TRAFFIC IMPACT OF PEDESTRIANISATION IN STELLENBOSCH

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ABSTRACT

The applicability of a pedestrianisation scheme in the historic city center of Stellenbosch, in alleviating the currently experienced transportation related problems, is investigated. These problems negatively affect the general health of a community, decrease tourism attraction and therefore also decrease turnover. Pedestrianisation is, therefore, analysed as being a catalyst for a healthy economy, as well as environment.
Various factors are identified as having a key influence in the feasibility of such an undertaking. These include the direct traffic flow patterns, parking utilisation in the area, as well as the operational aspect associated therewith. Each of these are analysed according to their vulnerability to change, given the implementation of such a scheme. Parking demand and resulting vehicle movement patterns are investigated using parking utilisation studies as well as license plate analysis data. When considering the operational aspect of such a scheme, alternative entrance and exit control procedures for delivery vehicles are considered. In terms of the traffic flow impact, a traffic microsimulation analysis was conducted using PTV Vissim. Factors such as queue length, delay time and LOS values are considered before and after implementation of the scheme.

Pedestrianisation can be a useful tool in bringing positive change to a city center and can be applied to a wide range of traffic scenarios. Considering this study, it was found that the application of such a scheme is possible due to sufficient alternative parking, a manageable operational aspect as well as a reasonable impact in terms of the traffic flow. It is, therefore recommended that pedestrianisation should be implemented in adding value to central Stellenbosch.

1 INTRODUCTION

Many urban areas in the world are faced with a rapid upsurge in private vehicle usage, as well as an ever increasing number of pedestrians. This is often in areas which were not originally designed for this kind of traffic and pedestrian loading, leading to congested, overused city centres.

The combination of this increase in private vehicles and the increased number of pedestrians is the main reason for a variety of negative consequences in central business districts (CBD’s). Some of the main problems include increased congestion, lack of available parking, increased pollution and noise levels as well as a higher number of pedestrian related accidents (Soni and Soni, 2016). If these resulting issues are not dealt with correctly, a negative impact on environment, economy and society can be experienced.

Stellenbosch is no exception. Here, also, there are visible consequences of high traffic and pedestrian volumes and the interaction between them. Stellenbosch is a student town as well as a hub for tourism in the area. Central Stellenbosch, as can be seen in Figure 1, is where most of the resulting transport related problems, as were previously identified, become evident. Narrow streets, minimal accommodation for non-motorised transport (NMT), insufficient public transport, high tourist attraction and a number of other reasons create conflict within central Stellenbosch.

