QUANTIFYING THE IMPACT OF INFRASTRUCTURE BASED TRAFFIC CALMING ON ROAD SAFETY; A CASE STUDY IN CAPE TOWN

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ABSTRACT

Transport is an essential component of today's society. It brings huge benefits, but it also has many costs. One of the major costs in South Africa is related to, and due to, road accidents. Annually, between 14 000 and 18 000 persons are killed (www.arrivealive.co.za) on South African roads. According to the World Road statistics (IRF, 2006), South Africa has one of the highest number of people killed in road accidents per 100 000 population in the world. National statistics reveal that between 40% and 60% of accidents involve pedestrians, and for around 30% of accidents, speeding is one of the main contributing factors. Locally, in Cape Town, pedestrians accounted for 59.2% of all persons killed. An analysis of data in 2003, revealed that the main contributory human factors were speeding and pedestrians jaywalking, at 23% and 40% respectively (CoCT, 2005).

Although infrastructure based traffic calming measures, including the use of feasible Intelligent Transport Systems (ITS), have been proven internationally, they have not been thoroughly investigated in the South African context. Furthermore, textured paving, speed humps and tables are the only road-based measures implemented thus far.

Road based traffic calming projects can vary from a few minor changes, to modifications of local streets, area wide changes and major rebuilds. Impacts range from moderate speed reductions to arterial design changes with various degrees of success in reducing crashes. The study described in this paper reviews potential traffic calming measures, including volume and speed related road infrastructure change. A microscopic simulation model is used to model detailed measures, either in isolation or in combination, and estimate likely effects.

The results provide an overview of common (inter)national road based traffic calming strategies and devices by category and their relative degree of success based on an extensive literature review. The findings are compared to modelled outcomes and differences discussed.

1. INTRODUCTION

1.1 Background

Transport is an essential component of today's society. It brings huge benefits, but it also has many costs. One of the major transport costs in South Africa is related to, and due to, road crashes. Annually, between 14 000 and 18 000 persons are killed (www.arrivealive.co.za, accessed 10/2009) on South African roads, which according to the World Road statistics (IRF, 2006), means that South Africa has one of the highest number of people killed in road crashes per 100 000 population in the world. The majority of crashes occur in urban areas where high vehicle/pedestrian speed differentials are prevalent and where infrastructure provision for the mobility disadvantaged is poor.

Road based traffic calming measures, amongst other strategies, have been proven to be successful in many parts of the World in reducing crash risk and, consequently, costs to society, as well as other societal benefits.

Definitions of traffic calming and the use of design features vary, but they all share the goal of reducing vehicle speeds and through-traffic, improving safety, mobility for non-motorised transport and enhancing quality of life by context specific design, which allows flexible standards that can accommodate community values and balanced objectives.

Calming projects can vary from a few minor changes, to modifications of local streets, to area wide changes and major rebuilds. Impacts range from moderate speed reductions to arterial design changes with various degrees of success in reducing crashes.

1.2 Micro- simulation Modelling

Over the last decade, microscopic simulation models have become available to the transport profession. These models enable researchers and practitioners to analyse the effectiveness of interventions on a disaggregated level as individual vehicles are simulated in detail, as they move through the road network, with the goal of reaching their destination by the most cost effective route. The vehicles interact with the road network, the control systems and with other vehicles. Models capture the majority of interactions of the real world road traffic through a series of algorithms describing car following, lane changing, gap acceptance and spatial collision detection.

2. OBJECTIVES AND METHODOLOGY

This paper provides an overview of common (inter)national road based traffic calming strategies and devices by category and their relative degree of success in helping increase road safety, based on an extensive literature review. The findings are then compared and contrasted to computer modelled outcomes, of those possible, and to determine whether modelled strategies can provide realistic results and whether models can be used to provide guidance on appropriate design for predefined goals and strategies without trials or physical implementation.

The research is as exhaustive as possible, but has been limited to presenting the most common road based traffic calming features used in practice and the results, comparisons and outcomes are not intended as a guide for appropriate use in specific contexts.
The research is limited to the evaluation of road safety benefits of traffic calming and, as such, does not attempt to quantify the other benefits derived in terms of increased non-motorised travel, environmental impacts, possible increases in property value, neighbourhood interaction etc.

3. TYPES OF TRAFFIC CALMING MEASURES

Road based traffic calming measures can be categorised into two groups based on the main impact intended. **Volume control measures** are primarily used to address cut-through traffic problems by blocking certain movements, thereby diverting traffic to streets better able to handle it. **Speed control measures** are primarily used to address speeding problems by changing vertical alignment, changing horizontal alignment, or narrowing the roadway. The distinction between the two types of measures is not as clear as their names suggest, since speed control measures frequently divert traffic to alternate routes, and volume control measures also slow down traffic flows (www.trafficcalming.org). Table 1 provides an overview of the different types of measures.

Table 1: Traffic calming measures

Speed control measures				Volume measures
Vertical deflection	Horizontal deflection	Horizontal narrowing	Others	Divertive/ restrictive
• Speed hump • Speed table • Raised crosswalk • Raised intersection • Textured pavements • Speed cushion • Rumble strips	• Traffic circle • Roundabout • Chicanes • Realigned intersection • Tight radii	• Neckdowns • Centre island narrowing • Chokers • 'Road diets' • Bike lanes	• Speed Limits • Speed alerts, enforce • Perceptual design • Warning Signs • Landscaping	• Full closure • Half closure • Diagonal diverters • Lateral shift • Median barriers • Neo-traditional design

Source: Adapted from www.trafficcalming.org and www.vtpi.org (both accessed 10/2009)

The remainder of this chapter provides a brief description of the potential individual measures, however, in practice, usually a combination of measures provide the greatest benefits and design is always context specific.

Readers need to realise that different measures are appropriate on different types of roads. Furthermore, effects on speeds and volumes are not mutually exclusive. Table 2 provides an overview of the applicability of various calming measures to road types (arterial versus local), as well as their anticipated impact on speed and volume.

