Working Paper

Inferring commercial vehicle activities in Southern Africa

Author(s):
Joubert, J.W.; Axhausen, Kay W.

Publication Date:
2009

Permanent Link:
https://doi.org/10.3929/ethz-a-005792479

Rights / License:
In Copyright - Non-Commercial Use Permitted
Inferring commercial vehicle activities in Southern Africa

J.W. Joubert∗,a,b,c,1, K.W. Axhausenc,2

∗Industrial and Systems Engineering, University of Pretoria, South Africa, 0002
bCSIR Built Environment, PO Box 395, Pretoria, South Africa, 0001
cInstitute for Transport Planning and Systems (IVT), ETH Zurich, 8093, Zurich, Switzerland

Abstract
To address the underreporting of freight from a transport geography point of view, we present an exploratory paper of the time and spatial characteristics of disaggregated commercial vehicle activities. The activities were extracted from raw GPS data collected in South Africa over a six-month period for more than 30 000 commercial vehicles. The analysis of the activity chains provides useful characteristics such as activity and chain durations, number of activities per chain, and the spatial extent of the activity chains. We introduce metrics to measure commercial activities, and compare three main commercial centers in South Africa. Also, in response to the South African government’s intent to better understand freight movement at a detailed, non-macroeconomic level, this paper is significant as it provides a means to support government’s transport infrastructure investment decisions. Although the activity densities contradict some accepted expectations found in literature, it highlights some of the impacts of past political inequalities still evident in South Africa, again providing valuable inputs to policy making.

Key words: GPS data processing, Commercial, Transport, Activity density, Freight

1. Introduction
Stakeholders in the economy pursue their goals typically through participating in a variety of activities. Since one’s choice of activities are usually separated by both space and time, some form of transport is implied, which in turn typically requires formal infrastructure. In areas where there is limited transport infrastructure for the amount of pursued activities, congestion occurs. The positive impact public infrastructure has on economic growth is well known from Aschauer [1989, 1993], Munnell [1992], and more specifically in South Africa from Fedderke et al. [2006] and Fedderke and Bogetic [2009]. The efficient movement of freight is critical to economic vitality, yet the development of freight models as public policy instruments have lagged the rapid evolution of the actual freight systems [Hensher and Figliozzi 2007].

Hesse and Rodrigue [2004] argue that freight transport is not merely a derived demand. Logistics are no longer just means to overcome space, but has a critical time component. The extension of supply chain structures, outsourced and subcontracted across vast geographic areas have resulted in smaller consignments delivered more frequently. As supply chains increase in complexity, activities of production, distribution and consumption are increasingly difficult to separate.

Freight transport models based on the classical four step modelling approach (attraction/generation; distribution; modal split; and assignment) were originally developed for passenger transport. The four steps are only handled at an aggregate level (zones) and the detail movement of the freight carriers are not considered [Fernández L. et al., 2003]. Figliozzi [2007] notes that four step models completely ignore the urban tours where vehicles make multiple stops. Another research stream of freight modelling is concerned with econometric models where the interest is in predicting price and...
demand elasticities (Beuthe et al., 2001; Kremers et al., 2002; de Jong et al., 2004; Rich et al., 2009). Both these models deal with aggregated flow of commodities, often expressed in tonne-kilometers or some volumetric measure. Although this is valuable from a macro-economic perspective, it is not the commodities that contribute to increased congestion, but the commercial vehicles transporting the commodities. With smaller and more frequent consignments, tonne-kilometers is not an accurate measure to evaluate the impact that commercial vehicles have on congestion.

Ambrosini and Routhier (2004) review urban freight modelling efforts across nine industrialized countries. The methods and tools included theoretical models, interviews, surveys, and experiments. In response to the review, Figliozzi (2007) notes that studies concerning vehicle activity chains are absent. Although still based on zonal aggregates, Friedrich et al. (2007) report on recent models where activity chain generation has been accounted for. As with other top-down multiclass assignment models based on the four step modelling approach, the aggregate models lack the ability to capture individual stakeholders’ behaviour.

