THE EFFECTIVENESS OF SIDEWALKS ON PEDESTRIAN SAFETY IN A TOWNSHIP ENVIRONMENT

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ABSTRACT

South Africa faces challenges to adequately provide safe roads for all road users. In its urban environments, pedestrians have often been neglected in the design and construction of road networks; a phenomenon seen in almost all urban areas, but which is ironically often most evident in poor income areas where residents are most dependent on walking as a form of mobility. These poor income areas include older 'Township' establishments as well as the more recent RDP housing developments that have been built since the end of apartheid. Some urban local authorities have begun the process of remedying poor pedestrian safety in such areas, through, for example, the retrofitting of sidewalks. International studies have shown that the physical separation of pedestrians and vehicles will typically reduce road crashes and fatal injuries to pedestrians in particular. In a township environment, where walking may be the predominant mode of transport, the potential of sidewalks to improve road safety seems straight forward. However, operational elements such as the lack of traffic enforcement and poor driver behaviour; poor road safety education; lack of infrastructure and undisciplined pedestrian and public transport movement, may well influence the effectiveness of sidewalks, and this has yet to be investigated. This study assesses the effectiveness of new sidewalks on pedestrian safety along four roads in three townships in eThekwini. Comparisons were made of crash data before and after installing a sidewalk on already constructed roads, and observations were carried out along each route to begin to understand the behaviour of the pedestrians and the overall effectiveness of the sidewalks at the sites. The analysis confirmed that sidewalks in this township environment have had a positive effect on pedestrian safety in that they have reduced pedestrian fatalities. The results also show, however, that even with the installation of sidewalks, pedestrian crashes persist – especially at non-designated crossing points. This is although sidewalks, and formal pedestrian crossings, appear to be used by the majority of pedestrians, which suggests that crashes are occurring at locations where pedestrians are unexpected. Unfortunately, the lack of driver behavioural studies before the sidewalks were installed means that it is difficult to assess whether drivers themselves are driving less safely now that pedestrians are better managed, and so this does remain a possible contributory factor.

1. BACKGROUND

During the apartheid era when township development was at its peak, the majority of South African townships were built without including formal roads. Today, many local authorities still have a backlog in converting such roads to asphalt surfaced roads (Mahajan, 2014). Further, funding constraints at the time of the road construction meant that pedestrian facilities that would separate pedestrians from motor vehicles were often not provided (Phillip, 2014). Since then, many pedestrian-vehicle crashes have resulted in injury or fatalities, and several such roads were retrofitted with sidewalks. There is currently a drive by the Roads Authorities in many parts of the country to build new roads and convert the gravel roads to asphalt surfaced roads to provide access to the communities.

International experience tells us that one of the most effective and most straight forward ways to protect pedestrians is to separate them from vehicle traffic by installing a sidewalk – ideally with a barrier kerb. Studies have shown that the physical separation of pedestrians and vehicles will reduce road crashes. However, the efficacy, of retrofitted sidewalks has not been evaluated within a township environment. This study aims to start the process of assessing how beneficial retrofitted sidewalks may be, by looking (primarily) at crash histories of four routes in the eThekwini municipality in Kwazulu-Natal (KZN) Province where these changes have been made.

1.1 Definition of 'Township'

A township is defined in the Spatial Planning and Land Use Management Act, 2013 as "an area of land divided into erven and may include public places and roads as indicated as such on a general plan" (Government Gazette, 2013).

Townships were created during the apartheid era, to accommodate black residents who had to live in proximity to job opportunities of the cities, but who were legally prohibited from living in the white residential areas (Herbert and Murray, 2015). Large dormitory towns built quickly and cheaply, sprung up on the periphery of cities, often bordered by major roads, railway lines, rivers, and valleys (Smith, 2003). While schools eventually came to be included, other service land-uses such as shopping, and leisure facilities were not provided for. Further, essential services and infrastructure such as tarred roads, sanitation, water, or electricity were not prioritized. Figure 1 is a photograph of Soweto – to the south-west of Johannesburg in the 1970s – this was one of the first and largest townships to be built and its design elements were used consistently across most townships of the 1970s and 1980s, including those in KZN.

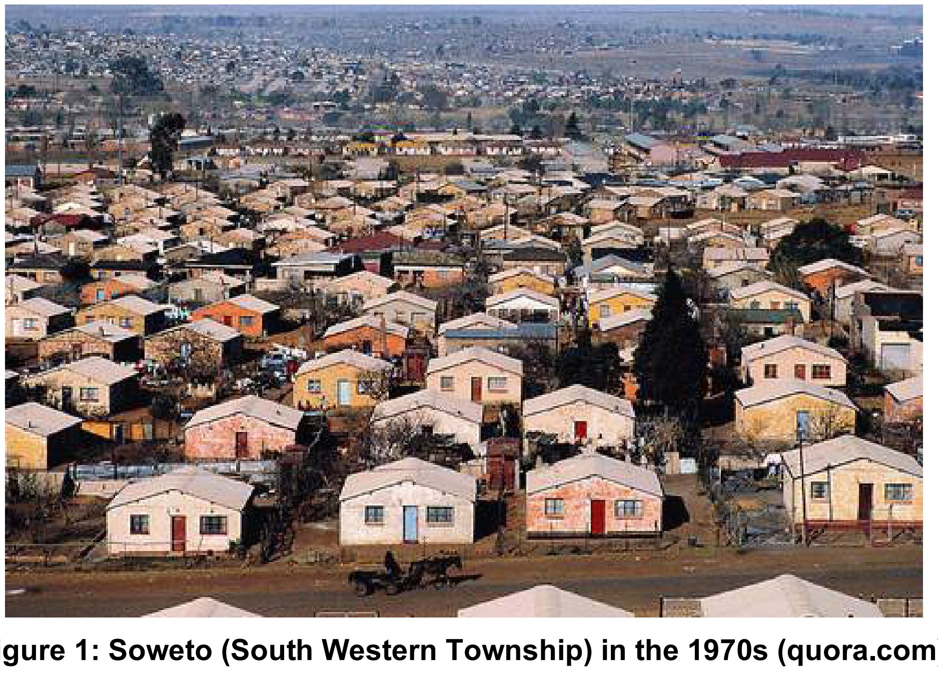

Figure 1: Soweto (South Western Township) in the 1970s (quora.com)