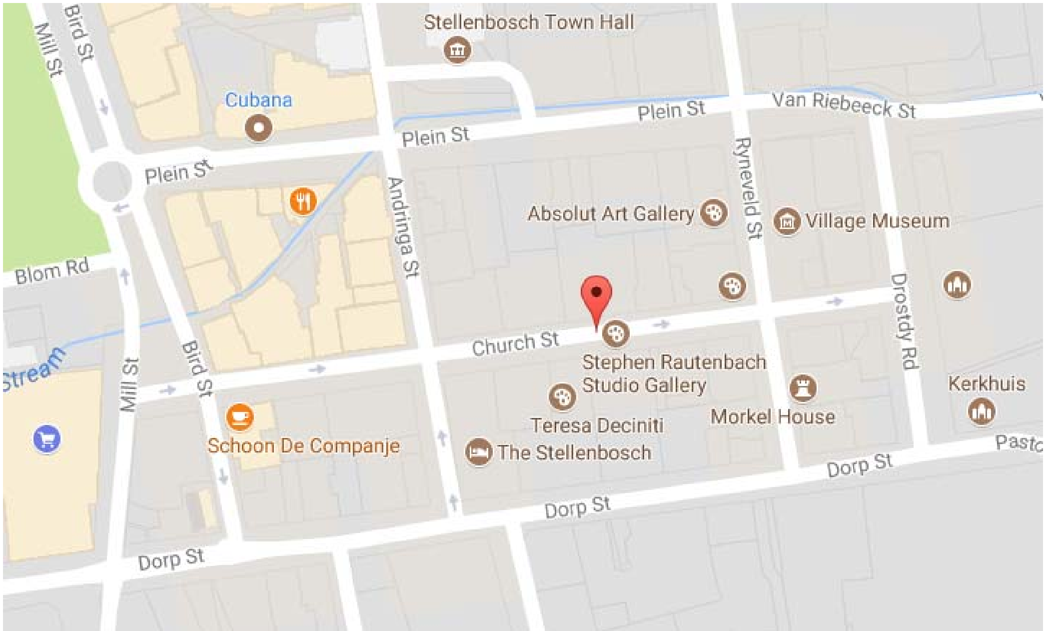

Figure 1: Central Business area in Stellenbosch (www.google.com)

Considering the specific transportation related issues in Stellenbosch, it becomes obvious that an alternative course of action needs to be sought out in order to ensure a liveable and sustainable Stellenbosch.

This project aims at analysing the feasibility of implementing a pedestrianisation scheme in central Stellenbosch. More precisely, the feasibility of pedestrianising Church Street, and the part of Andringa Street from Dorp Street to Plein Street, in order to combat the transportation related problems currently experienced in these Streets of Stellenbosch.

Part of this analysis is to determine the traffic impact this scheme would have on the surrounding area by utilising the PTV Vissim microsimulation software package. The traffic impact will be a conclusive factor in deciding whether to implement the scheme or not. Other possible negative consequences of implementing the scheme, such as parking problems, will also be analysed and a recommendation will be made whether the scheme is viable or not.

Finally, the best approach and extent of the pedestrianisation will be discussed. Also, the best way to implement, and where exactly it would be the most viable to do so, will be examined.

2 PEDESTRIANISATION

2.1 What is pedestrianisation?

Pedestrianisation, in its general form, is defined as the process of creating a pedestrian zone, or precinct, in an area which was typically used by motorized traffic before. This is done by either closing off access to motorized traffic permanently, or to allow for exempt access at specific times of the day or for a certain group of vehicles. The type and scale to which this is implemented is dependent on the situation and circumstances of the particular problem area (Naadiya, 2009).

There are a number of countries worldwide which have been implementing this concept for many years, with Germany having implemented it on a larger scale since the 1970's (Hass-Klau, 1993). It has been proven to be an effective way of reducing or eliminating transportation related problems within an area, which in turn positively affects the environment, increasing attractiveness of the area which directly increases turnover. It is, however, not just a means to improve the economy but aims mostly at improving the general health of the community.

Pedestrianisation is mostly implemented in historic city centres, either on a full-time, part-time or traffic calming level (Soni and Soni, 2016). Fitting to the level of implementation, an area can either be closed off by making use of retractable bollard or boom access control, or simply have sufficient signage to prevent vehicles from entering.

2.2 Benefits and challenges

Pedestrianisation has some major benefits, but also comes with some challenges. The benefits range from transportation benefits to social, environmental, economic and health benefits. Some of these are summarised in Figure 2.