The decisions that the commuting population make about the timing, route and mode choice to participate in activities, on the other hand, have been studied extensively. The advancement of technology, and the accessibility of Geographic Positioning Systems (GPS) have positively impacted on the disaggregate study of the movement of people and their associated activities (Yalamanchili et al., 1999; Draijer et al., 2000; Wolf et al., 2001, 2004; Marchal et al., 2005; Tsui and Shalaby, 2006; Schüssler and Axhausen, 2009).

Hensher and Figliozzi (2007) acknowledge that freight models are important in supporting public policy tools. They note, in a special issue on behavioural insights into freight transportation, that the basis of how choices are made across the distribution chain must be rethought. In the special issue, Hunt and Stefan (2007) present the first, to our knowledge, tour-based microsimulation model of urban commercial movements using data from an extensive survey of 37,000 activity chains in Calgary, Canada. The model developed by Le Jong and Ben-Akiva (2007), although not estimated on actual data, considers the frequency of chains; the number of activities per chain; the use and location of distribution centers; and the mode used for each leg of the activity chain.

Traffic counts produced by the South African National Roads Agency Limited (SANRAL) make distinctions between light and heavy vehicles on the majority of national and main roads. One could hence argue that we have a fair idea of where heavy vehicles travel on the road network. We acknowledge that a large portion of commercial vehicles may be hidden under light vehicle counts. In this paper, our interest is more on where commercial vehicles spend their time performing loading, offloading, or service activities, and not necessarily the routes they travelled. For the purpose of this paper travelling between activities is not considered an activity.

In this paper we describe how commercial vehicles move within and through South Africa. GPS data was obtained for 31,041 commercial vehicles over a six-month period using on-board fleet management tracking devices. We extracted more than 1.3-million activity chains containing in excess of 10-million vehicle activities from the raw GPS data. A distinction was made between vehicles performing the majority of their activities within a study area, termed within traffic; and those that perform activities across larger geographic areas, termed through traffic.

We show the activity densities across South Africa, and focus the analysis on the three economically most prominent provinces. The commercial vehicle activity metrics that we evaluated include the geographic extent of activity chains; the number of activities per chain; activity and chain duration; an economic measure to evaluate commercial productivity; and an infrastructure usage measure. We also report on the time-of-day characteristics of the activities.

Our study confirms Rodrigue (2006) that freight and passengers have very different spatial dynamics. Freight appears more flexible and varied in terms of origins and destinations, number of activities per chain, and the sheer geographical extent of activities. We show that more than 80% of activity chains are made up of between 3 and 15 activities, and that as much as 65% of commercial vehicle activities are outside the urban study areas. The difference in activity and chain characteristics is more prominent between within traffic and through traffic than between the three provinces. The time-of-day analysis of activities confirms the survey results of Hunt and Stefan (2007) that commercial activities take place throughout the business day and does not center around the morning and afternoon peaks.

The disaggregate description of commercial activities is a significant contribution to understand the spatial impact of commercial vehicles. This paper is novel as it is, to our knowledge, the first
detailed and disaggregate report on commercial vehicle activities, and activity chains, based on actual observed vehicle movement. Knowing the characteristics of commercial activity chains allows us to generate and simulate a synthesized population of commercial vehicles in the near future. Combining commercial and person movement in a single model provides improved decision support for policy and infrastructure evaluation.

Although the richness of the geography can not be fully exploited with only the observed characteristics, freight activity and population densities are correlated. This is in contrast with the perception that freight centres are on the periphery of urban and metropolitan areas. This reemphasizes the spatial and land use challenges facing South Africa as a result of racial and spatial segregation of the past.

Our paper starts with a brief history of South African policy affecting commercial traffic in Section 2. The method used to extract commercial activities from raw GPS data is then described in Section 3 followed by a provincial comparison in Section 4. Spatial distribution of activities are discussed in Section 5 where we also report on the time-dependent progression of activities. The paper is concluded in Section 6 with a suggested research agenda for using dissagregated freight movement data.