Table 2: Traffic calming application and impacts

Type	Application		Impacts	
	Arterial	Local	Volumes	Speeds
Speed hump	-	✓	Possible	Yes
Speed table	-	✓	Possible	Yes
Raised crosswalk	✓	✓	Possible	Yes
Raised intersection	With caution	✓	Possible	Yes
Textured pavements	✓	✓	Possible	Yes
Speed cushion	With caution	✓	Possible	Yes
Rumble strips	✓	✓	No	Yes
Traffic (mini) circle	-	✓	Possible	Yes
Roundabout	✓	-	Not likely	Yes
Chicanes	-	✓	Yes	Yes
Realigned intersection	✓	✓	Possible	Yes
Tight radii	✓	✓	Possible	Yes
Neckdowns	✓	✓	Possible	Yes
Centre island narrowing	✓	✓	Possible	Yes
Chokers	✓	✓	Possible	Yes
‘Road diets’	✓	✓	Yes	Yes
Bike lanes	✓	✓	Possible	Possible
Speed Limits	✓	✓	Yes	Yes
Speed alerts, enforcement	✓	✓	No	Yes
Perceptual design	✓	✓	Possible	Yes
Warning signs	✓	✓	No	Yes
Full closure	-	✓	Yes	Yes
Half closure	✓	✓	Yes	Yes
Diagonal diverters	✓	✓	Yes	Yes
Lateral shift	✓	✓	No	Yes
Median barriers	✓	-	Yes	Yes
Neo-traditional design	✓	✓	Yes	Yes

Source: Adapted from VTPI, 1999; based on various

Measures described as ‘Other’ in Table 1 are omitted from the detail in the remainder of this chapter as the focus has been kept on physical measures only. These measures are either design based, for example: Neo-traditional design, or are signage or enforcement devices, and are generally targeted at reducing speeds.

3.1 Speed Control Measures

3.1.1 Speed Humps

Speed humps are rounded raised areas placed across the roadway. They are generally between 75- 150 mm in height and vary in width depending on the desired outcome. They are often tapered as they reach the kerb on each end to allow unimpeded drainage. Speed Humps are good for locations where very low speeds are desired and reasonable, and where noise and fumes are not a major concern (see Table 3).

Table 3: Advantages, disadvantages and effectiveness of speed humps

Advantages	Disadvantages
• Relatively inexpensive. • Relatively easy for bicycles to cross if designed appropriately. • Effective in slowing travel speeds.	• Causes a "rough ride" for all drivers, and can cause severe pain for people with certain skeletal disabilities. • Forces large vehicles such as emergency vehicles and those with rigid suspensions, to travel at slower speeds. • May increase noise and air pollution. • Questionable aesthetics.

Source: Adapted from: www.trafficcalming.org

3.1.2 Speed table

Speed tables are flat-topped speed humps often constructed with brick or other textured materials on the flat section. Speed tables are typically long enough for the entire wheelbase of a passenger car to rest on the flat section. Their long flat fields give speed tables higher design speeds than speed humps. The brick or other textured materials improve the appearance of speed tables, draw attention to them, and may enhance safety and speed-reduction. Speed tables are good for locations where low speeds are desired but a somewhat smooth ride is needed for larger vehicles (www.trafficcalming.org). Other features are described in Table 4.

Table 4: Advantages, disadvantages and effectiveness of speed tables

Advantages	Disadvantages
• Smoother for large vehicles (such as fire trucks) than speed humps. • Effective in reducing speeds, though not to the extent of speed humps.	• Questionable aesthetics, if no textured materials are used. • Textured materials can be expensive. • May increase noise and air pollution.

Source: Adapted from: www.trafficcalming.org

3.1.3 Raised crosswalk

Raised crosswalks are speed tables outfitted with crosswalk markings and signage to channelise pedestrian crossings, providing pedestrians with a level street crossing. Also, by raising the level of the crossing, pedestrians are more visible to approaching motorists (see also Table 5). Raised crosswalks are good for locations where pedestrian crossings occur at haphazard locations and vehicle speeds are excessive (www.trafficcalming.org).

Table 5: Advantages, disadvantages and effectiveness of raised crosswalks

Advantages	Disadvantages
• Improves safety for both pedestrians and vehicles. • If designed well, they can have positive aesthetic value. • They are effective in reducing speeds, though not to the extent of speed humps.	• Textured materials can be expensive. • Impacts on drainage need to be considered. • They may increase noise and air pollution.

Source: Adapted from: www.trafficcalming.org

3.1.4 Raised intersection

Raised intersections are flat raised areas covering an entire intersection, with ramps on all approaches and often with brick or other textured materials on the flat section. They are usually built to the level of the sidewalk, or slightly below to provide a "lip" that is detectable by the visually impaired. By modifying the level of the intersection, the crosswalks are more readily perceived by motorists to be "pedestrian territory" (see also Table

6). Raised intersections are good for intersections with substantial pedestrian activity, and areas where other traffic calming measures would be unacceptable because they take away scarce parking spaces (www.trafficcalming.org).

Table 6: Advantages, disadvantages and effectiveness of raised intersections

Advantages	Disadvantages
• Improves safety for both pedestrians and vehicles. • If designed well, they can have positive aesthetic value. • They can calm two streets at once.	• Tend to be expensive, varying by materials used. • Their impact to drainage needs to be considered. • They are less effective in reducing speeds than speed humps, speed tables, or raised crosswalks.

Source: Adapted from: www.trafficcalming.org

3.1.5 Textured pavements

Textured and coloured pavements include the use of stamped pavement or alternate paving materials to create an uneven surface for vehicles to traverse. They may be used to emphasise either an entire intersection or a pedestrian crossing, and are sometimes used along entire street blocks (see Table 7). Textured pavements are good for "main street" areas where there is substantial pedestrian activity and noise is not a major concern (www.trafficcalming.org).

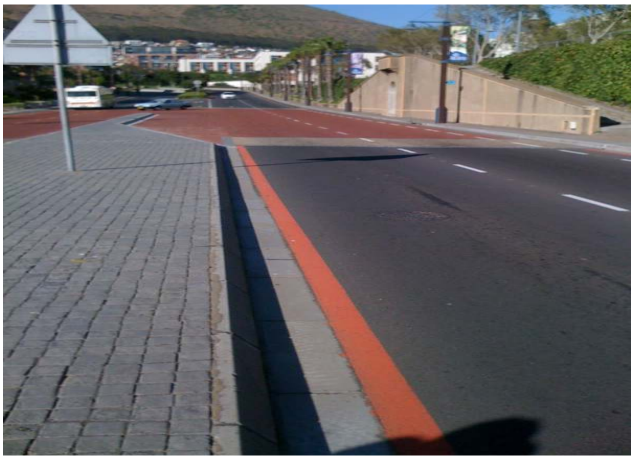


Table 7: Advantages, disadvantages and effectiveness of textured pavements

Advantages	Disadvantages
• Can reduce vehicle speeds over an extended length. • If designed well, they can have positive aesthetic value. • Placed at an intersection, they can calm two streets at once.	• They are generally expensive, varying by materials used. • If used on a crosswalk, they can make crossings more difficult for wheelchair users and the visually impaired.

