AN INVESTIGATION INTO THE ENVIRONMENTAL IMPACT OF THE TAXI INDUSTRY IN BUTTERWORTH

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INTRODUCTION

Man's impact on the natural environment has reached an unprecedented intensity. As a result, there is growing anxiety about the earth's physical and biological capacity to continue to carry such a burden. Predictions of dramatic global change arise from continued dumping of industrial by-products into the atmosphere.

The problem is worsened by destruction of forests and vegetation. Global warming could have catastrophic consequences for the inhabitability of the whole planet. It is therefore felt that we and our forebears are all responsible for the present situation.

BACKGROUND AND PROBLEM STATEMENT

This study attempts to discover and assess the impact that the increase in taxis has had on the environment in Butterworth. An earlier study had shown that the increase in number of taxis was from 10 in the 1970's to more than 100 in 1989 (Noah, 1989). The study had projected a further increase by the year 2000.

The sudden industrialization of Butterworth during the apartheid 'homelands' development led to the inflow of rural population to the urban areas thus resulting in the extension of townships. Consequently, pressure on public transport culminated in the rapid expansion of taxi services, and six taxi ranks were developed in town. These lead to concern about pollutants discharged by motor traffic which are carbon monoxide, hydrocarbons (un-burnt petrol fumes), nitrous oxides and lead deposits. Lead is the most dangerous of the elements that are discharged.

Further, most of its peri-urban streets in Butterworth (as a developing centre in a developing country) are not bituminised. The result is a cloud of dust created by taxis transporting passengers. Air pollution such as dust, fly ash and smoke are annoying but lead fumes cause serious health problems. However, air pollution has an indirect effect on man and his environment. Pollutants in the atmosphere more often than not return to the earth's surface and pollute the soil, water resources and plants on which man and animals are dependent.

Butterworth is also dependent on maize agriculture and sheep farming which are in danger of environmental impact from the increase in motor vehicles and the expansion of taxi services in the area. This situation forces environmental geographers to take a close look at air, water and ground pollution from taxis in particular, as well as littering by drivers and

passengers. Contrell (1978) maintains that cleanliness, fresh air, purity of water, greenness of landscape, quietness of surroundings are what we value, but in the more densely occupied parts of the world these are becoming scarce.

LITERATURE REVIEW

The theoretical and conceptual issues surrounding published work relevant to this paper are considered in this section. This is to place these issues within the context of this research paper. A general overview of the waste problem is considered and also some theoretical aspects concerning ground (litter) and air pollution will be reviewed. Even though there is still a gap in the knowledge about the relative impact of taxis on environment, this literature review is by no means exhaustive.

Litter has been seen as one of the most obvious forms of environmental degradation. Pedestrians and motorists have been singled out as major causes of littering. Social psychologists argue that the environmental contingencies are arranged in our culture in such a way that littering behaviour is acquired and maintained by immediate continuous negative reinforcement (Powers *et al.*, 1973; Kohlenberg and Phillips, 1973; Baltes and Hayward, 1976). It was therefore noted that clean environments reduced litter.

Research studies observed that decorated litter cans with lids induced people to litter less than when they use less attractive plain containers without lids. In view of these experiments and results, it is likely that behavioural awareness can be better stimulated through subtle manipulation of the environmental variables. A positive correlation between education and continuing concern about the degradation of the environment has been observed and concluded that concern for environmental degradation is a required forerunner of the desired behaviour.

The times of the day and function of traffic through the study areas in America showed a positive correlation with the amount of litter generated. Many investigators (Burgess *et al.*, 1971; Fannie 1973; Kohlenberg and Phillips, 1973) have reported that litter increases most heavily throughout the weekends in parks and urban areas. The literature on ground litter pollution shows the enormous amounts of litter generated and discarded or scattered in socially inappropriate area.

Other publications (Dutta and Mookerjee, 1981; Agrawal *et al.*, 1981; Chamberlain, 1983 and Nasralla, 1984) also revealed a positive correlation between the amount of traffic and lead concentration on both sides of busy roads. Tetraethyl lead added to petrol is now recognized as a major cause of environmental lead pollution. About 70-80% of added lead in petrol is released through the exhaust and the rest is retained and later released in dirty oil. A number of researchers (Collins, 1984 and Nasralla and Ali, 1985) have been positive that lead on foliage comes mainly from petrol lead as the foliage intercepts aerial deposition.