2. A brief history of South African transport policy

Stander and Pienaar (2002) review the early South African transport history of a permit system restricting carriage of goods by road since 1930, favouring government owned rail. Gradual deregulation of freight towards free competition started with the Road Transport Act, No. 74 of 1977, and ended with the Transport Deregulation Act, No. 80 of 1988, and the Road Traffic Act, No. 29 of 1989. The substantial increase in road freight haulage since the economic deregulation was only governed by technical and safety regulation of operators and vehicles. In essence, government lost control of where freight moved; and to a large degree what was moved.

Having approximately 270 000 km of roads and 20 000 km of rail network may seem extensive for a developing country. But the legacy freight system, as a result of the Apartheid era sanctions, was set up and configured to support the movement of national product of inward industrialization and provide cheap transport to a very limited and select number of economic participants: most of which were government-owned and regulated (Fourie, 2001). Although the system was successful in creating tailored solutions to the export of bulk commodities, mostly via the rail parastatals, it remained a racially selective employer (Iheduru, 1996). The network is characterized by uneven flows of goods, and have dramatic peaks in specific areas.

Two seemingly parallel economic systems resulted (Development Policy Research Unit, 2008). The first, popularized by the then President Thabo Mbeki in 2003 as the first economy, is a modern economy similar to that found in developed countries. The first economy is formal and is well-documented with receipts, records, a credit system, and legally enforceable rights and remedies. Contrary, the second economy lacks all these things: it is informal, regulated most often only by community norms, and based on small taxless cash transactions. As described by Edwards (2007), the two economies are embedded in two parallel sets of infrastructures, and are as a result of the political past, heavily influenced by race and ethnicity, as well as class.

The first strategic framework to integrate all parts of transport into a common vision and plan for action was the Department of Transport (1999)’s Moving South Africa. The document emphasized that the Apartheid government essentially created a transport system around its selective national goals aimed at creating employment for a privileged class, and a network engineered to support the spatial dispensation of separation and dispersion. Moving South Africa, in response, was a 20-year plan underlining the new government’s intent to be customer-focused and play a growth facilitation role in providing and maintaining high volume routes and nodes in the transport network as a backbone, and develop supporting networks to empowered dispersed and rural communities.

Although the subsequent National Land Transport Transition Act (NLTTA), No. 22 of 2000 emphasised public transport, it did require the minister to prepare an annual National Land Transport Strategic Framework, within which freight transport should be addressed. The launch of the first freight-specific policy document—a legal requirement under the NLTTA—the National Freight Logistics Strategy acknowledges that the growth of freight traffic has surpassed most of the
20-year growth forecasts made by *Moving South Africa*, 14 years earlier than expected (Department of Transport [2005]). The freight strategy was a response to the inability of the institutional and regulatory structure to promote the needed improved efficiency. The inefficiencies not only impacts on South African economic development, but also neighboring countries like Lesotho and Zimbabwe that are reliant on the South African freight logistics system, and that face greater developmental challenges than South Africa. The geographic challenges and the resulting need for regional cooperation is emphasized by Naudé (2009) who introduced the concept of Africa’s proximity gap.

The first *State of Logistics Survey* for South Africa was published by Van Dyk et al. (2005). The report highlights that although first world economies have achieved a significant reduction in the cost of transportation (and inventory) as a percentage of Gross Domestic Product (GDP), South Africa’s core structural problems put the country’s logistic state in a far worse than expected position. The study was the first attempt to measure the intrinsic logistics costs, and emphasized the importance of measuring logistics since it is a valuable tool as lead indicator for economic growth.