Source: Adapted from: www.trafficcalming.org

3.1.6 Speed cushion

Speed cushions can be described essentially as being speed humps with gaps to ease access for emergency vehicles, whilst still being close enough to reduce speed of normal vehicular traffic (see Table 8).

Table 8: Advantages, disadvantages and effectiveness of speed cushions

Advantages	Disadvantages
• Can reduce vehicle speeds over an extended length. • Allow unrestricted access for emergence vehicles. • Are generally inexpensive. • Relatively easy for bicycles to cross if designed appropriately. • Effective in slowing travel speeds.	• Can be a problem for emergency vehicles if there are parked cars on the street. • If used on a crosswalk, they can make crossings more difficult for wheelchair users and the visually impaired. • Causes a "rough ride" for all drivers, and can cause severe pain for people with certain skeletal disabilities. • Forces large vehicles, such as emergency vehicles and those with rigid suspensions, to travel at slower speeds. • May increase noise and air pollution. • Questionable aesthetics.

3.1.7 Rumble Strips

Rumble strips are essentially low bumps on the road surface that produce a noise when ridden over. They are usually formed by the use of common road marking paint. The spacing of the bumps is conventionally used to reduce speeds, particularly when approaching a hazardous area (see Table 9).

Table 9: Advantages, disadvantages and effectiveness of rumble strips

Advantages	Disadvantages
• Very effective at reducing vehicle speeds over a desired length. • Are generally inexpensive. • Are not obstructive to emergency vehicles or non-motorised transport.	• Causes a "rough ride" for all drivers, and can cause severe pain for people with certain skeletal disabilities. • Forces large vehicles, such as emergency vehicles and those with rigid suspensions, to travel at slower speeds. • Increases noise and air pollution.

3.1.8 Traffic circle

Traffic circles (mini circles or mini roundabouts) are raised islands, placed in intersections, around which traffic circulates. They are good for calming intersections, especially within neighbourhoods, where large vehicle traffic is not a major concern but speeds, volumes, and safety are problems (www.trafficcalming.org). See Table 10 for the advantages and disadvantages of traffic circles.

Table 10: Advantages, disadvantages and effectiveness of traffic circles

Advantages	Disadvantages
• Very effective in moderating speeds and improving safety. • If designed well, they can have positive aesthetic value. • Placed at an intersection, they can calm two streets at once.	• They are difficult for large vehicles (such as fire trucks) to circumnavigate. • Must be designed so that the circulating lane does not encroach on the crosswalks. • May require the elimination of some on-street parking. • Landscaping must be maintained, either by the residents or by the municipality.

Source: Adapted from: www.trafficcalming.org

3.1.9 Roundabouts

Roundabouts require traffic to circulate around a centre island. Unlike Traffic Circles, roundabouts are used on higher volume streets to allocate right-of-way between competing movements (www.trafficcalming.org). Roundabouts promote traffic calming at high accident locations, intersections where queues need to be minimised, and at intersections with irregular approach geometry. They provide an inexpensive-to-operate traffic control as an alternative to a traffic signal and handle a high proportion of U-turns (see Table 11).

Table 11: Advantages, disadvantages and effectiveness of roundabouts

Advantages	Disadvantages
• Can moderate traffic speeds on an arterial. • Generally aesthetically pleasing if well landscaped. • Enhanced safety compared to traffic signals. • Can minimise queuing at the	• May be difficult for large vehicles (such as fire trucks) to circumnavigate. • Must be designed so that the circulating lane does not encroach on the crosswalks. • May require the elimination of some

approaches to the intersection. • They are less expensive to operate than traffic signals.	on-street parking. • Landscaping must be maintained, either by the residents or by the municipality.

Source: Adapted from: www.trafficcalming.org

3.1.10 Chicanes

Chicanes are kerb extensions that alternate from one side of the street to the other, forming S-shaped curves. Chicanes can also be created by alternating on-street parking, either diagonal or parallel, between one side of the street and the other. Each parking bay can be created either by re-striping the roadway or by installing raised, landscaping islands at the ends of each parking bay (see also Table 12). Good for locations where speeds are a problem but noise associated with speed humps and related measures would be unacceptable (www.trafficcalming.org).

Table 12: Advantages, disadvantages and effectiveness of chicanes

Advantages	**Disadvantages**
• Discourage high speeds by forcing horizontal deflection. • Easily negotiable by large vehicles (such as fire trucks) except under heavy traffic conditions.	• Must be designed carefully to discourage drivers from deviating out of the appropriate lane. • Kerb realignment and landscaping can be costly, especially if there are drainage issues. • May require the elimination of some on-street parking.

Source: Adapted from: www.trafficcalming.org

3.1.11 Realigned intersections

Realigned intersections are changes in alignment that convert T-intersections with straight approaches into curving streets that meet at right-angles. A former "straight-through" movement along the top of the T becomes a turning movement (see also Table 13). While not commonly used, they are one of the few traffic calming measures for T-intersections, because the straight top of the T makes deflection difficult to achieve, as needed for Traffic Circles (www.trafficcalming.org).

Table 13: Advantages, disadvantages and effectiveness of realigned intersections

Advantages	Disadvantages
• Can be effective reducing speeds and improving safety at a T-intersection that is commonly ignored by motorists.	• Kerb realignment can be costly. • May require some additional right-of-way to cut the corner.

Source: Adapted from: www.trafficcalming.org

3.1.12 Tight radii

The radius of streets, especially corners, affects traffic turning speeds. The tighter the radius, the slower the traffic speed. Tighter radii are particularly useful for intersections with numerous pedestrians (see Table 14).

Table 14: Advantages, disadvantages and effectiveness of Tighter radii

Advantages	Disadvantages
• Can be effective reducing speeds and improving safety, particularly, at intersections.	• Kerb realignment can be costly. • May require some additional land if retro-fitting. • Needs to be adequately enforced or may lead to increased accident levels.

3.1.13 Neckdowns

Neckdowns are kerb extensions at intersections that reduce the roadway width from kerb to kerb. They 'pedestrianise' intersections by shortening crossing distances for pedestrians and drawing attention to pedestrians via raised peninsulas. They also tighten the kerb radii at the corners, reducing the speeds of turning vehicles (see also Table 15). They are good for intersections with substantial pedestrian activity and areas where vertical traffic calming measures would be unacceptable because of noise considerations (www.trafficcalming.org).

Table 15: Advantages, disadvantages and effectiveness of neckdowns

Advantages	Disadvantages
• Improve pedestrian circulation and space. • Are easily negotiable by large vehicles. • Create protected on-street parking bays. • Reduce speeds.	• Effectiveness is limited by the absence of vertical or horizontal deflection. • May slow emergency vehicles • May require the elimination of some on-street parking near the intersection. • May require bicyclists to briefly merge with vehicular traffic.