One of the reasons for the current lack of service delivery and backlog in SA today is that, in the post-apartheid era, the aim of urban developers has been to address historic inequality with regards to access to housing. This has involved building a million low-cost houses in a five-year period but not always considering a sustainable township and the associated road network and services (Mahajan, 2014). Ironically, perhaps, some of the RDP settlements of recent years have more in common with the design elements of township developments under apartheid than with modern, human-centric design principles. Most city populations in South Africa have grown significantly since the 1990s - as a result of natural population growth and also internal migration of people to the cities - and almost all township/RDP areas now contain, or are abutted by, informal housing which has grown on almost all available space.

In spatial planning of both townships and the post-apartheid RDP settlement, and certainly in the informal settlements that emerge around them, there are very few public spaces, and residents are usually located some distance from economic opportunities and the CBD. Most of the residents are of a low-income and lower education bracket with a heavy reliance on public transport and walking, therefore increasing the probability of being involved in pedestrian crashes (Mahajan, 2014; Yu, 2015). These lower-income areas also have poorer maintenance and aesthetics of infrastructure such as sidewalks and higher crash rates compared to higher-income areas (Yu, 2015).

1.2 Scale of the Problem

According to the Global Status Report on Road Safety (World Health Orgainisation, 2018) for 2016, in South Africa, there were 14 071 reported road traffic deaths with an estimated road death rate of 25,9 per 100 000 population. The estimated total cost of road traffic crashes on South Africa's road network in 2015 was determined to be R142,95 billion (representing 3,4% of GDP).

In South Africa approximately 35-40% of all road fatalities are pedestrians. As is common in pedestrian crashes, some of the contributing factors to pedestrian fatalities include human factors such as distraction, alcohol and intentional law breaking (on the part of both pedestrians and motorists) (Hatfield and Murphy, 2007), as well as social norms (Parker *et al.*, 1994) though humans are also prone to make errors of judgement in terms of speed and distance (Shinar, 2017).

While human error is known to be a major contributing factor in most fatal injury crashes, the role of the physical environment, particularly associated with pedestrian injuries, has come under growing scrutiny. One study carried out in Johannesburg, South Africa shows that children in low socioeconomic areas were more likely to be killed as pedestrians than in any other socioeconomic level (Bulbulia*et al.*, 2020). In other words, poor neighborhoods had more child pedestrian fatalities. As importantly, this study found that child pedestrian deaths were directly correlated to informal settlement and to overcrowding. These are not unique findings - a study in California, by Agran et al. (1996) found that the incidence of injury for children living in high-density residential areas was three times higher than that of children living in less dense areas. But it is significant, here, in that is focuses our attention on the role that the built environment has in fostering the potential for crashes. Certainly, high density and impoverished areas such as those in the township context have a predisposition towards high number of pedestrian crashes.

1.3 Effectiveness of Separation Between Pedestrians and Motorized Vehicles

Pedestrian segregation involves physically separating the pedestrians from the risk posed by vehicle traffic - in South Africa the lack pedestrian facilities is one of the major causes of injuries on roads (Wesson et al., 2016). This would be in the form of providing sidewalks, pedestrian barriers, or demarcating areas in which pedestrians are allowed to walk.

Rizzi et al (2011) carried out research into the effectiveness of retrofitting pedestrian segregation measures in areas of high crash rates. They found that crash rates were noticeably reduced as follows:

- Pedestrian fatalities were reduced by 45%.
- Fatalities in the roadway (excluding crossings) were reduced by 60%.

This yielded the overall effectiveness of a 35% reduction in road fatalities on roads sections with pedestrian segregation.

There are of course other ways to improve pedestrian safety that do not include the installation of sidewalks: speed control, traffic calming, random breath testing of drivers and reflective clothing for pedestrians; all have shown some benefit in terms of improving crash rates among pedestrians (Bartlett *et al.*, 2012). But literature is convincing that separating pedestrians from motorized vehicles is generally the most effective solution.

It is important to bear in mind that the World Health Organization suggests that, in developing countries, road fatalities may be increasing simply as a result of growing numbers of people, so road safety measures might not actually produce the expected savings in road casualty that are hoped for. This could be compounded by the fact that, as Yu (2015) noted, installing a sidewalk (engineering improvement) attracts more pedestrians (or non-motorized road users) to the improvement and can yield as much as an 18% increase, therefore increasing the probability of pedestrian-vehicle crashes (Yu, 2015).

2. METHODOLOGY

2.1 Overview

Retrofitting sidewalks on some of the routes through high-density, low-income areas that were built without them, is being carried out by numerous municipalities in SA. Unfortunately, the areas where improvement have been made have not always been subject to rigorous data collection, and it proved impossible to find cases where there was appropriate data from before and after installation to use. Pre-installation records of speeds, as well as pedestrian and driver behavior were simply not available for this study, and so the analysis presented here is based largely on crash data (which is available for before and after study) as well as some qualitative analysis of the behaviour of pedestrians in the present situation. Given the lack of hard quantitative data with respect to the use of the road-space before the intervention it is impossible to be definitive about how that behaviour may have changed, and as such the findings of this paper are intended only to give an indication of some of the patterns that may be emerging where sidewalks have been added retrospectively.