With the publication of the most recent strategic plan, the Department of Transport (2008) acknowledges the need to understand the movement of freight at a more detailed level. The structural alignment of the different spheres of government is still prominent in policy documents, but more detailed measures are sought, and the majority of the budget earmarked for freight interventions are dedicated to the development of an integrated National Freight Information System that allows industry to tap into and benefit from a cargo information and tracking system. It is anticipated that such a system will allow transport planners to better understand, and incorporate the impact and interaction of freight movement with the people movement on the road infrastructure: improving decision making regarding transport infrastructure investment.

3. Extracting activities from GPS data

Extracting activities from GPS data has been the topic of a number of recent research activities. Similar to Schüssler and Axhausen (2009), we do not have any additional information beyond the GPS record, and we’ve followed the high-level process depicted in Figure 1 to extract commercial activity chains from raw GPS data.
The data set, gratefully provided by a South African fleet management and tracking company *DigiCore Holdings Limited*, was a single-file containing all the GPS log records for commercial vehicles for the six months 1 January 2008 to 30 June 2008. Each GPS record has six fields: 1) a unique vehicle identifier; 2) a seconds-based Unix time stamp; 3) a longitude and 4) latitude value, both in decimal degrees according to the WGS 84 reference coordinate system used by global positioning systems; 5) a vehicle status identifier used by *DigiCore* for fleet management purposes; and 6) a speed value. With a total file size in excess of 30 Gigabyte, the first step was to split the data into separate files, one for each vehicle.

A total of 31 041 vehicle files were identified, and had to be sorted chronologically according to the time field. Since sorting was considered a time-intensive operation, we limited the files to only those vehicles that had GPS log records within the given study area. Once identified, the vehicle files were sorted.

The fleet management device installed on each vehicle monitors various engine and electronic triggers, including temperature, water levels, braking, ignition activity, tampering with the GPS unit, triggering of the panic alarm, and opening and closing of vehicle doors, to name but a few. Whenever a log trigger is observed, a GPS update is sent to a central server and logged. When the vehicle is idling or in motion under *normal* conditions, i.e. no exception triggers are recorded, the GPS will send log records every 5 minutes.

In this study we focussed on ignition-related triggers to identify activity start and stop times. An activity start was identified as the point when an *ignition off* trigger is received, and an activity stops when the ignition is turned on again. To eliminate any false starts or false stops, such as a failed engine start attempt requiring the driver to switch the ignition off and back on before starting again, we provided a threshold for activity duration of 8 minutes. The threshold is assumed realistic since commercial vehicles are involved in time-consuming loading, unloading and refuelling activities. Using vehicle status triggers to identify activities, as opposed to recurring geo-locations, allowed us to avoid identifying a heavy vehicle waiting to cross a busy intersection, or short stops at toll gates, as potential activities.

Figure 2 shows the activity durations of all activities before chains were identified. Note the extreme tail of the activity durations with many activities longer than a day (1440 minutes). The inefficient use of commercial vehicles is a clear contributor to the high logistics cost reported in the State of Logistics report, 15.7% of GDP, putting it in 124th position out of 150 countries on the World Bank’s Logistic Performance Index based on logistics costs ([Httnam et al., 2008](#)). [Stander and Pienaar (2002)](#) argue that freight, as a subcategory of commercial vehicles, are not paying the full cost of using the road infrastructure. It could be argued that commercial traffic is relatively *cheap*, and financial gains are not a burning platform to motivate efficiency gains for both shippers and carriers.

![Figure 2: Histogram of all activity durations. The threshold of 300 minutes (5 hours) between minor and major activities is indicated.](#)
The complete list of sequential activities was then categorised as being either a major, lasting in excess of 5 hours, or a minor activity, lasting less than 5 hours. The threshold of 5 hours was arbitrarily chosen since no empirical evidence was found suggesting an intuitive, definite and distinguishable difference in activity durations.

Whenever a major activity was identified, a new activity chain was created, starting with the major activity. Subsequent minor activities were added sequentially until the next major activity was identified. Once all activities were chained, the chains were cleaned: any chain not starting and ending with a major activity, was removed to ensure only complete chains were evaluated. Chains containing only two major activities were considered mere relocations, and since they made up a very small proportion of the activity chains, they were also removed. Figure 3 provides one example of the resulting activities. This particular vehicle only performed activities within a very small extent during the entire study period, and illustrates the locations of both major and minor activities. We did not map the vehicle movement to the road network, mainly because the GPS log records in our data set were too infrequent.

