists' driving patterns two months later when the fine was received by the accused. This led to a further reduction in the accident rate.
- The decrease in the accident rate continued through the first months of 2009. There was an increase in the accident rate in March 2009 due to a strike by the JMPD.
- On the 1st of March 2009, AARTO was introduced in the JMPD Metropolitan Area. As in 2008, this only had an effect on motorists' behaviour, two to three 3 months later when the infringing notice was received by the accused. This led to another huge reduction in the accident rate. The fines introduced under AARTO are much higher than the fines issued under the Road Traffic Act. Motorists were also informed of the possibility of losing points under the AARTO Act.

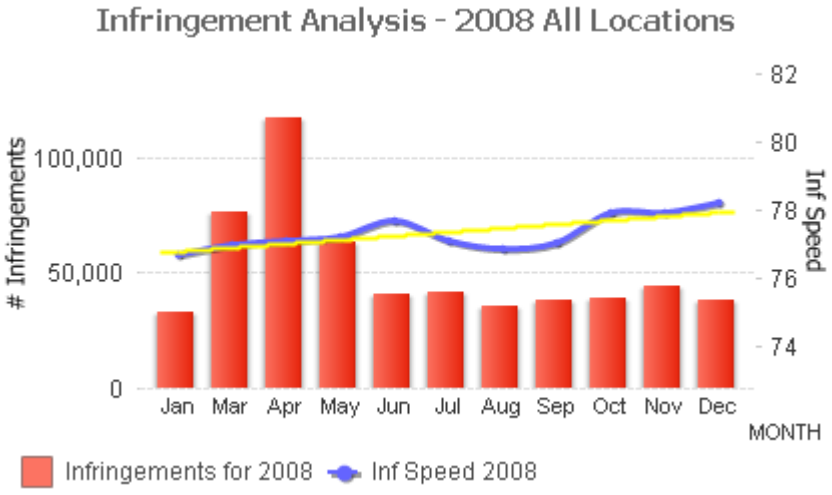
Comparison of accident statistics and average vehicle speed for 2008 to 2009

A significant reduction in the average vehicle speed for 2008 led to a slight decrease in the accident rate. On the other hand the average vehicle speed started much higher in 2008 compared to 2009: namely 65km/h compared to 55.5km/h. This reduction may be attributed to more visible policing and more manhours spend on speed enforcement by camera.

Number of infringing vehicles/average infringing vehicle speed analysis 2008

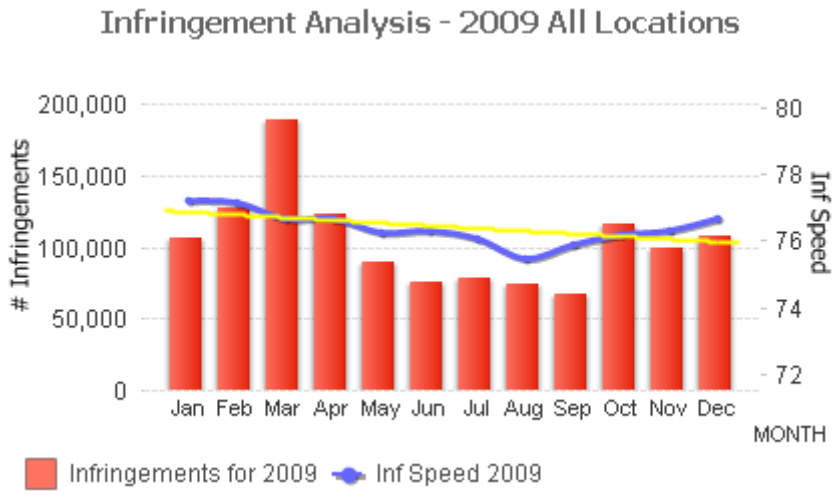
The average speed on all 12 roads combined was recorded as 55km/h. 815 226 of the total number of 24 620 942 vehicles that were surveyed, exceeded the speed limit by more than 10km/h or, in other words, drove at a speed of more than 71km/h in the 60km/h speed limit zone. The average law violating vehicle speed increased from 77km/h to 78km/h in 2008 while the number of vehicles violating the speed limit (infringing vehicles) fluctuated between 35 000 and 120 000 vehicles per month.

Fig 5: Number of Infringements/Average Infringement Speed 2008



Although there was a significant reduction in the number of vehicles exceeding the speed limit in 2008, there was a slight increase in the speed at which these vehicles violated the speed limit. The nominal increase can be attributed to speed enforcement by camera tolerance of up to 20km/h in 2008.