The study area includes four specific roads in townships in KwaZulu-Natal, South Africa, specifically within the eThekwini region, as shown in Figure 2. These areas are peri-urban with sporadic town planning or road networks with many pedestrian road users and public transport users (in particular taxis and buses (Mahajan, 2014). Most of the road network within the township environment is currently gravel in nature and is currently in the process of being upgraded to asphalt surfaces. The asphalt roads were built to accommodate or create public transport routes to serve these communities, and sometimes did not have formal pedestrian facilities. This was due to the vast backlog of gravel roads that must be upgraded to asphalt and the lack of funding (Mahajan, 2014).

2.2 Site Selection

The approach taken was to identify sites to study that had the characteristics of a township and which had sidewalks installed within a specific period, in this case 2015-2016. The reason for selecting the period between2015-2016 is because this period would provide the most recent pre and post sidewalk crash data. The roads which were selected as a sample set were based upon the availability of reliable crash data in townships, and these were in Inanda, Kwadabeka and Demat within the eThekwini region. The eThekwini Transport Authority Road Safety Branch provided a report on a collection of roads that generated the most pedestrian traffic and the most crashes and provided additional crash data. All four of the routes were paved prior to this time but were without sidewalks – they all had sidewalks retrofitted between 2015 and 2016.

The routes shown in Table 1 were chosen due to the initially high number of pedestrian crashes and significant pedestrian volumes. Figure 2 shows where each of the study routes is located in Kwa-Zulu Natal.

Table 1: Study route details and crash statistics before sidewalk installation

Route Name	All crashes/km	Ped crashes/km	Length of route	Location
Ithendele Drive	52.1	14.4	7.3	Inanda
Dr Langalibalele Dube Drive	89.4	29.4	1.6	Inanda
Khululeka Drive	55.7	9.7	5.35	Kwadabeka
Demat Road	17.1	5.7	7.6	Demat

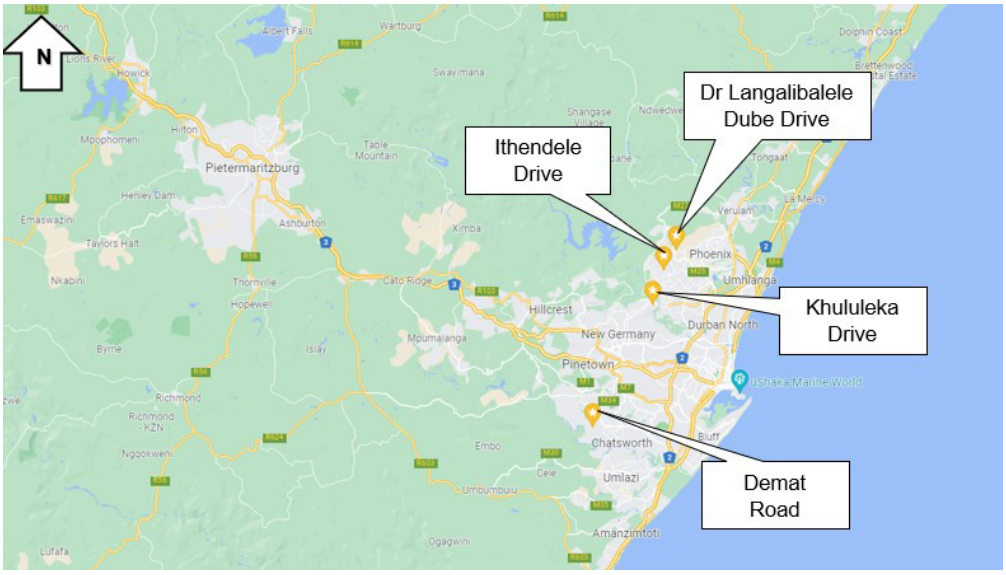

Figure 2: Portion of Kwa-Zulu Natal showing the study routes (Google, 2021)

The crash history of the routes, prior to the installation of the sidewalks in each case, is shown in Figure 3.

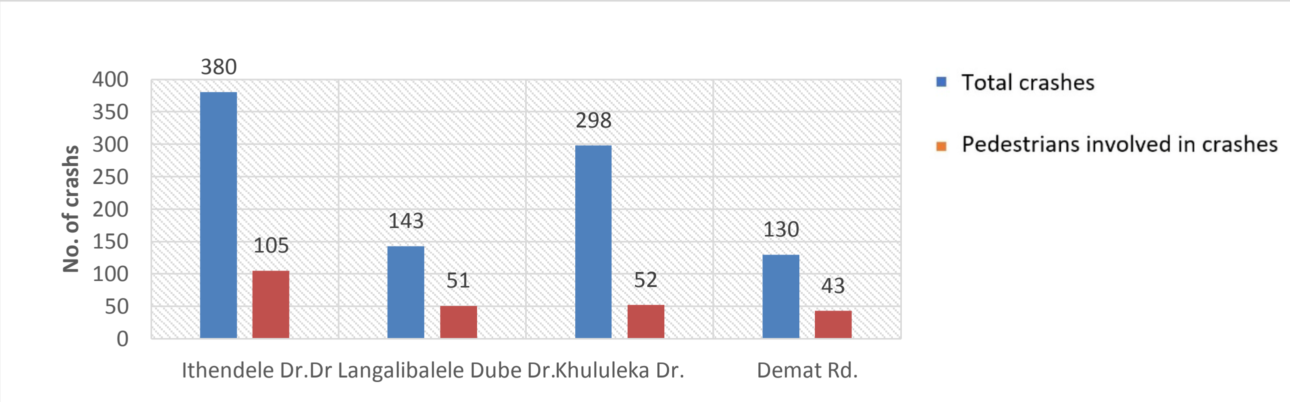

Figure 3: Total crashes across the study routes (2012-2014)

In the pre-intervention 3-year period, a total of 951 crashes were recorded along these four routes of which 251 involved pedestrians. In terms of all types of injury-crash, the split by severity for pedestrians, in the crashes before the construction of the sidewalk, is illustrated in Figure 4. These included 13 fatal crashes (resulting in 18 deaths), 57 serious injury crashes and 169 slight injury crashes.