Source: Adapted from: www.trafficcalming.org

3.1.14 Centre island narrowing

A centre island narrowing is a raised island located along the centreline of a street that narrows the travel lanes at that location. Centre island narrowings are often landscaped to provide a visual amenity. Placed at the entrance to a neighbourhood, and often combined with textured pavement, they are often called "gateway islands." Fitted with a gap to allow pedestrians to walks through at a crosswalk, they are often called "pedestrian refuges" (see also Table 16). Centre island narrowings are good for entrances to residential areas, and wide streets where pedestrians need to cross (www.trafficcalming.org).

Table 16: Advantages, disadvantages and effectiveness of centre island narrowings

Advantages	Disadvantages
• Increase pedestrian safety. • If designed well, they can have positive aesthetic value. • They reduce traffic volumes.	• Their speed-reduction effect is somewhat limited by the absence of any vertical or horizontal deflection. • May require elimination of some on-street parking.

Source: Adapted from: www.trafficcalming.org

3.1.15 Chokers

Chokers are kerb extensions at midblock locations that narrow a street by widening the sidewalk or planting strip. If marked as crosswalks, they are also known as safe crosses. Two-lane chokers leave the street cross section with two lanes that are narrower than the normal cross section. One-lane chokers narrow the width to allow travel in only one direction at a time, operating similarly to one-lane bridges (see also Table 17). They are good for areas with substantial speed problems and no on-street parking shortage (www.trafficcalming.org).

Table 17: Advantages, disadvantages and effectiveness of chokers

Advantages	**Disadvantages**
• Are easily negotiable by large vehicles (such as fire trucks). • If designed well, they can have positive aesthetic value. • Reduce both speeds and volumes.	• Their effect on vehicle speeds is limited by the absence of any vertical or horizontal deflection. • May require bicyclists to briefly merge with vehicular traffic. • May require the elimination of some on-street parking.

Source: Adapted from: www.trafficcalming.org

3.1.16 Road Diets

Road 'diets' are applications that reduce the number and width of traffic lanes, particularly on arterials to reduce speeds which consequentially will reduce volumes. Typical applications include the conversion of a 4 lane road to 3 lanes with a centre turning lane and bicycle lanes. Aesthetic and pedestrian improvements also help the effect (www.vtpi.org). For more information on the advantages and disadvantages of road diets refer to Table 18.

Table 18: Advantages, disadvantages and effectiveness of road 'diets'

Advantages	Disadvantages
• If designed well, they can have positive aesthetic value. • Reduce both speeds and volumes. • Does not require additional land. • Can help provision of, and integrate, non-motorised transport. • Should reduce overall accident levels.	• May cause consequential congestion elsewhere on the network due to reduced capacity. • May require bicyclists to briefly merge with vehicular traffic. • May require the elimination of some on-street parking.

3.1.17 Bike Lanes

The introduction of bike lanes on existing roads narrows traffic lanes, thereby reducing traffic speeds and facilitating cycling (see Table 19).

Table 19: Advantages, disadvantages and effectiveness of bike lanes

Advantages	Disadvantages
• If designed well, they can have positive aesthetic value. • Can reduce both traffic speeds and volumes. • Does not require additional land or road construction. • Can help provision of and integrate non-motorised transport. • Should reduce overall accident levels.	• May require bicyclists to briefly merge with vehicular traffic. • May require the elimination of some on-street parking. • May be problematic at intersections. • Road surfaces could be problematic for cyclists. • Could be unsafe where road speeds are high.

3.2 Volume Reduction measures

3.2.1 Full closures

Full closures are barriers placed across a street to completely close the street to through-traffic, usually leaving only sidewalks open (see also Table 20). They are good for locations with extreme traffic volume problems and where several other measures have been unsuccessful (www.trafficcalming.org).

Table 20: Advantages, disadvantages and effectiveness of full closures

Advantages	**Disadvantages**
• Are able to maintain pedestrian and bicycle access. • Are very effective in reducing traffic volume.	• Might require legal procedures. • Cause circuitous routes for local residents and emergency services. • May be expensive. • May limit access to businesses.

Source: Adapted from: www.trafficcalming.org

3.2.2 Half closure

Half closures are barriers that block travel in one direction for a short distance on otherwise two-way streets (see Table 21). They are good for locations with extreme traffic volume problems and where non-restrictive measures have been unsuccessful (www.trafficcalming.org).

Table 21: Advantages, disadvantages and effectiveness of half closures

Advantages	**Disadvantages**
• Are able to maintain two-way bicycle access. • Are effective in reducing traffic volumes.	• Causes circuitous routes for local residents and emergency services. • May limit access to businesses. • Depending on the design, drivers may be able to circumvent the barrier.

Source: Adapted from: www.trafficcalming.org

3.2.3 Diagonal diverters

Diagonal diverters are barriers placed diagonally across an intersection, blocking through movements and creating two separate, L-shaped streets. Like half closures, diagonal diverters are often staggered to create circuitous routes through the neighbourhood as a whole, discouraging non-local traffic while maintaining access for local residents (see Table 22). They are good for inner-neighbourhood locations with non-local traffic volume problems (www.trafficcalming.org).

Table 22: Advantages, disadvantages and effectiveness of diagonal diverters

Advantages	**Disadvantages**
• Do not require a closure per se, only a redirection of existing streets. • Are able to maintain full pedestrian and bicycle access. • Reduce traffic volumes.	• Cause circuitous routes for local residents and emergency services. • May be expensive. • May require reconstruction of corner kerbs.

Source: Adapted from: www.trafficcalming.org

3.2.4 Lateral shifts

Lateral shifts are usually shifts designed into the horizontal alignment of the lane centreline to introduce a curve or shift, thereby forcing a reduction in vehicular speeds (see Table 23). Shifts are normally undertaken at intersections to maximise effects.

Table 23: Advantages, disadvantages and effectiveness of Lateral Shifts

Advantages	**Disadvantages**
• Do not require a closure per se, only a redirection of existing roads. • Are able to maintain full pedestrian and bicycle routes. • Reduces traffic speeds and volumes.	• Cause circuitous routes for local residents and emergency services. • May be expensive. • May require additional land. • Needs to be adequately enforced or could lead to increases in accidents.

3.2.5 Median barriers

Median barriers are islands located along the centreline of a street and continuing through an intersection to block through movement at a cross street (www.trafficcalming.org). They are good for local street connections to main streets, where through traffic along the continuing local street is a problem and, main streets where left-turns to, and/or from, the side street are unsafe (see Table 24).