In urban environments, exhaust gases from cars containing very fine particulates of the order of 0,01mm in size and about 50% of lead emissions were reported to form stable aerosols. Environmental implications of air pollution particularly lead, were also noted in animals which in turn affect human beings.

Phosphates used as water softeners in synthetic detergents were identified as the main sources of water eutrophication (Simpson, 1990; Goldsmith and Hildyard, 1990). The above mentioned and unmentioned published works have been the sources in the selection of adequate methods for data collection in the next methodology section.

METHODOLOGY

The requirements of this study data involved observing a single group of taxis. Taxi data involved taxi rank localities, taxi numbers, area served by each taxi rank and number of passengers conveyed by taxis. Meanwhile, pollution data is divided into ground (litter) and air (dust) pollution. The size of the population involved has made it necessary to employ sampling methods for data collection. Sampling, survey and observational research methods were found to be the most appropriate in view of the exploratory nature of this study.

The collection of samples was undertaken between 16 June and 21 July 1990 being the typical winter month during which the Southern African subcontinent experiences strong inversions (Tyson *et al*., 1976). In view of the winter inversion in South Africa, monitoring of the dust sample sites in this period would provide a clear idea of air pollution accumulation.

A simple directional dust gauge consisting of four cylinders was used to collect dust samples. It is a simplified version of the more advanced directional dust gauge shown by Perry and Young (1977). This has proved effective in an air pollution pilot study in Kwa-Dimbaza in the Eastern Cape (Tanga, 1986). Next to most of the dust gauge samples, a box collector was placed on the ground to sample ground dust fallout.

Taxi frequency data was collected three times a day (07h00 - 08h00, 13h00 - 14h00 and 16h30 - 17h30) and this count took place only from Mondays to Saturdays. Buses and private cars or trucks were also noted to cross check which mode of transport most frequently used the taxi routes. For each day and week, total frequencies of the three modes of transport were recorded.

Litter from the six town taxi ranks was collected on three days a week (Mondays, Wednesdays and Saturdays). This was later sorted into the different constituent parts (paper, plastic, bottles, cans and biodegradable material) for weighing. The Butterworth municipality precincts were inspected for abandoned minibus-taxi bodies and parts, and were plotted on a map.

Samples of soil and water from the six taxi ranks were taken to trace contamination. Muddy water samples were filtered for sediment to be analysed by the PGT Energy Dispersive Eletron Microscope. Both filtered and other water samples were tested for their pH conductivity values. The control areas not used by taxis were also monitored as the control for the data collected at taxi ranks and along routes.

DATA ANALYSIS AND RESULTS

Ground Pollution

Litter collected from each taxi rank was sorted into its component parts (paper, plastic, biodegradable, cans, bottles and miscellaneous). Each of these was later weighed, using a Salter Spring balance. The quantity of litter per week and month-ends is shown on Figure1 for the taxi ranks and the Control area.

With reference to Figure 1, the middle weeks (1st & 5th) and month-end (2nd & 3rd weeks) show an accumulation of litter generated. The largest taxi rank (*Umtata*/KWT) has the largest generated litter on the 5th week (353kg) followed by the 3rd week (337kg) then the

2nd week (315kg). The largest and the smallest taxi ranks were established by considering the physical size of the rank, the number of taxis always on standby in the taxi rank and number of passengers conveyed.

Whereas, the second largest taxi rank (*Mchubakazi/Msobomvu*) shows 2nd week (146kg), 1st week (143kg) and 3rd (134kg) as having accumulated tremendous litter. Ibika, Library and Ncedo taxi ranks depict that the 3rd week generated larger amounts of litter. The only exception is with Centane, which shows the 5th week as having collected more litter than the other weeks. The Control area generates relatively smaller amounts of litter in all weeks. The dominant types of litter which are in excess of other types, were observed collected and collated in each respective taxi rank and Control area as shown by Figure 2.

Biodegradable (fruit and vegetable remnants) litter is dominant and the most polluting ground litter in the Umtata/KWT (390kg), Mchubakazi/Msobomvu (248kg) Centane (55kg) and Ibika (48kg) taxi ranks. In the largest taxi rank (Umtata/KWT), plastic bag litter (250kg) follows biodegradable material.