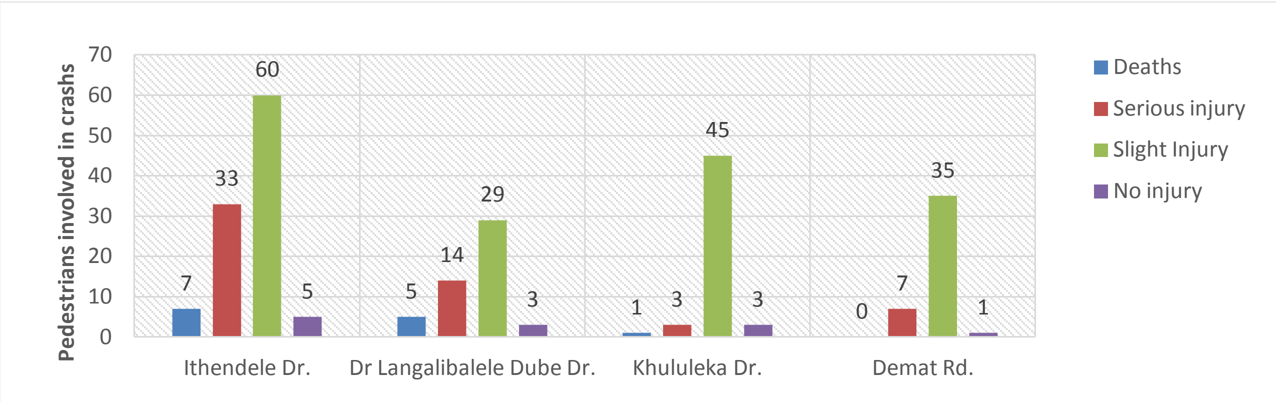

Figure 4: Severity of pedestrian crashes pre-sidewalks

Figure 5 reflects a particularly serious aspect of the crash situation, which is the high number of children involved in crashes at these locations. Within this breakdown, of the 13 fatal crashes reported during the period 2012-2014; 7 (58%), involved children.

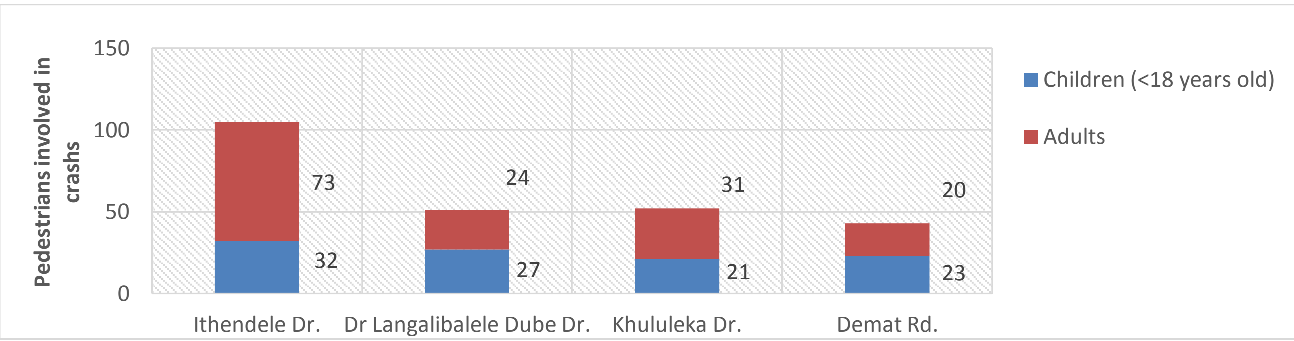

Figure 5: Adults versus Children (2012-2014)

The location of the recorded crashes (shown in Figure 6) was predominantly outside a formal crossing. Pedestrian crossings had been present before sidewalks were introduced, but there are no records as to how well they were utilized before sidewalks were installed.

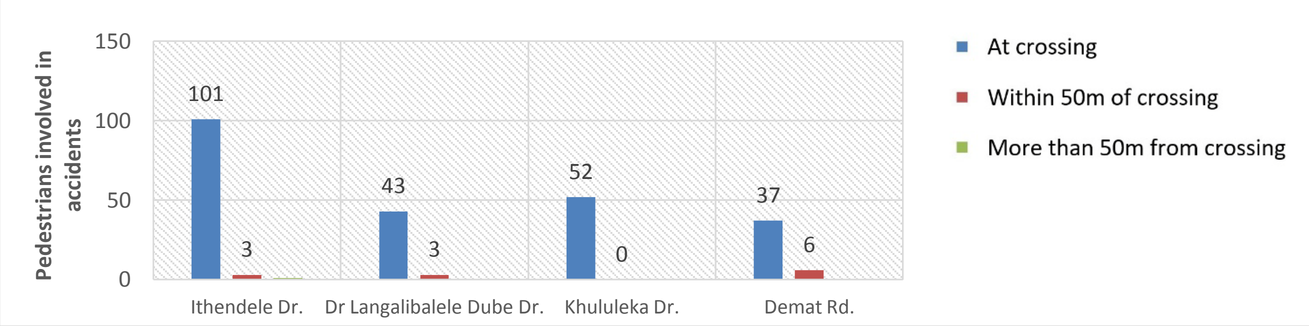

Figure 6: Location of pedestrian crashes (2022-2014) – where recorded

Finally, the pre-intervention data allows us to have a sense of when crashes involving pedestrians were likely to occur. From Figure 7 it can be seen that while most crashes were during daylight hours (an average of 67%), 20% occurred during the hours of darkness and 13% during dusk or dawn.