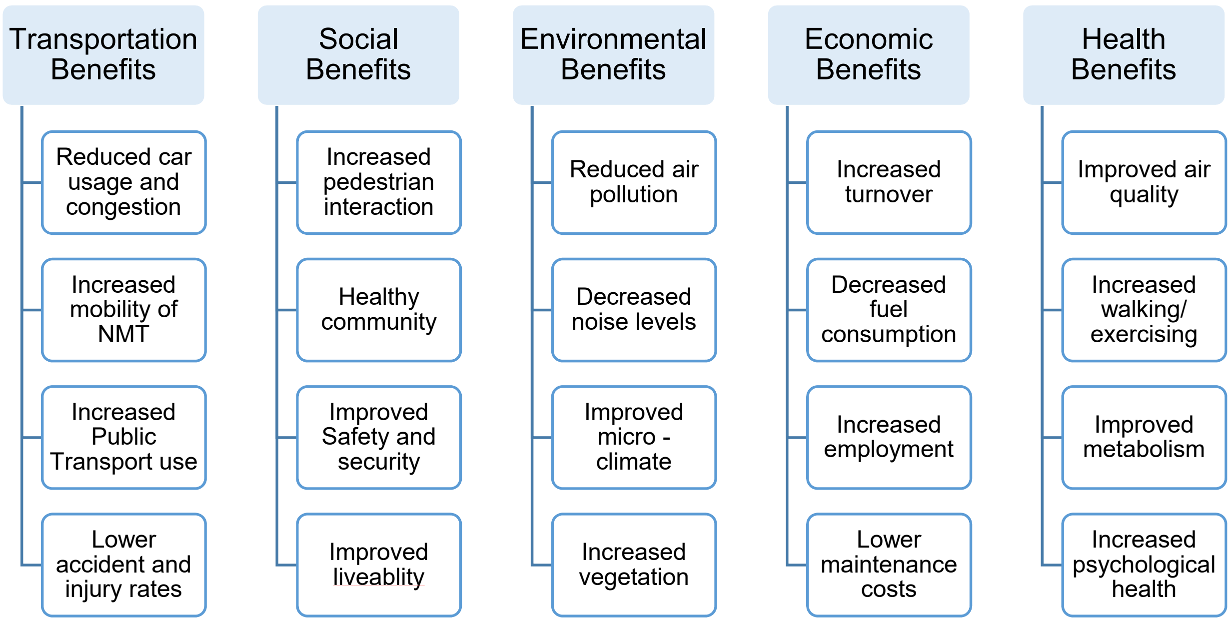

Figure 2: Some pedestrianisation benefits (adapted from Soni and Soni, (2016))

Some challenges have been identified in the execution of pedestrianisation schemes. Most of these are experienced in the beginning stages of the implementation and solutions are often available.

Opposition faced from business owners, wrongfully assuming that their businesses will be negatively affected, is a generally faced theme (Hass-Klau, 1993). This has, however, mostly been proven wrong. Businesses fringing the precinct yet often face a decreased turnover and the surrounding environment might also experience an increase in noise and air pollution (Hass-Klau, 1993). The accessibility of the pedestrian precinct via public transport, as well as sufficient surrounding parking availability, can also be a challenge in implementing pedestrianisation (Muñuzuri *et al.*, 2013).

The concept of pedestrianisation in South Africa has only been applied very recently when compared to the rest of the world, especially Europe. It has however been recognised since the 1970’s that in order for city centers to stay up to standard, pedestrianisation would have to form a part of them, since non-motorised transport is the most efficient mode in CBD areas (Gasson, 1975).

3 METHODOLOGY

In light of the research done on the topic of pedestrianisation, a research methodology is formulated in order to determine a suitable approach to applying this concept to Stellenbosch.

3.1 Data processing

Firstly, it is important to understand what the current situation and circumstance looks like before the possible negative consequences of pedestrianisation can be recognised. This is done by obtaining data such as traffic counts, parking availability as well as general site information, including tourist attractions, street layout and retailer details. Secondly, this data has to be analysed and rated according to its vulnerability to change, given the implementation of a pedestrian precinct.

Traffic counts, site surveys and parking studies will be conducted to obtain the data, which will then be analysed and implemented as part of the concept development and Vissim modelling phases.

3.2 Concept development

As seen from the literature review, there are a number of different ways in which pedestrianisation can be implemented. These alternatives include full- and part-time pedestrianisation as well as traffic calming measures, which will be evaluated and compared to determine a suitable implementation in Stellenbosch.