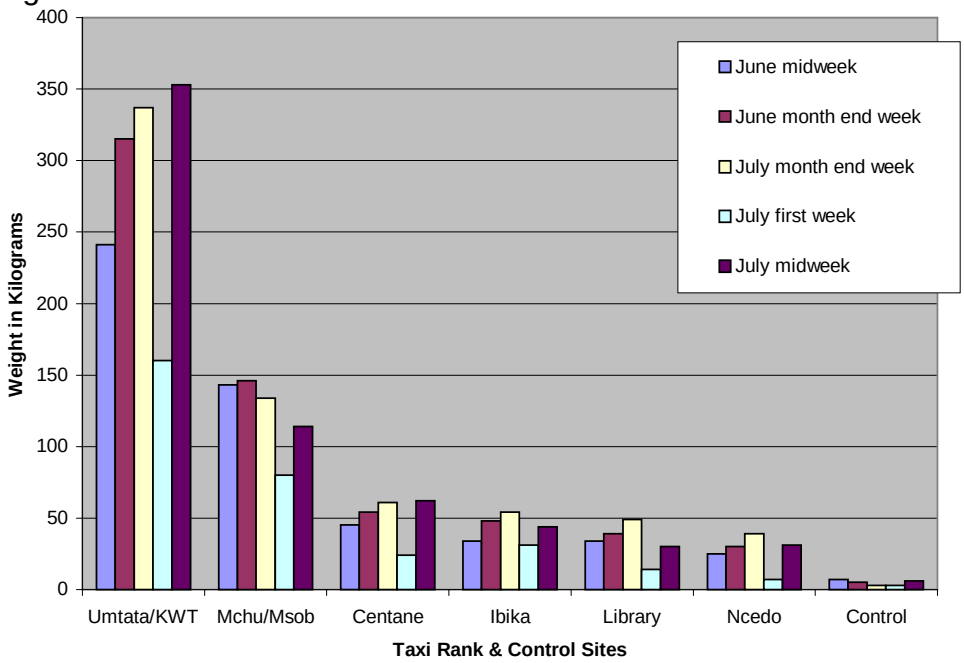

Figure 1. Minibus taxi rank and accumulated litter

It is composed of bread bags, milk, yoghurt and fruit juice containers, detergent containers and soft flexible packaging material (polystyrene cups, and dishes as well as plastic bags. Mchubakazi/Msobomvu (48kg) taxi rank follows the Umtata/KWT (250kg) site. Bottles in Chubakazi/Msobomvu (155kg), Centane (51kg), and Ibika (28 and Ncedo (24kg) taxi ranks ranked immediately behind plastic material. These are mainly cool drink, spirit and beer bottles.

Contrasting with the quantity in the respective taxi ranks was the Control area. It had miscellaneous (5kg), paper (4kg) and cans (3kg) as the dominant and most ground polluting types of litter collected. Miscellaneous included matches' sticks, cigarette butts, bottle lids, and cool drink straws and can opening handles. The control area generates the least volume of miscellaneous litter while the biggest taxi rank, Umtata/KWT generated 110kg followed by Ncedo (10kg).

In addition to the usual ground litter generated from the taxi ranks, motor vehicle waste products were also considered as litter. This refers to the litter generated particularly by taxis which involves everything used by them for motor parts and accessories to body and tyre polish.

Unlike the taxi rank sites, the control area had virtually no motor vehicle litter.