Table 24: Advantages, disadvantages and effectiveness of median barriers

Advantages	**Disadvantages**
• Can improve safety at an intersection of a local street and a major street by prohibiting dangerous turning movements. • Can reduce traffic volumes on a cut-through route that crosses a major street.	• Require available street width on the major street. • Limit turns to and from the side street for local residents and emergency services.

Source: Adapted from: www.trafficcalming.org

3.2.6 Neo-Traditional Designs

Neo-Traditional Designs use a network of through streets (as opposed to a hierarchy) with narrow streets, shorter block lengths, T-intersections and other features to reduce vehicle speeds and volumes (www.ite.org, 1998). Advantages/disadvantages of neo-traditional designs are described in Table 25.

Table 25: Advantages, disadvantages and effectiveness of Neo-Traditional Design

Advantages	**Disadvantages**
• Narrower lanes and lower traffic volumes can significantly improve safety. • Designs usually allow the increased facilitation of non-motorised modes and greater integration between modes.	• Can reduce speeds of emergency vehicles. • Needs sufficient public transport infrastructure to work appropriately.

4. ESTIMATED TRAVEL IMPACTS OF TRAFFIC CALMING MEASURES

4.1 Literature Review

A significant amount of research over the last few decades has been devoted to reviewing traffic calming measures, detailed designs, various strategies, their impact on road safety etc. From these reviews a limited selection, concerned with impact evaluation, is presented below.

The TRL (www.trl.co.uk, accessed 1/2010) and Department for Transport, UK (www.dft.gov.uk/pgr/roads, accessed 1/2010), amongst many others, report that reducing traffic speeds and volumes can reduce the severity of vehicle crashes, particularly those involving pedestrians and cyclists. Each 1 mph traffic speed reduction typically reduces vehicle collisions by 5% and fatalities by an even greater amount. Stuster and Coffman, report that fatality risk increases with speed to the fourth power; a 1% reduction in speed provides a 2% reduction in the risk of injuries and a 4% reduction in the risk of fatalities.

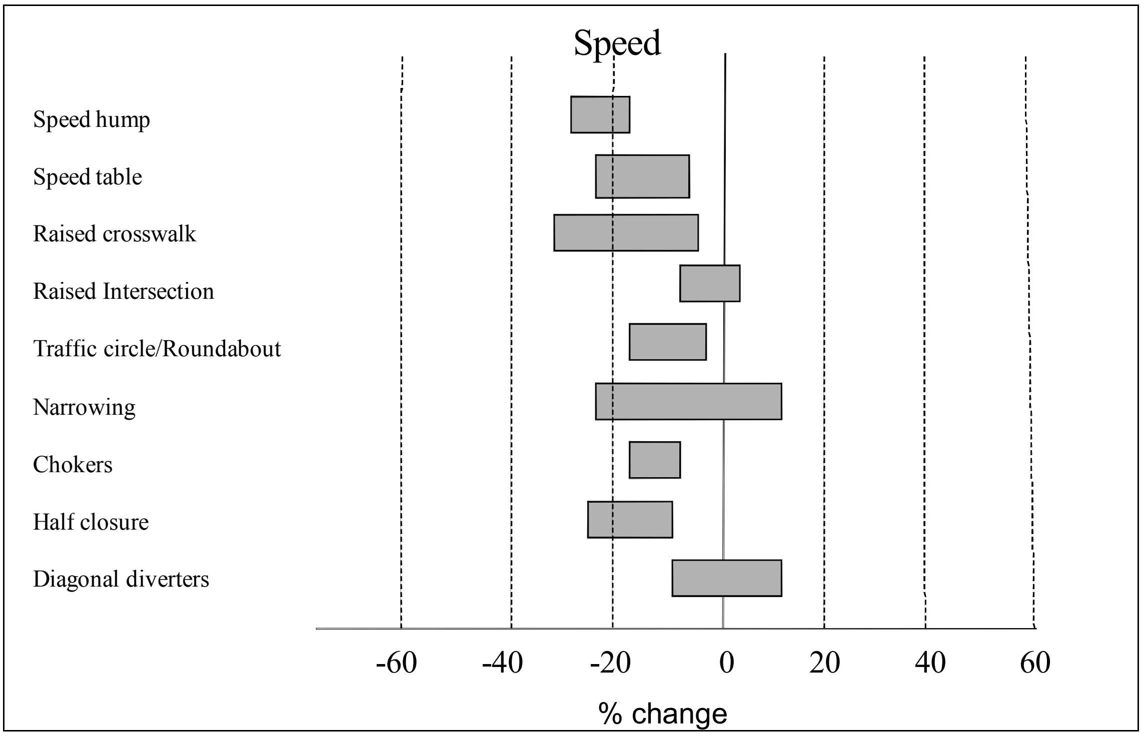
A study of a range of measures in the US by Ewing, found that traffic speeds were reduced by 23% for humps, 11% for circles, 4% for narrowings etc. Another study, by DKS, indicates that for every 1m increase in width the 85^{th} percentile vehicle speed increases by 1.6km/h.

Various studies on volumes indicate an elasticity of vehicle travel with respect to travel time of -0.5 in the short run and -1.0 in the long run, meaning that a 20% reduction in vehicle speeds will reduce total vehicle travel by 10% in the short term and up to 20% in the longer term (www.vtpi.org).

Other studies found that road based traffic calming measures that result in a speed reduction of 14.4 km/h reduce traffic accidents by 60–70%. Furthermore, fatal or serious injury accidents are significantly reduced when road based traffic calming measures are implemented (Webster and Mackie, 1996). Garder (2004) found that crashes involving pedestrians were lower in two-lane streets with a middle island than on wider streets due to lower vehicle speeds. Milton and Mannering, and Noland have also reported on the improved safety of narrower streets.

In general, roundabouts are also reported to have a favourable effect on traffic safety, at least for accidents causing injuries (Daniels at al., 2008). A meta study of 28 projects in eight different countries estimated a reduction of injury accidents by 30-50% (Elvik, 2003). A Dutch road safety study, regarding the replacement of controlled intersections with roundabouts, also revealed a decrease in accidents after a six month period amounting to 51% (www.swov.nl).

In summary, the literature indicates that measures designed to reduce speeds have been successful to a varying degree. They have been similarly successful in reducing accidents by reducing speed, conflicting movements and focussing driver attention. Volume control measures have also been successful in achieving their objective. The degree of success is clearly context and type specific. An aggregate of the findings from literature is shown in Figure 1 in bar format to reflect the variance in success levels reported.