3.3 Vissim Modelling

The PTV Vissim microsimulation software is utilised to simulate the traffic network in the study area. This includes the current and pedestrianised scenarios. The relevant data obtained from the data collection phase will be used in defining an accurate model of the area. Simulation results, such as queue length, delay time and level of service (LOS) evaluation, will be compared before and after implementation of the pedestrianisation scheme.

Based on the results obtained from the parking surveys, concept development and Vissim modelling phases, conclusions and recommendations will be provided in terms of the feasibility of the scheme.

4 DATA COLLECTION AND ANALYSIS

The different data components of this study, how they are collected and why they are important, is discussed in this chapter.

4.1 Site data

It is important to understand the current environment such that it is possible to understand what the pedestrianised environment would look like, as well as to accurately model the affected road network. Some of the relevant street properties are shown in Table 1. From this it can be seen that a very narrow street environment is present. It was also observed that most of the available road width, especially in Church Street, is already utilised for parking spaces, which contributes to the restrictive feel of the area.

Table 1: Current Street properties in central Stellenbosch

Street Name	Total no. of lanes	Lane width (m)	Length[1] (m)	Direction[2]	Total available parking	Speed limit (km/h)	Total street width[3] (m)
Plein St	2	3.5	360.0	E & W	64	60	15
Drostdy Rd	2	3.0	165.0	N & S	23	60	15
Church St	1	3.0	336.0	E	82	60	12
Rynelveld St	1	2.8	180.0	S	30	60	12
Andringa St	1	2.8/3.5 [4]	180.0	N	30	60	12
Bird St	2	3.0	188.0	S	22	60	12
Mill St	1	3.0	188.0	N	25	60	12
Dorp St	2	2.5	400.0	E & W	0	60	12

[1] As part of study area.
[2] N - Northbound, E - Eastbound, S - Southbound, W - Westbound.
[3] Including the lanes, parking spaces and pedestrian walkways.
[4] Two different street layouts of Andringa Street are present either side of Church Street

Various other parameters, such as the intersection control in the area, as well as the current pedestrian provisions, were also noted and formed part of the environment definitions. Pedestrian and vehicle attractors were identified in order to gain a better perspective into how the pedestrian-vehicle conflict arises.

As part of visually analysing the CBD of Stellenbosch, a number of Street Mix views of the main streets of interest were generated, one of which can be seen in Figure 3.

Figure 3: Street Mix view of Church Street (www.streetmix.net)

4.2 Parking studies

As part of analysing the feasibility of a pedestrianisation scheme in Stellenbosch, it was very necessary to conduct a parking utilisation study. This sort of study is vital to consider when looking at a situation where parking will potentially be removed from an area. A clear understanding of the current parking demand situation in the area of interest is important. As part of this study some recent license plate analysis data of central Stellenbosch, available from the Municipality, was examined, in order to assist in establishing a clearer picture of what the parking demand is (Stellenbosch Municipality, 2017). The study area for that survey coincided with the same area shown in Figure 5 of this report as being possible pedestrian zones.

Firstly, the total private vehicle parking (P), as well as the load, bus and disabled parking (L/B/D) availability in the affected streets, was counted. Secondly, the number of unused parking spots were tallied at specific times during a typical high demand day, after which the volume-capacity (V/C) ratio for each street could be calculated. These times were between 08:00 - 09:00, 12:30 - 13:30, 15:30 - 16:30 and 19:00 - 20:00. Analysis periods 1 and 2 are shown in Table 2.