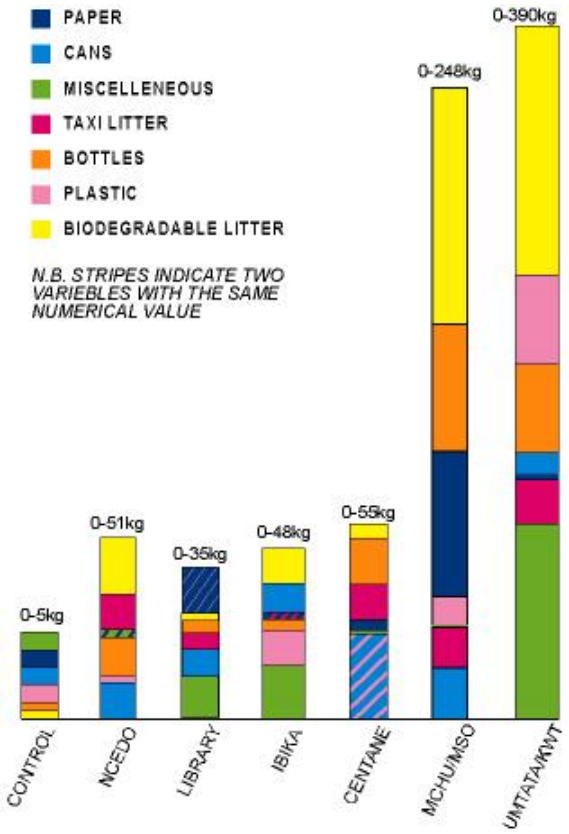

Figure 2. Comparison by types of litter generated on different taxi ranks

While Umtata/KWT generated the most vehicle-related litter (135kg) as it is the biggest and serves the long-distance passengers. In order to consider the relative importance of ground litter generated, total weight of litter in each taxi rank was weighed including control area as shown on Figure 3. Umtata/KWT followed by Mchubakazi/Msobomvu taxi ranks generated the most litter.

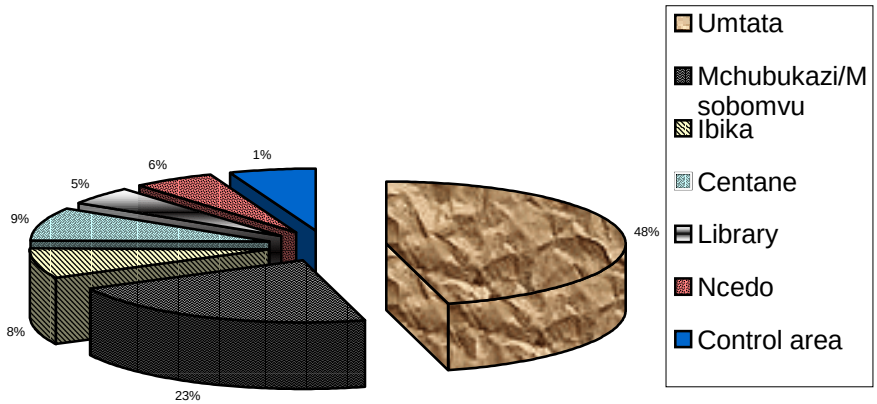

Figure 3. Total ground litter distribution in the sample sites

Environmental degradation caused by minibus taxis through oil and brake fluid leaks on the road was observed. The road safety quality of tarmac in the taxi ranks has been compromised, as oil patches make the road slippery.

Also, the number of 'abandoned' minibus taxi bodies was observed by plotting them on the Butterworth town street map (Figure 4). Mchubakazi suburb showed the densest presence of abandoned bodies followed by Msobomvu and Ibika suburbs.

Taxi Rank Population and Man-made Features

The impact of the large number of both the human and minibus taxi population in the respective taxi ranks has also been observed on man made features such as hedges, wire fences and water drainage systems. Passengers, their companions and fruit vendors lean against the wire fences. Minibus taxi cleaners hang wet and heavy car floor rubber mats on the fence. Fruit vendors and passengers throw fruit and vegetable remnants into the water drainage system. House owners next to the taxi ranks have also reported blockage of residents' private motor way.

Figure 5 provides a visual relationship between the quantity of litter and the number of passengers conveyed by minibus taxis. In relation to minibus taxi capacity, taxis were all considered being 10-seaters although there are 16-seaters as well as those, which overload. It is therefore highly probable that the number of passengers is underestimated.

A direct relationship is noted on some weekdays of the 5 data collection weeks. On Mondays, an increase in number of passengers (2780) was also reflected in an increase in the average quantity of litter collected (43kg) on the same day. This pattern was later followed by decrease of both variables (1990 passengers and 24kg litter) on Wednesday. This day happens not to be busy for the taxi industry.

On Fridays, a slight increase has been noted in the number of passengers (2880). Unfortunately, Fridays were not on the sample days for litter collection but are always busy days. Unlike the other days of the week, Saturdays reflect an indirect relationship where litter (38kg) has increased and the number of passengers tremendously decreased (2270) compared to Monday.

Water Quality in Town Taxi Ranks

The filtered road pothole, river and tap water (control) was left to cool down at room temperature for 24 hours. The purpose was to standardize the samples for each sample in preparation for the actual analysis. The results of the water quality tests are shown in Table 1.