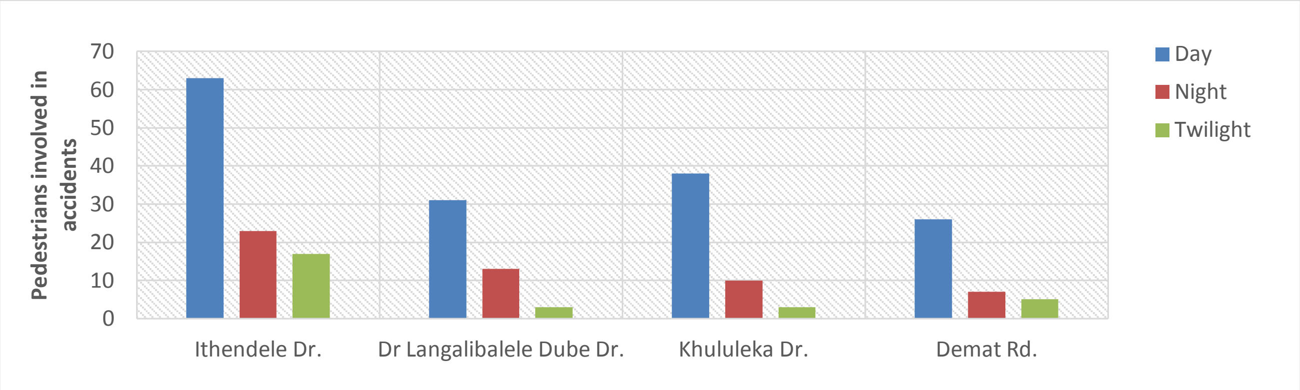

Figure 7: Time of dayand pedestrian crashes (2012-2014) – where recorded.

2.3 Use of Observational Data

While crash data comparisons would give some indication of the levels of safety following the installation of sidewalks, crash data itself relates to reported crashes only, and tells little about how sidewalks may be used in reality. As a result, observations were carried out to assess the behaviour of road users (pedestrians and drivers); and the presence or absence of obstacles on the sidewalks. Unfortunately, such investigations were not conducted prior to the installation of the sidewalks and so the observations relate only to the post-installation present.

Observations included a breakdown of the number of people walking until (and using) a crossing point; the number of people not crossing at a crossing point; and the number of people choosing to walk in the carriageway (i.e. not on the sidewalk).

The observed number of vehicles parked on a sidewalk was also categorized into 'mini-bus taxis' and 'other vehicles' and compared with the crash data and typical crash locations to help ascertain whether the presence of vehicles parked on a sidewalk affect pedestrian crashes. Obstructions on the sidewalk were also documented.

As far as possible, crash data was reviewed considering these observations, on the assumption that the observed patterns were typical of the last few years.The reported visibility and weather conditions at the time of crash were also considered but because of space limitations this is not reported on in this paper.

3. RESULTS

3.1 Change in Crashes

Figure 8 shows the total number of crashes (985), and number of pedestrian crashes (243), for the three years after (2017-2019) the installation of the sidewalks. Both the total crash numbers and the pedestrian crash numbers are slightly lower than for the three before years (2012-2014) the installation of the sidewalks, though not significantly lower (6 and 8 respectively). Indeed, at first glance it would seem as if little improvements were made.

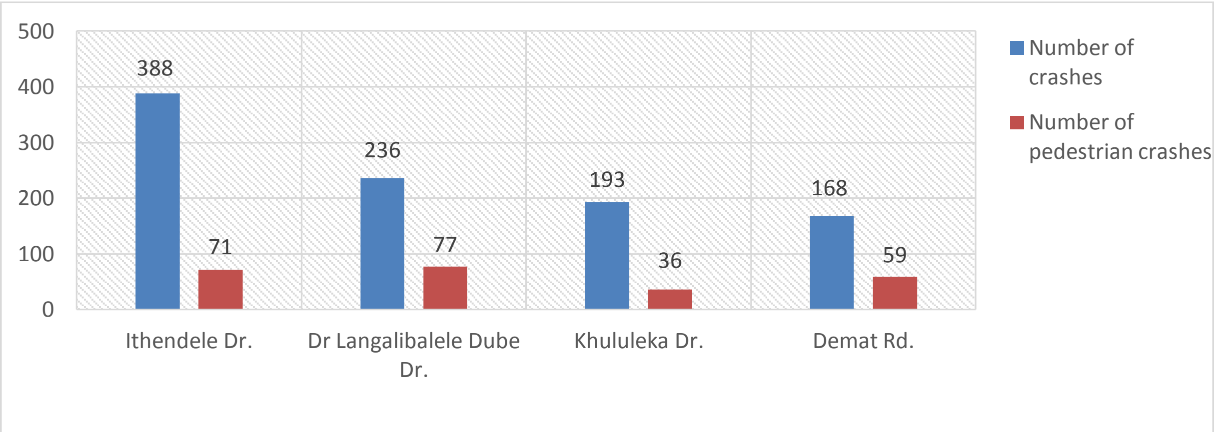

Figure 8: Crashes recorded after sidewalk installation

Looking more specifically at fatal crash data shows a somewhat more encouraging picture. Please note that Figure 9 below illustrates the number of individuals or injured, not types of crashes.