Table 2: Volume/Capacity ratios for analysis periods 1 and 2

Street	P Capacity	L/B/D Capacity	08:00 - 09:00				12:30 - 13:30			
			P in use	L/B/D in use	P V/C ratio	L/B/D V/C ratio	P in use	L/B/D in use	P V/C ratio	L/B/D V/C ratio
Plein St	55	11	31.00	2.00	0.56	0.18	53.00	9.00	0.96	0.82
Drostdy Rd	21	3	2.00	0.00	0.10	0.00	20.00	1.00	0.95	0.33
Church St	74	11	36.00	2.00	0.49	0.18	73.00	6.00	0.99	0.55
Rynelveld St	22	8	6.00	2.00	0.27	0.25	21.00	6.00	0.95	0.75
Andringa St	25	5	8.00	3.00	0.32	0.60	25.00	4.00	1.00	0.80
Bird St	19	3	13.00	0.00	0.68	0.00	18.00	2.00	0.95	0.67
Mill St	22	4	18.00	3.00	0.82	0.75	21.00	4.00	0.95	1.00

Figure 4 shows the graphical representation of the private vehicle parking volume/capacity ratios. From this it can be seen that there is a high parking demand in the area, especially during the lunch and dinner times. This is relatable to the high number of eateries in the area. The L/B/D parking demand in the area showed very similar results, with a very high parking demand. It has to be noted, however, that most of the L/B/D parking spots which were occupied in the evening, were indeed occupied by private vehicles. This adds to the conclusion that there is a very high parking demand in central Stellenbosch, which often exceeds the capacity.

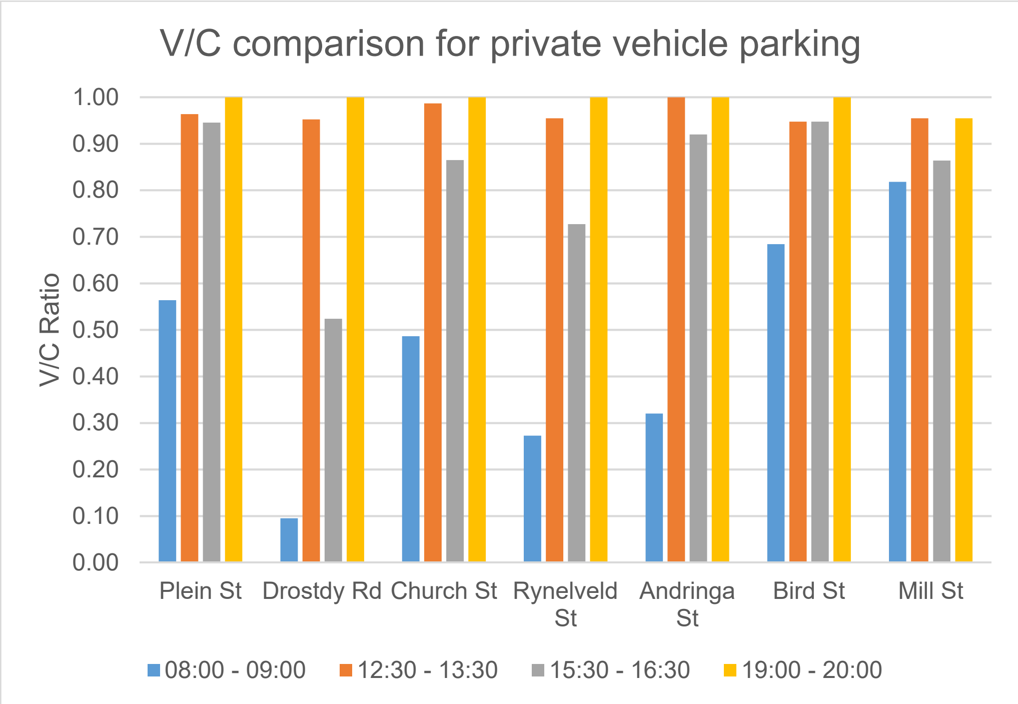

Figure 4: Volume/Capacity comparison for private vehicle parking

From the license plate analysis study conducted by the Municipality of Stellenbosch in April 2017, it could be noted that there is a very high amount of traffic in central Stellenbosch which is circulatory traffic and not through traffic. These would be vehicles circulating the area, in search for parking, which unnecessarily contributes to the traffic related problems in the CBD. Circulation was found to be confined into and out of the same area as shown in Figure 5 of this report. An example of this behaviour can be seen in Table 3, which shows the data for Monday, the 24th of April.