Table 1: Water purity in the taxi ranks and the control site

Source of Water	**T°C**	**pH**	**Conductivity (μ*mhos*)**
Control water (from tap)	20	8.71	580
Water in pothole	20	8.61	1 030
Water in gutter (upper road)	20	8.59	1 110
River water	20	8.90	1 320
Taxi wash water (furrow)	21	8.40	1 520
Dirty water (washed cars already)	20	8.70	2 500
Gutter water (wash bay)	20	8.65	4 100
Filtered muddy water (Gutter water)	20	9.44	5 600
Filtered muddy water soaked in urine	20	8.5	25 000

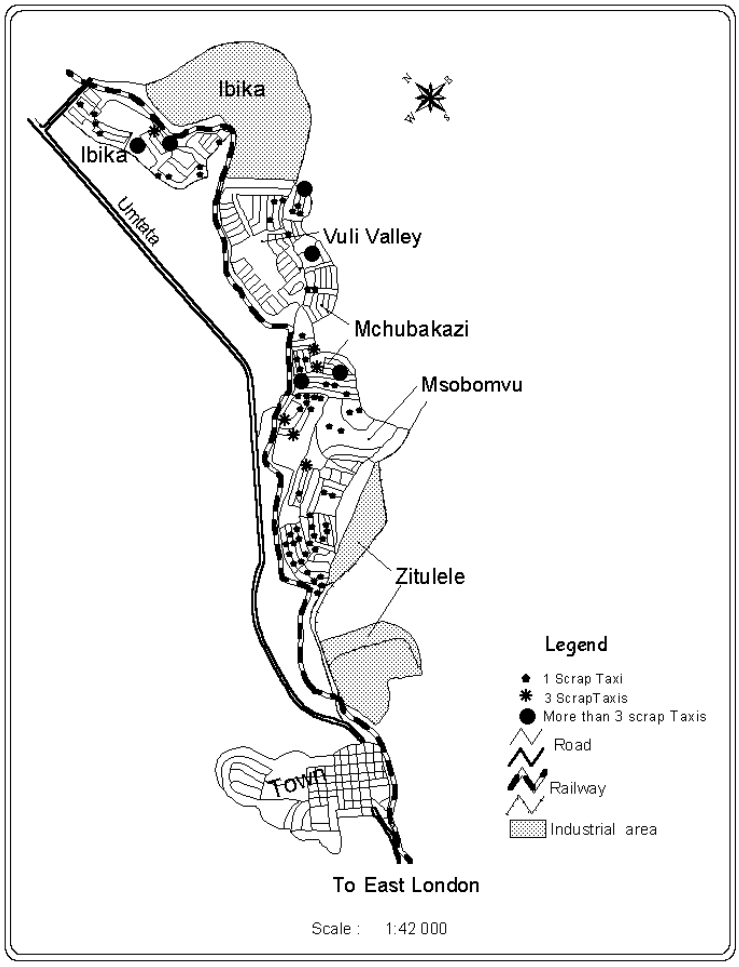

Figure 4 Map of abandoned minibus taxi bodies in the Butterworth Municipality precincts