Fig 6: Number of Infringements/Average Infringement Speed 2009

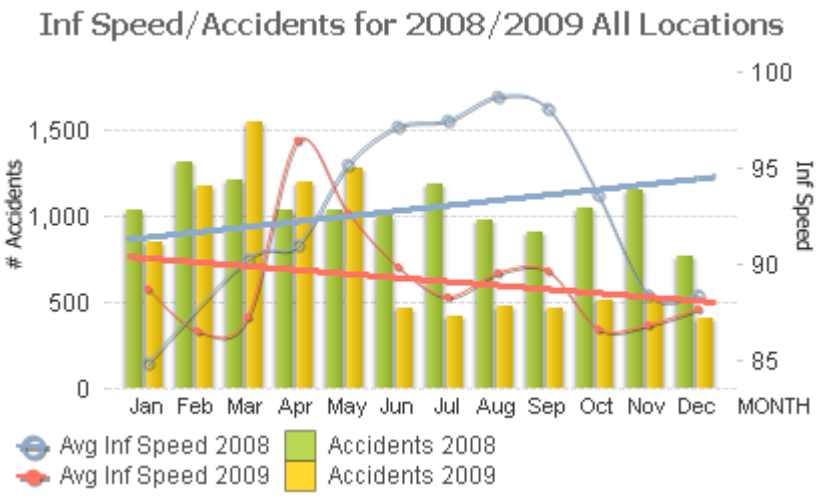


In 2009 the average infringing vehicle speed decreased from 77km/h to 76km/h while the number of vehicles violating the speed limit fluctuated between 102 000 and 190 000 vehicles per month. This indicates a reduction in the speed at which vehicles exceeded the speed limit, but an increase in the number of vehicles exceeding the speed limit. This can be attributed to an increase in vehicle numbers as more vehicles were registered in 2009 compared to 2008, but what played even a more significant role was the dramatic increase in speed fines with the introduction of AARTO in March 2009.

<u>Comparison of average infringement vehicle speed and the number of vehicles in violation of the speed limit for 2008 to 2009</u>

In 2008 there was an increase in the average infringement vehicle speed compared to a decrease in the average infringement vehicle speed in 2009. Despite a huge increase in the number of vehicles violating the speed limit in 2009 compared to 2008.

Fig. 7: Infringement speed/Accident Analysis 2008/2009



In fig. 7, the combined number of accidents per month on the 12 above mentioned roads in 2008 (green columns)were compared to 2009 (yellow columns). The average speed per month for 2008 (blue dotted line) was compared to the average speed per month for 2009 (red dotted line).Trend lines were added to indicate the trend in average speed for 2008 (blue solid line) to 2009 (red solid line).

An increase in the average infringing vehicle speed in 2008 resulted in only a slight decrease in the number of accidents in 2008. A reduction in average infringing vehicle speed in 2009 (red trend line) resulted in a significant reduction in the number of accidents in 2009 compared to 2008 (yellow columns).