Table 3: Frequency of vehicles entering the CBD (24/04/2017)

Frequency of entry	No of vehicles
1	153
2	71
3	41
4	24
5+	105

This same study by the Municipality made reference to a parking occupancy study, which showed that there is indeed sufficient parking available at the Stelkor parking lot which can accommodate the increased demand in parking, if indeed the pedestrianisation of Church and Andringa Street would be implemented. A total of 79 public parking bays in the CBD would be displaced, with an average of 80 bays available at Stelkor on a typical day (Stellenbosch Municipality, 2017).

4.3 Concept development

When considering some of the site data and other applicable components of the environment, a specific concept can be formulated as to how the pedestrianisation would be the most optimally applied. This is relevant in terms of the actual streets to be closed, the level of implementation of the scheme, i.e. full- or part-time, as well as the entrance and exit control procedures for vehicles having to enter the area.

Several concept options were evaluated and option 1, shown in Figure 5, was found to be the most optimal. This is because the through traffic is not affected in a drastic way. Ryneveld Street carries a significant amount of trough traffic, especially in the AM peak traffic hour, and is thus not included in the pedestrianisation scheme. Most of the historic city centre would be positively affected by closing of these sections of street, with minimal surrounding traffic impact. The level of implementation would be seen as full-time, with access only granted to delivery-, emergency- and waste removal vehicles, as well as residents and hotel guests in the area. Position 1 would be a typical entrance point to the precinct, usually controlled by retractable bollard or boom access control, whereas position 2, 3 and 4 would be typical exit points, usually controlled by a weight actuated boom. The section between positions 5 and 6 could be semi-permanently closed due to minimal vehicular access needed to that area.