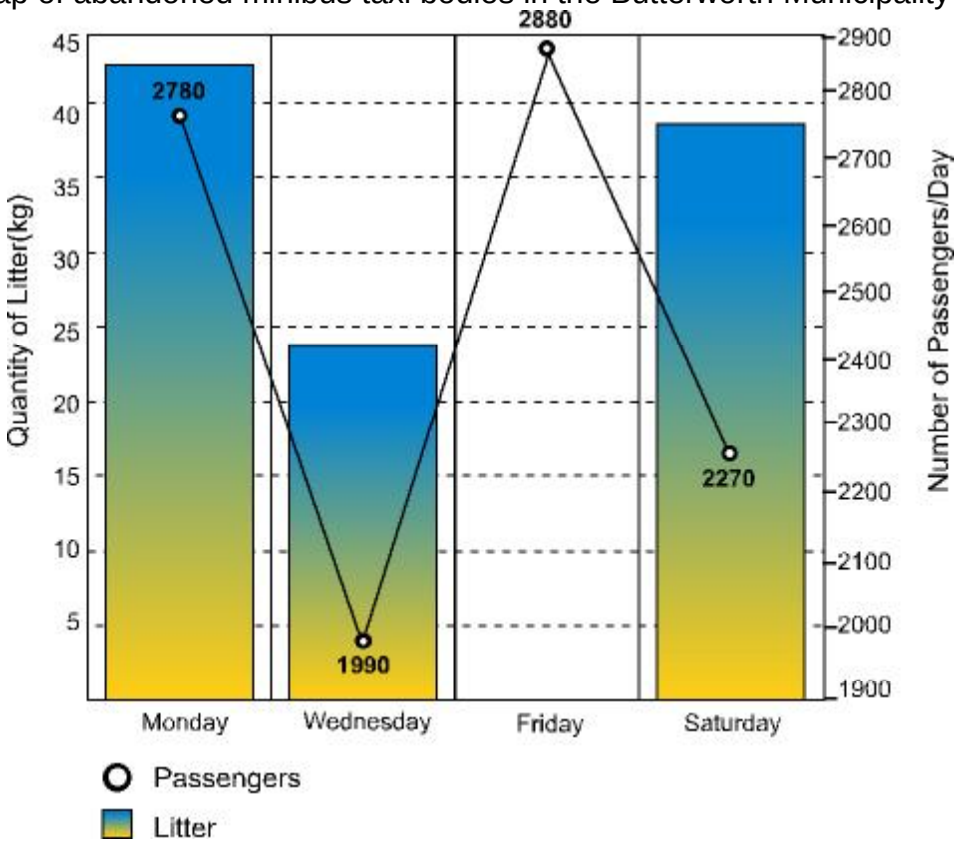

Figure 5 Quantity of litter and density of passengers

Taxi Routes Generated Airborne Dust

Taxis in the suburbs also make use of the gravel road, which in turn generates airborne dust. Directional dust gauges were placed along these roads and control site in Ibika. Each slit of the four cylinders faced one of the cardinal points (N, E, W and S) and the results for all sites are reflected in Table 2.

Table 2: Total quantity of dust collected per cylinder and site

Cardinal Points	Quantity of Dust per Cylinder (g)					
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
North	5.366	6.966	8.546	11.975	*7.124	11.445
South	4.968	6.999	8.629	9.563	9.424	9.179
East	5.051	6.608	8.780	9.412	*8.180	9.473
West	5.321	6.988	9.037	9.736	9.782	9.535
Total	**20.706**	**27.561**	**34.992**	**40.686**	**34.510**	**39.632**

Sites are: Control area = 1; Mchubakazi = 4,5 & 6; Ibika = 2 & 3

*Data interfered with on the 3rd & 5th week

Dust box collectors were placed on the ground next to all directional airborne dust collectors (except for Sites 3 & 6) to establish the quantity of dust that falls on the ground as opposed to airborne dust. The Control area (Site1) collected the least volume of ground dust (13.77g) whereas, the largest volume was collected in Site 5 (Mchubakazi, 74.879g). This was followed by Site 4 (67.354g), then Site 2 (21.595g). Again Ibika suburb taxi route has collected a smaller amount of ground dust than Mchubakazi. At Sites 1 [13.770g] and 2 [21.595g] in Ibika, ground dust collected was less than the airborne dust.

Transport Vehicle Frequency and Dust Accumulated

The number of minibus-taxis using the Ibika and Mchubakazi suburb taxi routes were observed over three hours (7h00-8h00, 13h00-14h00 and 16h30-17h30) a day. This was done on specific days of the week (Monday, Wednesday, Friday and Saturday) for 5 consecutive weeks. The monitoring of dust was done at the same time as monitoring of taxis to establish a relationship between them (Figures 6 and 7)