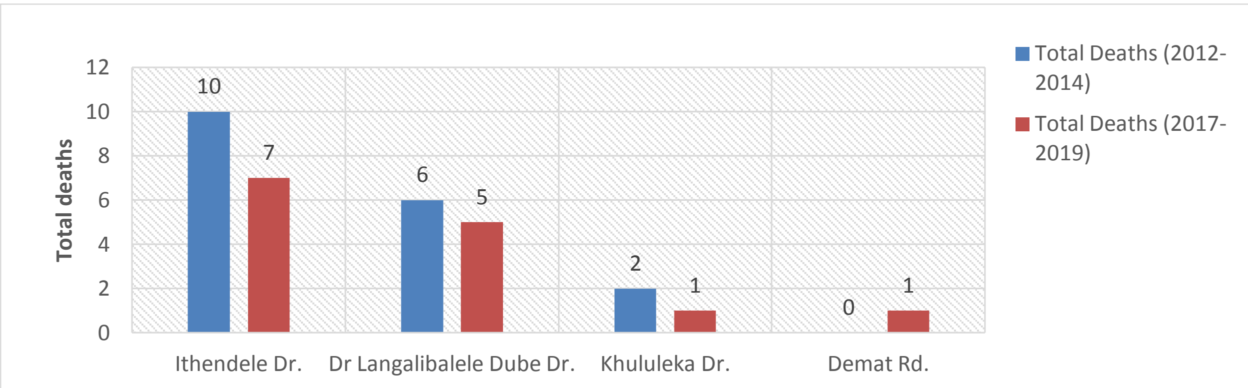

Figure 9: Total Fatal Injuries: 2012-2014 versus 2017-2019

Rizzi et al. (2011) reported that pedestrian segregation (in their study) had reduced pedestrian deaths by 45% and had overall effectiveness in reducing total deaths by 35%. In this study, however, pedestrian segregation had an effectiveness of 38.5% in reducing pedestrian deaths and 22.2% in reducing the total deaths in the areas where pedestrian segregation (sidewalks) had been achieved.

The overall number of crashes involving pedestrians was not, however, significantly different, and increased numbers were seen in two of the four sites (KhulelekaDrive and Demat Drive) – see Figure 10.

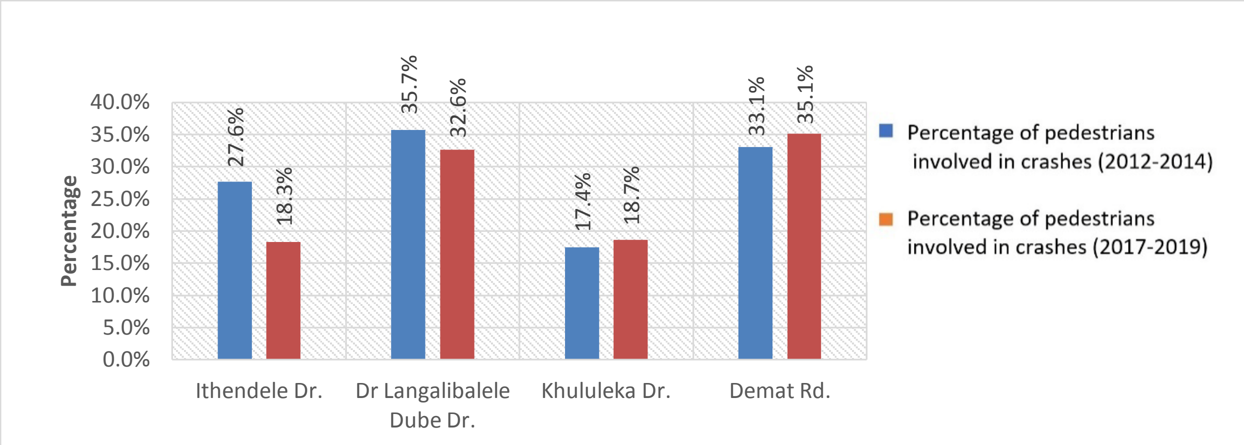

Figure 10: Percentage of pedestrians involved in crashes

Whereas before there had been 13 fatal injury crashes (resulting in 18 deaths), 57 serious injury crashes and 169 slight injury crashes, the numbers for the three-year period after sidewalk installation were: 10 fatal crashes, 93 serious injury crashes and 112 sight injury crashes. Breakdown per route is shown in Figure 11 below.

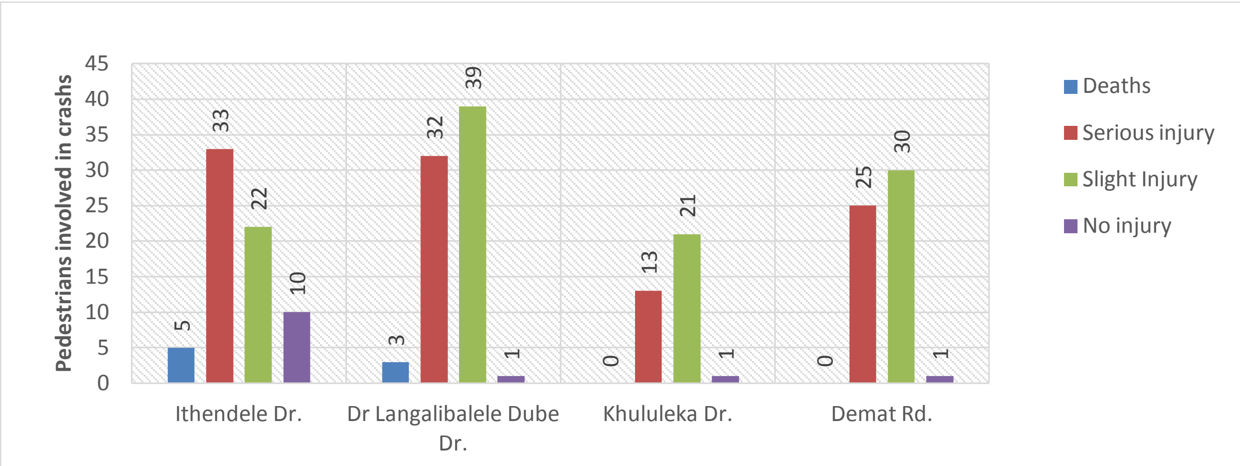

Figure 11: Severity of injuries involving pedestrians (2017-2019)

When looking at the age of victims of crashes after the installation of sidewalks along the four study routes, it becomes clear that that the proportion of adults involved in crashes has increased on all roads except for Khululeka Drive (see Figure 12). The proportion of adults involved in crashes has on average increased by 4.1%, and the proportion of children involved in crashes has on average decreased significantly by 13.6%. Dr. Langalibalele Dube Drive and Demat Road experienced significantly more adults involved in crashes than children after the sidewalk installation.