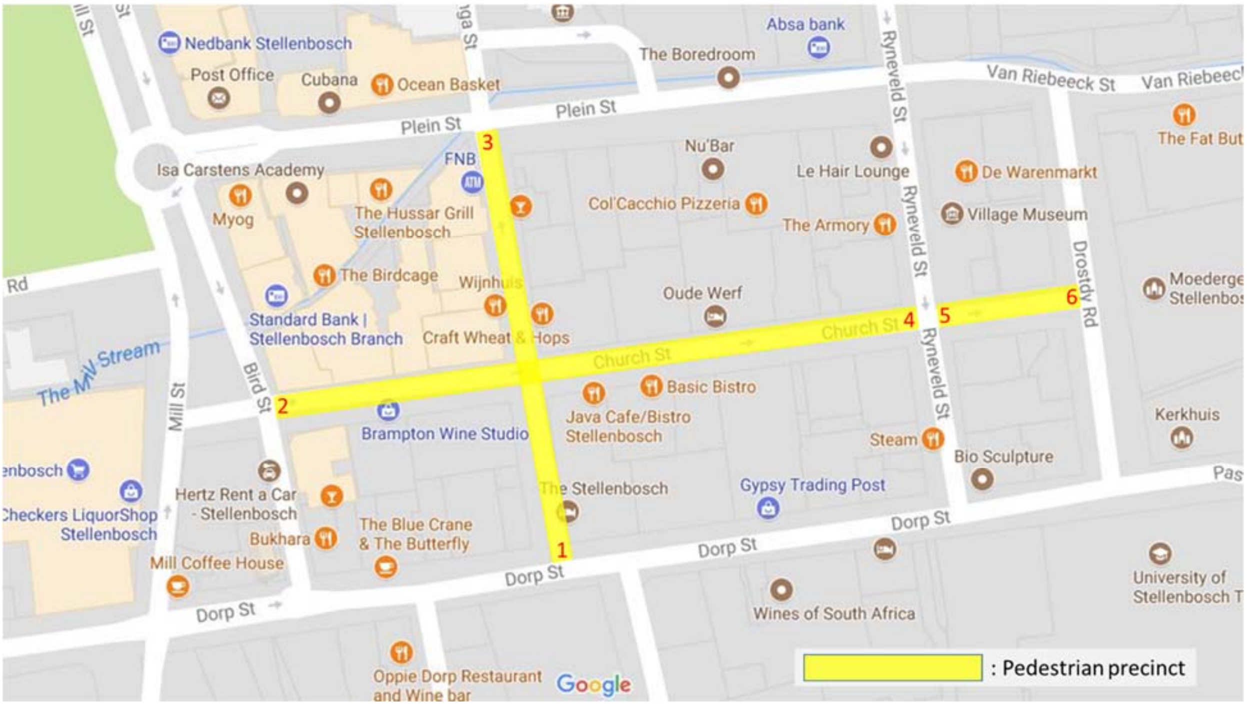

Figure 5: Pedestrian precinct option 1 (background image: www.google.com)

4.4 Traffic simulation

As a final, and most important, evaluation factor in terms of defining the feasibility of the pedestrianisation scheme, a relevant traffic microsimulation model of the area was conducted. This was done using PTV Vissim, which allows for the individual simulation of each entity, i.e. vehicle or pedestrian. Due to project related time constraints, this simulation only included the direct traffic flow of the area, not taking account of the pedestrians themselves or the parking situation. This was seen as accurate enough in order to compare the direct impact on the traffic flow behaviour before and after the closure of the streets.

The data required to accurately model the traffic environment to resemble reality was obtained from the site surveys. One of the most important input parameters are the vehicle inputs. These were obtained by conducting traffic volume counts at each of the included intersections in the AM and PM peak traffic hours. For each intersection, the general layout with the different turning movements was visually presented, as is shown in the example of a typical four-way stop intersection in Figure 6. The applicable vehicles per hour for each movement at each intersection were recorded in this way.