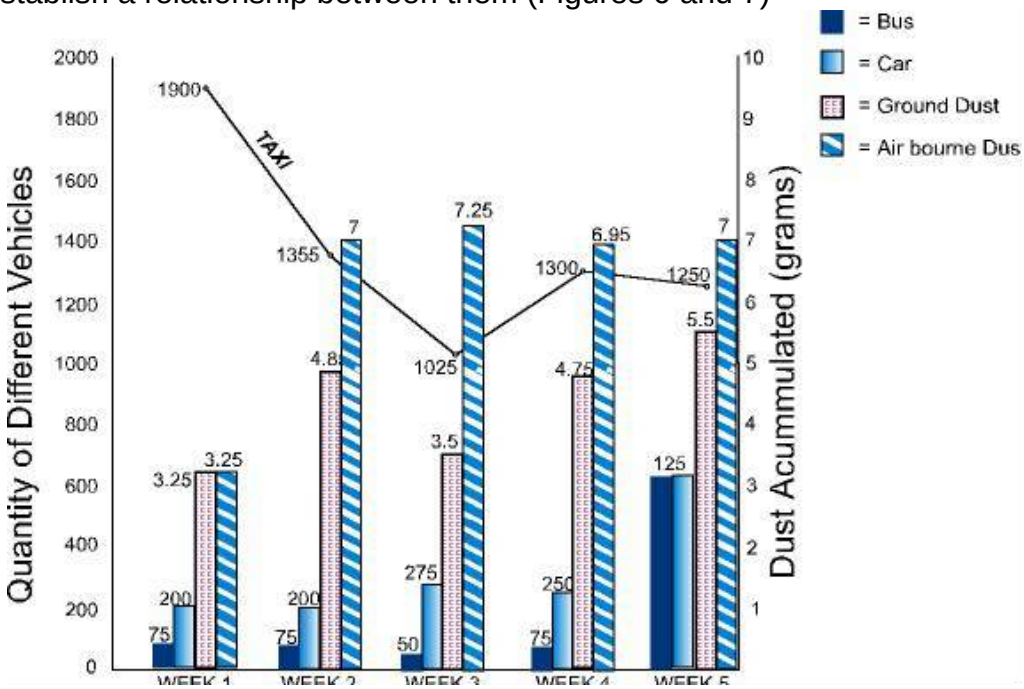

Figure 6 Ibika suburb transport modes frequency and accumulated dust

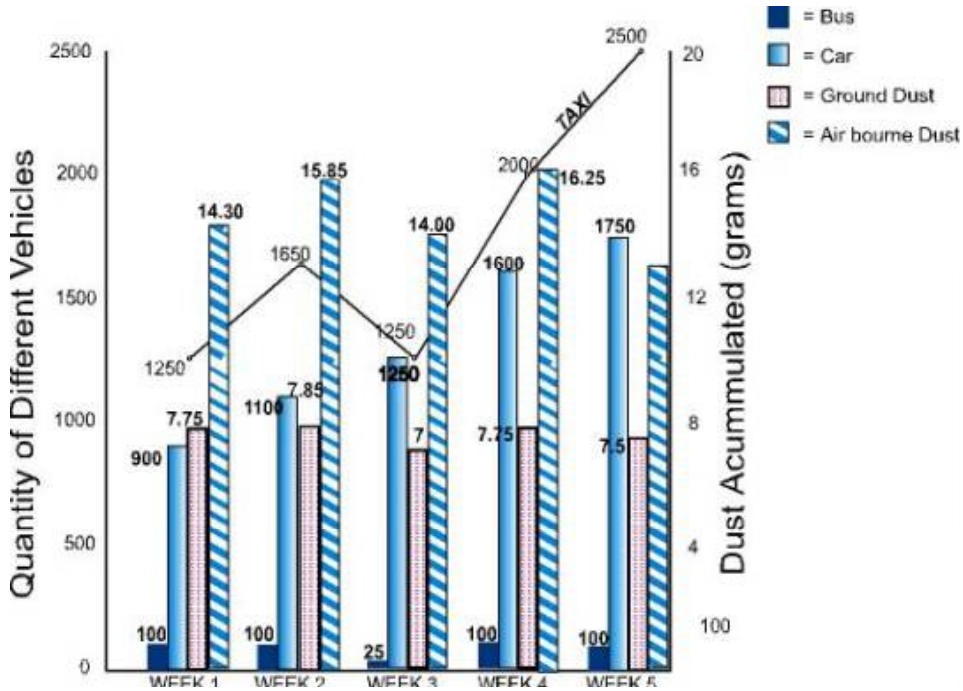

Figure 7 Mchubakazi suburb transports modes frequency and accumulated dust

DISCUSSION

People and Ground Litter

Data from this study shows a direct relationship between passenger numbers and ground pollution. In the long-distance taxi rank (Umtata/KWT), passengers wait inside a taxi for a full load and during that period are not allowed to eat or drop litter inside the taxis (Figures 1 & 5). This encourages them to throw litter through the windows.

The majority of shops that serve this area (Chiken Licken and different restaurants) concentrate on take-away wrapped with paper, plastic, milk or fruit juice bottles and soft plastic film as a packaging material. These are all reflected in the constituent quantity of litter collected during data collection. In other taxi ranks, passengers dropped litter on the pavements due to lack of rubbish bins, while in others water drains are used as rubbish cans.

The absence of public toilets in the Umtata/KWT taxi rank, which is the biggest, forced passengers into the habit of relieving themselves anywhere. There are problems of urine stains on the pavement and bad smell in some areas of the taxi ranks. This problem is not experienced in the Msobomvu/Mchubakazi taxi rank, as there are public toilets. Lack of proper rest places in the taxi ranks has also forced passengers to lean against the hedges and fences of the nearby houses and these ultimately collapse. The inhabitants of these surroundings have responded by building concrete walls thus denying the town of greenery that beautifies.