When considering the location of pedestrian crashes, Figure 13 confirms that once again the vast majority occur away from formal crossing points.

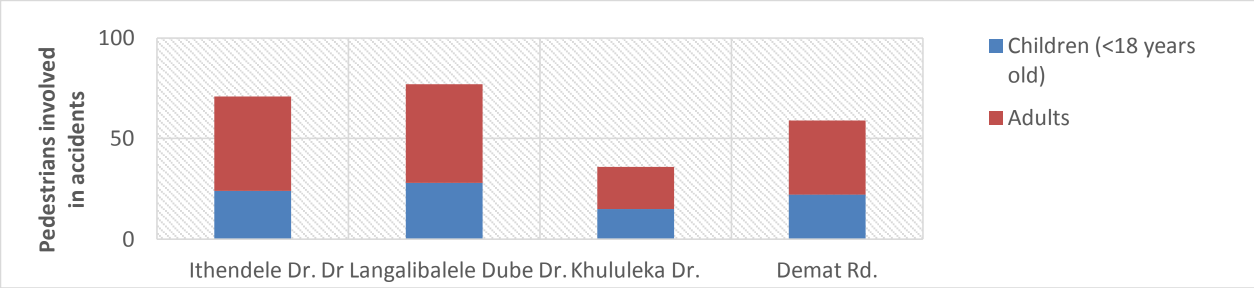

Figure 12: Adults vs children (2017-2019)

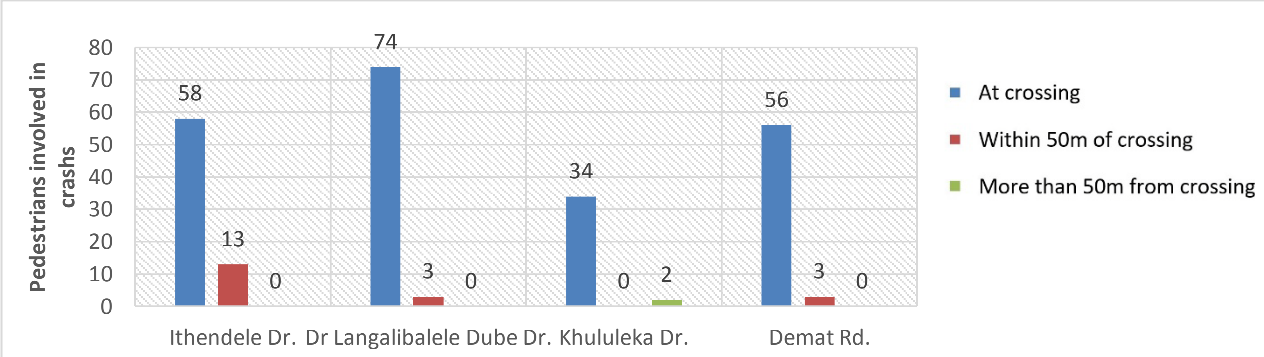

Figure 13: Location of pedestrian crashes (2017-2019)

Figure 13 shows that, after the installation of a sidewalk, Dr. Langalibalele Dube Drive experienced the highest incidence or non-crossing crashes, Ithendele Drive had the second-highest number of pedestrian crashes occurring away from a crossing and had no crashes within a marked crossing. However, Khululeka Drive experienced twocrashes occurring within a marked crossing. The crashes within 50m from a marked crossing increased against baseline levels.

Overall and when comparing the crash locations from before the sidewalk installation to after the sidewalk installation, crashes remained in similar positions on each road. Yu (2015) states that pedestrian crashes at specific locations are rare (Yu, 2015); however, traffic crashes in these areas are expected because these are 'crash zones.' So, before installing the sidewalks, crashes typically occurred at intersections, non-designated crossing areas, and areas with particularly high pedestrian volumes, and these locations have not been affected by the new sidewalks.

There was a small but noticeable change in the time of day during which crashes were reported: after the installation of the sidewalks, the percentage of daytime related crashes dropped, and relatively more were reported during the hours of darkness, as well as during dusk and dawn (see Figure 14).

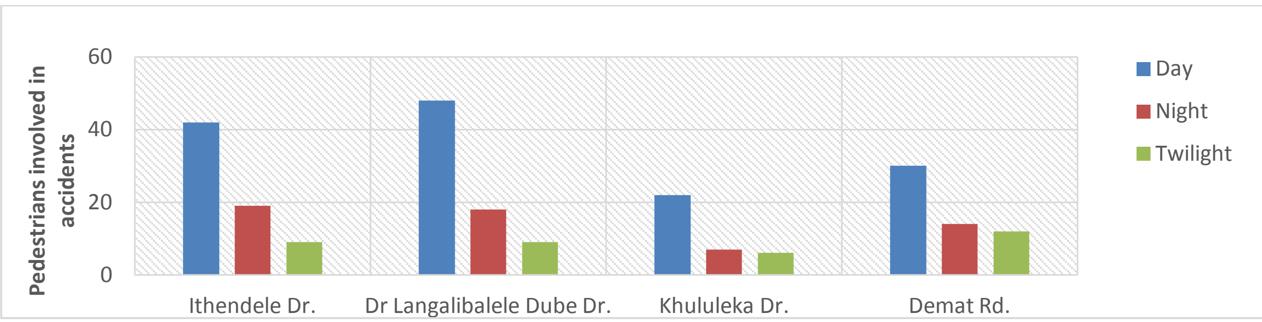

Figure 14: Time of day and pedestrian crashes (2017 -2019)

3.2 Observed Pedestrian Behaviour

3.2.1 Pedestrian's Use of Sidewalks

Figure 15 illustrates the fact that the vast majority of pedestrians along these four routes used the sidewalk – the observations showed this to be approximately 93.8%. Only 6.2% were recorded walking in the carriageway. Further, most pedestrians used the formal crossing points to cross -the lowest percentage at was around 85% for Dr Langalibalele drive, and the highest was 92% for Ithendele. We cannot know if this reflects changes to crossing behaviour prior to the improvements, but the sidewalks arguably are proving successful in channeling pedestrians towards safe crossing places.