Fig. 8: Accident Difference/Infringement Speed/Average Speed2008/2009

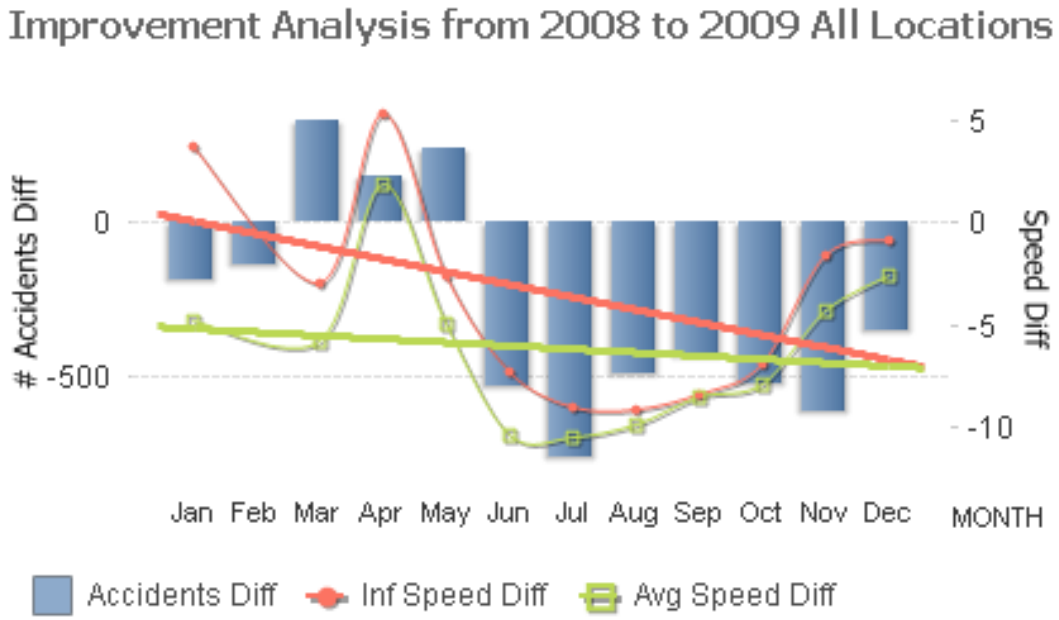


Fig 8 indicates the difference in accidents per month between 2008 and 2009. A blue column above the 0 mark indicates an increase in the number of accidents in 2009 compared to 2008. A blue column below the 0 mark indicates a decrease in the number of accidents in 2009 compared to 2008, the longer the column the more the increase or decrease.

The green trend line indicated a decrease in the average vehicle speed in 2009 compared to 2008. The red trend line indicated a decrease in the average infringing vehicle speed in 2009 compared to 2008.

Fig. 9: In-depth analysis per road

STREET NAME	Max Zone	Avg Speed	Vehicles Checked	Captured	Avg Inf. Speed Improv	Avg Speed Improv	% Inf Vehicles Improv	No of Months Data
	60	**56**	**39 963 657**	**1 418 951**				
Aerodrome Dr	60	60	878 286	92 974	1.5%	0.4%	31.6%	12
Barry Hertzog Ave	60	57	8 090 316	198 572	0.8%	12.4%	80.3%	12
Beyers Naude Dr	60	53	7 635 291	174 310	-0.4%	-1.9%	-29.7%	12
Club St	60	62	206 080	30 309	13.2%	5.8%	86.4%	12
Columbine Ave	60	58	654 852	47 187	0.0%	9.5%	40.7%	12
Comaro Rd	60	55	5 641 673	123 173	2.5%	-1.4%	-8.7%	12
Jan Smuts Ave	60	52	10 076 443	299 689	0.0%	13.7%	54.2%	12
Johannesburg Rd	60	60	728 258	66 644	4.3%	2.3%	49.4%	12
Langerman Dr	60	60	805 400	75 028	3.6%	-2.7%	38.2%	12
Louis Botha Ave	60	60	1 704 461	178 451	0.9%	-3.4%	25.1%	12
Rifle Range Rd	60	58	205 969	13 266	-0.7%	-5.8%	11.3%	12
Rustenburg Rd	60	45	2 440 137	49 122	1.4%	5.1%	52.4%	12

A positive number in average infringement speed improvement, average speed improvement and % of infringements improvement indicates a decrease, while a negative number indicates an increase for 2009 compared to 2008.

There was an overall improvement in the reduction of the number of accidents, a decrease in the reduction of the average infringement vehicle speed and a decrease in the reduction of the average infringement vehicle speed on these specific roads in 2009 compared to 2008.

5 CONCLUSION

Speed Enforcement by Camera resulted in a significant overall decrease in the accident rate on these specific roads. The factors that contributed to this decrease were identified as follows:

- Visible policing
- GPS warning devices, speed enforcement by camera warning signs
- An increase in visible policing
- An increase in enforcement effort and an increase in manhours
- The introduction of AARTO in the JMPD Metropolitan Area
- A reduction in average vehicle speed
- A reduction in the percentage of motorists exceeding the speed limit
- A reduction in the average speed of vehicles exceeding the speed limit

Fig. 10: Factors that had an effect on the accident rate

	Effect of a decrease on Accident Rate			
Road	Average Infringement Speed	Average Speed	%of Infringing Vehicles	Decrease in Accident Rate
Aerodrome Dr				
Barry Hertzog Ave				
Beyers Naude Dr				
Club St				
Columbine Ave				
Comaro Rd				
Jan Smuts Ave				
Johannesburg Rd				
Langerman Dr				
Louis Botha Ave				
Rifle Range Rd				
Rustenburg Rd				

Fig. 10: Green indicates a decrease, yellow no change, and red an increase.

The result of this study proves that the use of speed camera enforcement is a highly effective tool in decreasing the accident rate on roads in the City of Johannesburg.

Although all the above factors play a role in the reduction of accidents, the fundamental factors that were most effective in reducing the accident rate were the introduction of AARTO and a reduction of the average speed at which motorists exceeds the speed limit (infringement speed).

The reason for this is that a reduction in average infringement vehicle speed also reduces the difference between the average vehicle speed and the average speed of vehicles exceeding the speed limit, the smaller this difference, the less the risk of accidents occurring.

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