Researchers in America (Kohlenberg and Phillips, 1973) established that littering rates correlated positively with the parking lot receipts. They further reported that littering increase in the afternoon hours. These relationships can be interpreted as a function of traffic through the area. In view of the above, the volume of traffic can be expected to have a direct relationship with the amount of litter generated in an area. Taxi service expansion is therefore bound to generate litter in the taxi ranks, but ways and means to limit this habit have to be devised.

Taxi Litter

Taxi ranks have also produced taxi litter (motor waste) of different quantities in the form of brake linings and fluid containers, gearbox oil containers, oil additive cans and filters, motor accessories (wheel caps, fan belts, stone guards and wiper blades), tune-up kits and car cleaning equipment. This is attributed to taxi drivers who reported servicing their minibuses at the taxi ranks. In the process of changing brake linings, brake fluid leaks out onto the tarmac and creates another environmental impact. Oil and brake fluid leaks reduce the tarmac quality by making it slippery and soft. Heavy traffic on such terrain leads to the development of potholes on the surface and this promotes accidents that result in social loss and costly damage to vehicles.

Air Pollution

Data from this study shows that ground and air pollution is prevalent in the taxi ranks in town and routes on the suburbs. Taxis on these routes have created dust bowls on the dirt roads. Mchubakazi and Ibika taxi routes generated more dust than the control area in Ibika suburb. This has lead to problems for the former residential suburb particularly next to this route. Residents complained about dust entering their houses, which they could smell in their clothing. As a result they use plastic covers to protect it. Further, women had problems with their washing on the line as they had to determine the direction of wind before doing any washing on any day.

Cleanliness of the house was also emphasised as housekeepers were annoyed by dust that made the dwellings dirty with-in a short period of time. These results are similar to those of a study conducted in Kwa-Dimbaza suburb in the Eastern Cape (Tanga, 1986), where larger quantities of dust were collected from sites along or near the major traffic routes in the residential section where all the streets are not tarred. Air pollution such as dust, fly ash and smoke are mainly annoying but dust with lead causes serious health problems.

Water supply pollution

The taxi industry in Butterworth has created additional job opportunities such as taxi cleaning. In this process, cleaners make use of detergents to wash their vehicles and aerosol cans to clean dashboards. The contaminated water runs down the gutter and flows into the Cegcwane River that in turn joins the Gcuwa River. Phosphates from other detergents and sources pollute water as they provide food for algae, which then grows at a faster rate. Algal blooms are aesthetically unpleasant and on decomposition create uninhabitable conditions for aquatic animals.

Other arguments indicate that synthetic detergents cause unsightly foams in natural water (Revelle and Revelle, 1974). They argue that detergents contain about 50% by weight of a phosphate compound such as sodium tripolyphosphates. This prevents dirt from re-depositing on clothes, and maintains a proper level of alkalinity. In this study, water at the confluence of Cegcwane River had more pollutants as it recorded conductivity of 1320 μ*mhos* compared to the control water (580 μ*mhos*).

Comparing the Eastern Cape and KwaZulu-Natal Provinces, the latter province has made some strides in controlling littering by providing decorated rubbish bins. In America, these have been found to be effective as the colourful bins attract users, understanding their purpose and ultimately drop litter in them. In both provinces public latrines are built in the taxi ranks but are too few to accommodate the number of taxi passengers. There is apparently a visible lack of taxi wash-bays. As a result, taxi operators use areas

convenient to them even though there are garages and special places to wash vehicles. Establishment of taxi-cities would help to solve part of this problem when vehicle wash bays and adequate latrines are included in the plans.

CONCLUDING REMARKS

This study has therefore established that the magnitude of environmental impact by taxis is related to the size of taxi rank and population, and the type of litter generated varies with the destination and distance passengers have to travel. It has also been established that the increase of taxis leads to environmental pollution and that contra-normative rules and demands in the taxi ranks led passengers to litter more in the long distance taxi ranks.

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Mongezi Noah, a professional teacher by qualification did his university education with Fort Hare and his Doctor of Philosophy degree with Royal Holloway, University of London. His doctoral thesis was on "Minibus-taxi Safety Issues, Operators, Patrons and the State in the Eastern Cape Province of South Africa, 1982-1994".

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