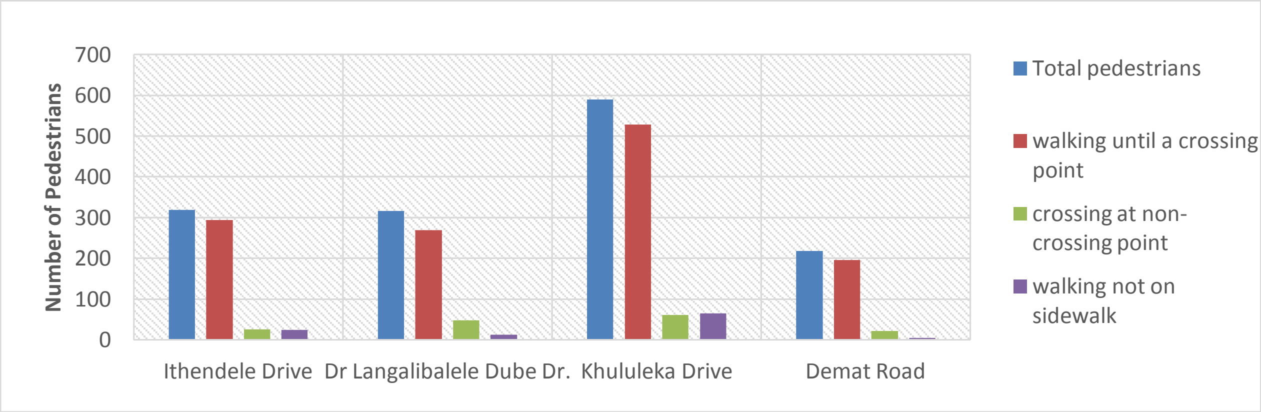

Figure 15: Observed location of pedestrians

Comparing crossing behaviour with crash locations, post installation, of the 243 reported pedestrian crashes from all four sites, only two involved crashes at a formal crossing. The vast majority of pedestrian crashes are still occurring at locations either close to the formal crossing, or some distance from the crossing, in spite of the fact that most people were observed to be using crossings. A limitation of the observations was that they were carried out during the daytime, and the times of day in which crashes were reported included nighttime hours. So, behaviour of pedestrians crossing could be very different during darkness.

3.2.2 Presence of Obstructions on Sidewalks

All four routes exhibited some forms of obstructions – either permanent such as vendors' structures, or temporary such as private vehicles, mini-bus taxis or animals (see Figure 16). In each case, pedestrians were temporarily channeled into the carriageway, undermining the function of the sidewalk, and placing the pedestrians into an unsafe situation.

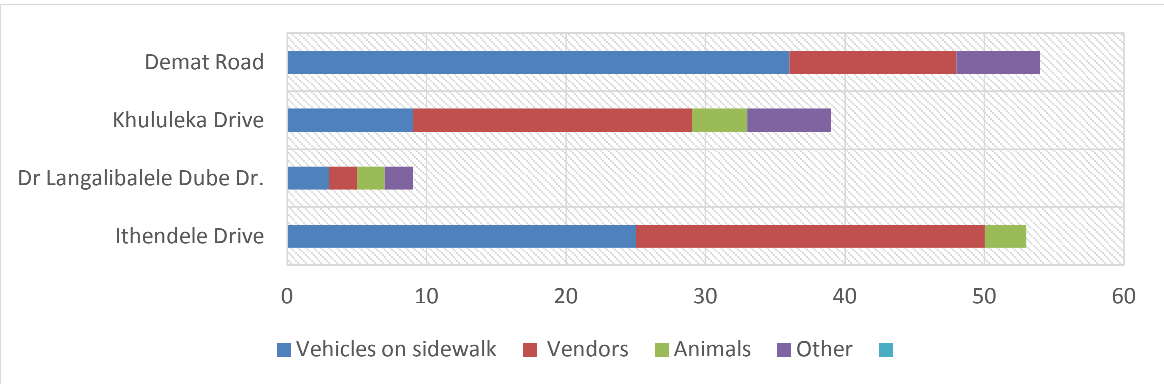

Figure 16: Relative incidence of obstructions on sidewalk

It is not possible, retrospectively, to correlate the obstructions with the crash locations, but these obstructions are marked as being of critical importance to pedestrian safety going forward.

4. DISCUSSION AND CONCLUSIONS

The paper has looked briefly at four cases of roads that were upgraded to introduce sidewalks between 2015 and 2016 in eThekwini, all which are in low-income, former township areas. The purpose of the sidewalk installation is undocumented in all cases, but it was our assumption that the safety of pedestrians was a main driving force behind the change. Looking at the crash data before and after installation, we see that the overall number of crashes remains almost unchanged; though the number of deaths has been reduced. Unfortunately, the number of serious injuries has increased against pre-installation levels. It was impossible, from the study and the limited data available, to understand why this is the case, and a more detailed investigation of the individual crash records is recommended. The research was limited in time, and by certain of the limitations imposed during the Covid pandemic, but the lack of 'before' data is itself an important finding in this study.

No traffic data was available to describe some of the characteristics of the traffic (eg speed and volume), or indeed to assess whether these have changed in the interim, and there were no baseline pedestrian behaviour studies to help understand whether pedestrians (or indeed drivers) were, in the past, more careful (being so directly exposed to each other), than they have since become. The research highlights not only the necessity for good data to be captured before and after infrastructure changes are planned and made, but also – interestingly – that sometimes obvious improvements do not always bring with them the positive changes that are expected (and budgeted for). More research into other examples of road safety improvements in township areas is clearly warranted.

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