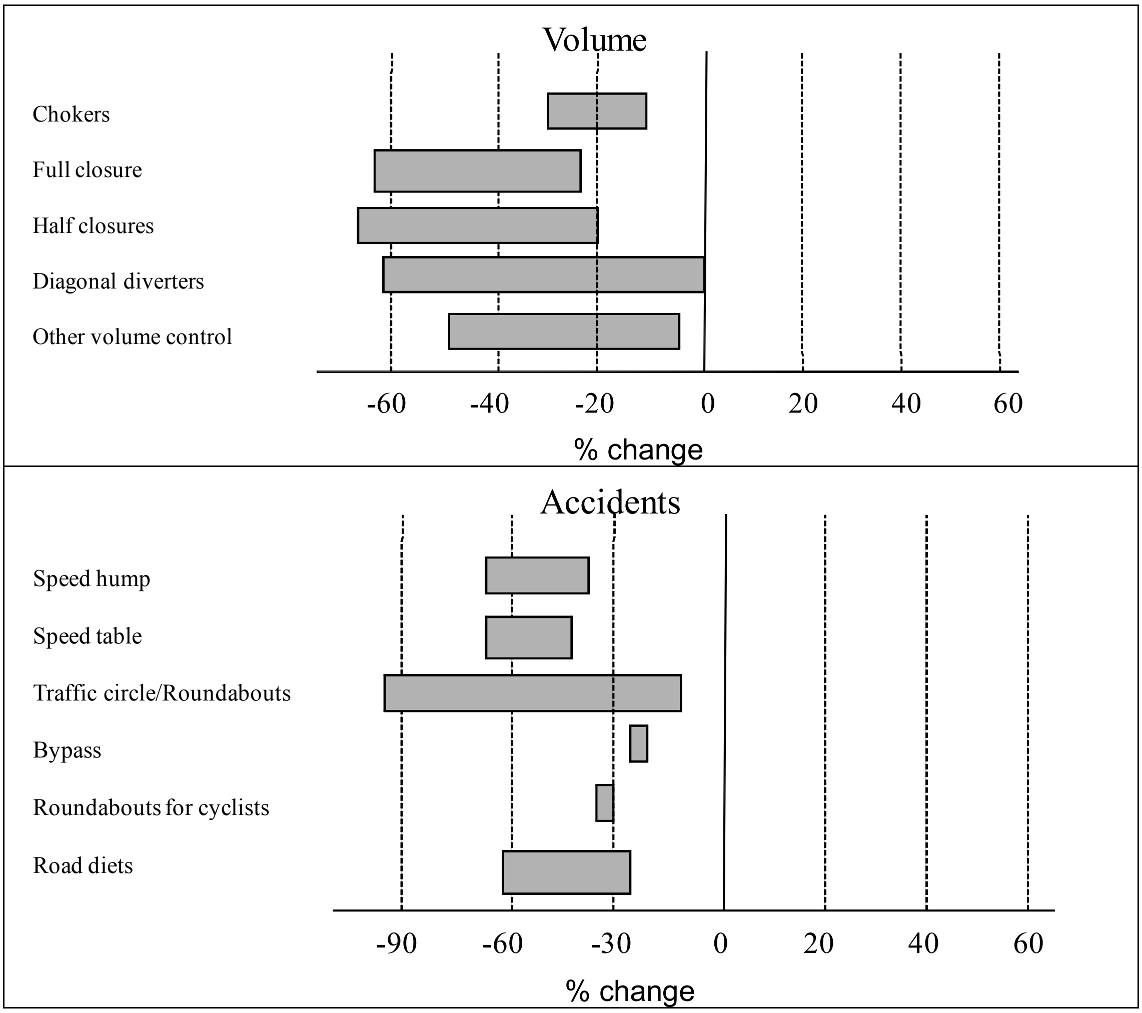


Figure 1: Speed, volume and accident effects of traffic calming measures
Source: Based on various reports, journal articles and working documents

4.2 Micro-Simulation Modelling

4.2.1 Modelling approach

Road based infrastructure is complex and difficult to accurately model as well as analyse on computer models. In recognition of this, and in order to provide supportable and verifiable results of measures, a network of the inner City of Cape Town, including some peripheral roads, was modelled along with a basket of measures selected from the literature review.

A small section of the overall network, as shown in Figure 2, was selected as the test area as there are opportunities for alternative routes and because this area could reasonably be traffic calmed if required. Traffic flows were obtained from the City's database for the morning peak and distributed via an O/D matrix linked to various zones within the network. The flow incorporates buses and mini-bus taxis to reflect typical South African traffic public transport conditions. Modelled road speeds reflected real speed limits and road widths were reasonably consistent with existing widths. Infrastructure and external effects such as signage, road furniture, speed cameras, proximity of building and the general environment were kept constant throughout the exercise. Aggression and awareness values which influence gap acceptance, car following, lane changing and collision detection were modified from default values, to reflect driving habits in Cape Town which are perceived to be more aggressive and possibly less 'aware' than those in developed countries. All vehicles were modelled to be an average of 10 years old.

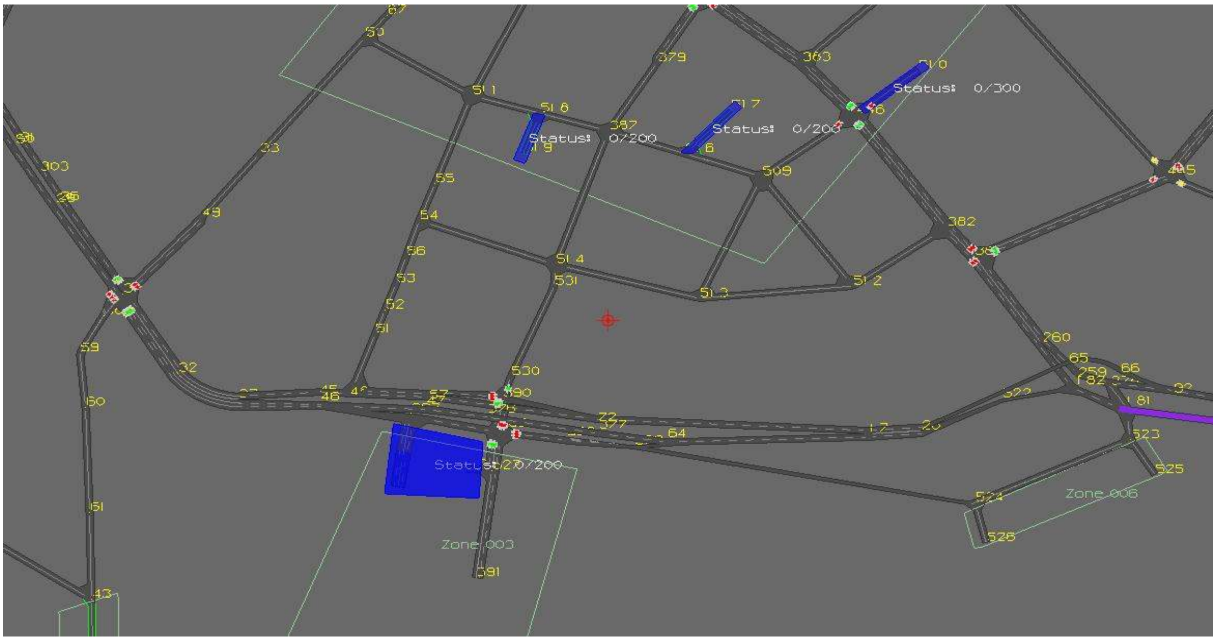


Figure 2: Screen shot of the model network.