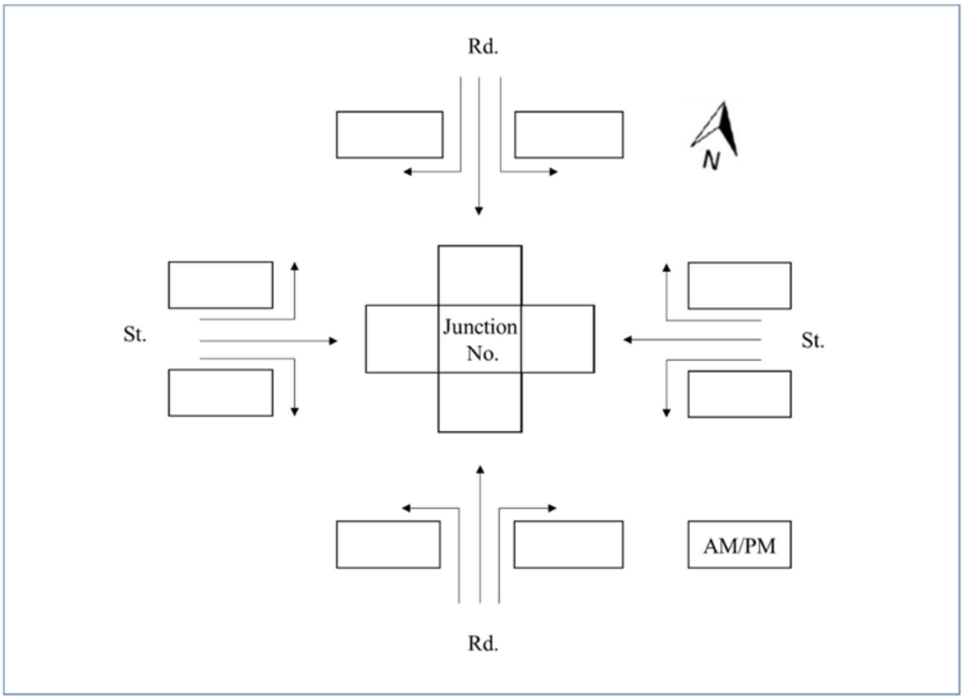

Figure 6: Example of an intersection turning movement template

Some of the components of the Vissim model include a background image on which the network is “built”, links and connectors to represent the road surfaces, reduced speed areas and desired speed decisions, vehicle inputs, vehicle routes and routing decisions, conflict areas, priority rules and stop signs, as well as nodes at the most affected intersections as points of evaluation. An assembly of the model can be seen in Figure 7 on the next page. Scenario management was utilised to differentiate between the current and pedestrianised environments.

The specific result parameters which were evaluated, were the level of service (LOS), queue lengths as well as vehicle delay times. These results were obtained for each of the movements at the nodal intersections, as well as an average value for each node. The average nodal results, for nodes 1 to 6 as shown in Figure 7, obtained from the Vissim simulation, are shown in Table 4 on the next page.

Figure 7: Simulation network model showing input links outlined in black and the nodes

Table 4: Average Nodal evaluation results

Node	Base scenario				Pedestrianised scenario			
No	LOS	LOS_VAL	Q_LEN(m)	VEH_DELAY(s)	LOS	LOS_VAL	Q_LEN(m)	VEH_DELAY(s)
1	LOS_C	3	13.23	15.9	LOS_B	2	8.26	12.08
2	LOS_A	1	1.42	4.96	LOS_A	1	1.49	4.82
3	LOS_A	1	0.93	2.98	LOS_A	1	1.53	3.82
4	LOS_A	1	3.14	6.74	LOS_A	1	2.31	4.72
5	LOS_B	2	9.32	12.85	LOS_C	3	13.73	20.9
6	LOS_B	2	8.04	11.11	LOS_C	3	11.37	16.57

The average results shown in Table 4 are representative of the individual turning movement results as well. From these results it can be seen that the LOS at node 1 improves slightly, remains constant at nodes 2, 3 and 4, and worsens slightly at nodes 5 and 6. The improved LOS at node 1 can be explained by realising that the traffic which would normally have entered Plein Street from Andringa Street is now rerouted elsewhere, thus resulting in less traffic moving towards node 1. Only two individual turning movements at node 5, and one at node 6, were found to reach a LOS D after pedestrianisation. This does not present a major problem and can be dealt with by improvement to the intersection layouts, such as widening or even making use of coordinated signalised intersections. The same trend as observed for the LOS evaluation, was found to be applicable to the queue length and delay time results. It can, therefore, be seen that the impact on the traffic flow is manageable.

5 CONCLUSIONS

Based on the findings of this study, the following conclusions can be drawn and corresponding recommendations can be provided.

There are definite transport related problems in Stellenbosch CBD, such as congestion and lack of parking, and pedestrianisation was found to be a possible solution. Various street closure options were considered and deemed feasible, with emphasis placed on Church Street and Andringa Street, having very little through traffic and a concentration of traffic problems. After pedestrianisation, the simulation model showed an acceptable change in the LOS condition at the most affected surrounding intersections and it was found that sufficient parking for regular users can be provided within walking distance, especially at the Stelkor parking lot, such that the CBD parking demand is covered. This means that, with minimal negative consequences on the surrounding traffic flow, pedestrianisation would remove transport related problems from Church and Andringa Street and create a more socially, economically and environmentally friendly environment there.

It is, therefore, recommended that a pedestrianisation scheme in central Stellenbosch should be implemented in the previously proposed street sections. It is also recommended that available parking spaces at the Stelkor parking lot should be utilised in accommodating the loss in parking in central Stellenbosch. Finally, a move towards non-motorised transport, as well as increased public transport, should be implemented to enable the reduction of total vehicles, thereby reducing the total parking demand.

6

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