Measures were modelled along a single street, rather than on an area-wide basis.

The modelling work was supported or verified by the collation of field data on speeds and volumes for speed humps, a speed table, a raised intersection and a mini-roundabout at various local locations.

4.2.2 Findings

The exercise revealed that the software had several small quirks which required careful manipulation in order to accurately simulate infrastructure and vehicle speeds. The software calculates speeds based on actual speed limits imposed, either on the link or via infrastructure (in most cases, except for very tight radii), and compliance by drivers and, therefore, in order to effectively model the speed reductions of road humps, the entire length of the link calmed had to be simulated with the observed speed limit as a control (in our case 20km/h) as vertical changes of even 150mm made almost no difference to speeds.

It was also apparent that measures such as tighter radii, road diets or chokers did not affect vehicle speeds significantly which, intuitively, would be the case in reality, without artificially imposing speed controls (such as speed cameras). There was, however, a volume reduction, which one would expect, indicating that the time/cost function for driver behaviour was operating correctly.

Dynamic and static data can be obtained from the software for links, nodes, paths, car parks etc. As safety is the key component of this study and given the weight of evidence on the relationship between speed and accidents/injury risks, differences in speed and volumes between the base case (i.e. as existing) and the modelled measures were considered the most appropriate outputs of effectiveness of the measures modelled as shown in Table 26.

Table 26: Results of modelling work

Measure	Design Features	Volume (one way v/h)	Average Vehicles Speeds (km/h)		% Change from Base Case			Remarks
					Speed		Volume	
			Bus#	Others	Buses	Others	Trial area	
Base Case	Link width 7.3m, 50km/h speed	1232	55	55	-	-	-	
Humps	20km/h speed	864	15	18-28	-73%	-49%	-30%	
Choker	4.5m width, 20km/h speed	1008	30	32-39	-45%	-29%	-18%	
Choker	4.5m width, 20km/h speed with directional priority	824	10	7-20	-82%	-64%	-33%	% change shown for travel towards give way
Chicane	20m radius with 20km/h speed	864	20	20-25	-64%	-55%	-30%	
Mini-Roundabout	20m radius	864	25	20-25	-55%	-55%	-30%	
Road Diet	5m width 40km/h, link speed	1048	38	40-44	-31%	-20%	-15%	
Tight Radii	100m, 40km/h speed	1056	40	40-45	-27%	-18%	-14%	
Lateral shift	Terminal intersection shifted from cross to staggered	1232	55	55	0	0	0	Speeds at mid block

Depends on position of Bus Stops

5. COMPARISON OF MODELLING RESULTS WITH INTERNATIONAL LITERATURE

In comparison to the literature reviewed, the results of the modelling in relation to speed were significantly different for almost all measures (see Figure 3). Some reasons for this are immediately apparent. There could be differences in the before and after speed limits, the point at which speeds were measured, the time of day and, the physical design of the measure, all of which will have a major influence on results.

In observed cases in Cape Town, at speed humps, speeds reduced from around 55km/h to 20km/h or below and at mini-roundabouts (or traffic circles) to between 20-30km/h. Observations were during the morning peak and, therefore, the differences in speed reduction seems to be attributable to the physical size of the pieces of infrastructure.

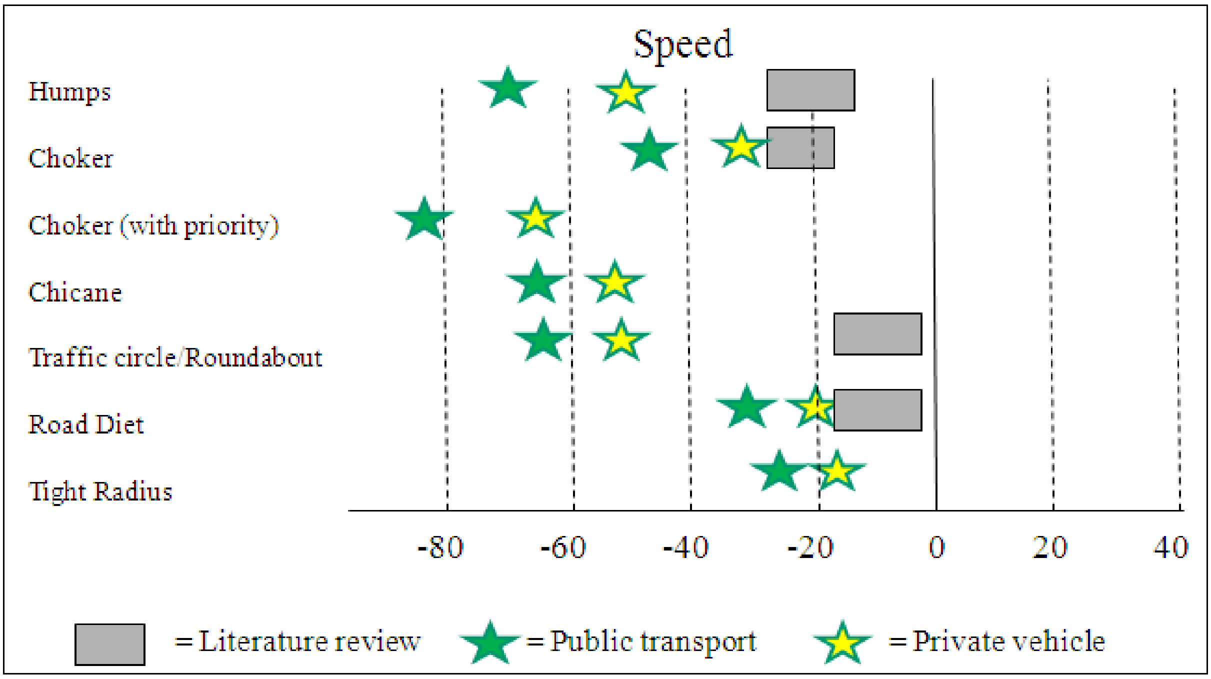


Figure 3: Traffic calming speed comparison between literature and modelling study

The studies reviewed did not differentiate between public and private transport and, therefore a comparison for public transport could not be made, however, observations show that the speed reduction effect of calming measures are usually greater on public transport vehicles and, therefore, modelled results seem to reflect reality.

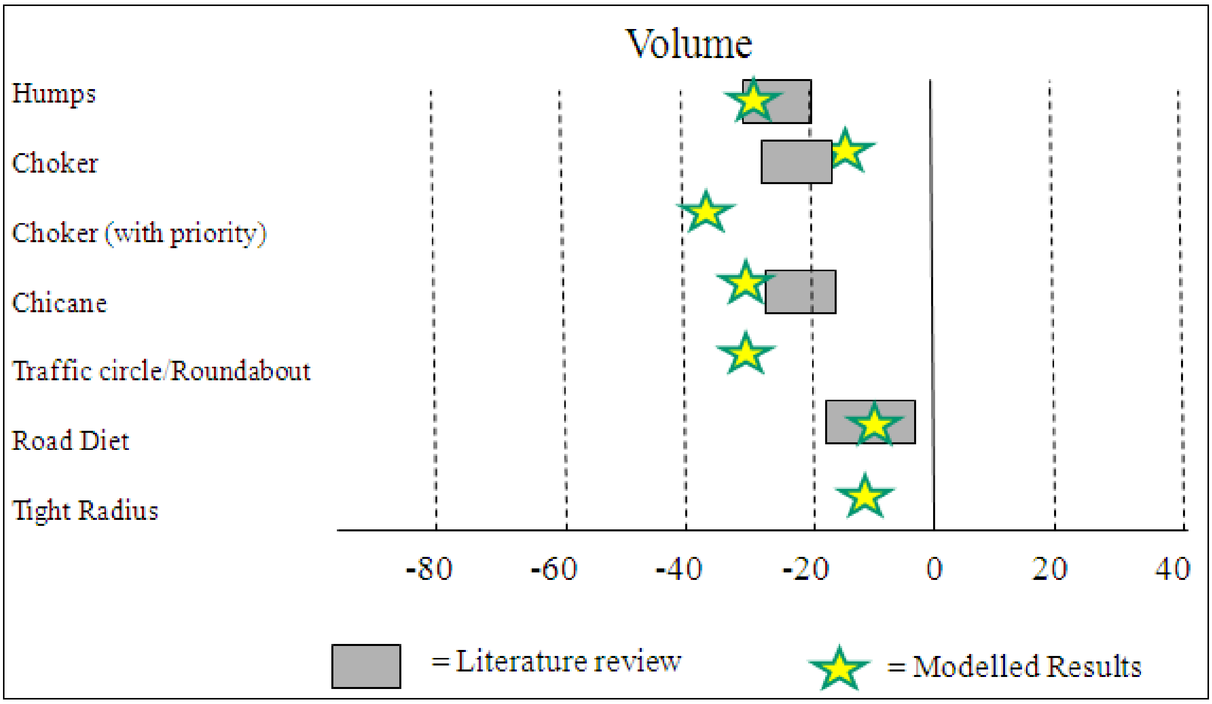


Figure 4: Traffic calming volume comparison between literature and modelling study

Computed volume reductions are much more in keeping with literature reviews and, therefore, it seems that this aspect can be modelled with some degree of confidence.

The reduction in speeds, as well as, volumes also implies a reduction in crashes and their severity, however, there is no way to predict actual reductions from a modelling exercise, one can only state that there would or would not be a reduction in accident risk.

6. SYNTHESIS AND CONCLUSION

Over the past few decades, transport policy has focussed on providing road based infrastructure that is faster, wider and more efficient. These policies facilitated driving faster and neglected the human impact of crashes, the degraded conditions for walking and cycling and neighbourhood liveability.

Road based traffic calming (or management) is a strategy developed to reduce the impact of vehicles on neighbourhoods via measures that either reduce speeds or volumes of traffic, or both, or to increase multi-modality and, possibly, neighbourhood interaction. Strategies for traffic calming (whether for speed control, volume control or both) can involve the use of one or more types of measure, as their appropriateness is completely dependent upon the local circumstances and the problem encountered.

Micro-simulation models enable researchers and practitioners to analyse the effectiveness of interventions on a disaggregated level, as individual vehicles are simulated in detail as they move through the road network, with the goal of reaching their destination by the most cost effective route. The study modelled a series of measures, which could reasonably be modelled using computer software, to determine the reduction in speed and volumes of traffic. The objective being: to determine if these modelled calming strategies can provide realistic results and, whether models could be used to provide guidance on appropriate design for predefined goals and strategies.

A comprehensive review of literature indicating the most common traffic calming measures implemented internationally was undertaken. The literature indicated the effectiveness of individual measures as follows. The majority of measures reviewed by researchers provided a significant reduction in traffic speeds (up to 30%), volumes (up to over 70%) and, therefore, accidents (by between 15% and 90%) from the base case (unaltered). However,

Calibration of the model for speed humps, speed camera compliance and traffic circles was undertaken using observed data in various locations in Cape Town. The findings of the computer simulation following this exercise were, generally, consistent with the literature review, although there was a significant difference in some of the results specifically in relation to speed reduction (showing a speed reduction of around 50% which was significantly greater than the 20-25% reported in the literature reviewed). Many reasons are apparent for this difference such as:

- The calming could be at a single street only level or part of an area wide strategy;
- There could be differences in overall traffic volumes;
- The observation time of the 2 studies could be different (i.e. peak or inter-peak);
- The actual measurement of speed could be at different locations;
- The physical design of the measure could be different (heights and distances);
- There could be differences in generalised driving behaviour;
- There could be differences in levels of speed limit enforcement etc.

It was notable that volume and speed reductions for road diets and tight radii were marginal when initially simulated by the software, whereas experience and intuition suggests otherwise. Therefore, in this regard the software may generate results which need to be used with caution or input needs to be calibrated using local or similar conditions as a guide.

Generally, it can be concluded from this exercise that micro-simulation models do have the potential to be a helpful tool at a decision making level as they provide realistic results and the opportunity to explore different impacts of road based traffic calming measures before implementation. However, modelled strategies need careful calibration to simulate local conditions to adequately mimic real-life driving conditions and behaviours and thus ensure realistic results.

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