The total number of activities exceeded 10.5-million, and although 31 041 vehicles can be considered a sizable sample of the population of commercial vehicles in South Africa, we could only estimate the density of commercial vehicle activities, and this was achieved through the kernel density estimation implementation of ESRI ArcGIS—popularized by Silverman [1986]'s quadratic kernel function. Conceptually, kernel density estimation fits a smooth surface over each point. The volume under the surface equals the estimate number of activities in that grid cell. The density map of minor activities illustrated in Figure 4 used a grid size of 500 x 500 meters, with a search radius of 5000 meters. Although activities were recorded as high up as the southern part of the Democratic Republic of Congo, the activity density outside South Africa was so low that it was barely distinguishable on the density map.

Noticable, even when only considering South Africa, is the dispersed nature of activity clusters, emphasizing the proximity gap that Africa suffers [Naudé 2009]. Road remains the dominant cargo mode in South Africa, even across large distances.

This paper focuses on the three of the nine South African provinces highlighted in Figure 3 that have elevated levels of both major and minor activities. The study areas considered are Western
Figure 4: The extent of vehicle activities throughout South Africa. The three provinces considered as study areas are indicated.
Cape (WC) and KwaZulu-Natal (KZN) because of the high density of vehicle activities around the two respective port areas; and Gauteng (GT), the smallest of the nine provinces, accounting for less than 1.5% of the country’s surface, yet is contributing approximately 33% of the GDP (Statistics South Africa, 2009).

4. Vehicle and provincial characteristics

Consider the complete set of vehicles as \( C = \{1, \ldots, 31041\} \). If a GPS log record implied that a vehicle \( i \in C \) travelled through a specific study area \( j \in \{GT, KZN, WC\} \), the vehicle was considered part of the subset of vehicles visiting the specific study area, i.e. \( i \in C_j \subseteq C \). Vehicles having activities in multiple study areas are hence accounted for in each study area, and this is different to the national activity density reported in Figure 4 where each vehicle was only accounted for once.

Figure 5 compares the percentage of activities for the vehicles in each \( C_j \) that were performed in each study area \( j \). A clear distinction is observed between within area traffic concerning vehicles performing 90% or more of its activities within the study area, and through traffic where fewer activities than the 90% threshold are performed. Vehicles that spent 0% of their activities within a study area indicate that although the vehicles travelled through the area, it never conducted any activities, and can be considered pure through traffic. The percentage of through traffic in south Africa is considerably higher than the 6% reported by Hunt and Stefan (2007) in the Calgary study in Canada.

Of the 31 041 vehicles considered, 11 507 vehicles were classified as producing through traffic. Table 1 provides a breakdown of the through traffic, and indicate in which of the three study areas they performed activities. The number of vehicles transporting goods between Gauteng and KwaZulu-Natal correlates with the corridors discussed in Masango (2004), especially the tonnage reported in Ittmann et al. (2008).

The structure of the activity chains vary quite significantly for the within- and through traffic. Figure 6 shows how within vehicles (Figure 6a) generally have shorter chains, i.e. fewer activities per chain. There are slight differences among the study areas too, with KwaZulu-Natal having notably shorter chains than the Western Cape. Through traffic illustrated in Figure 6b have more variation in the number of activities. Vehicles travelling through Gauteng appear to have more activities per chain than vehicles travelling through the Western Cape. Note the slight increase in the percentage of vehicles that have approximately 22 activities per chain. This bimodality is more prominent in Figure 7 showing the average chain duration for vehicles.

The average duration of within vehicles’ chains (Figure 7a) is much shorter than that of through traffic, especially vehicles within KwaZulu-Natal. The bimodality is most prominent for Gauteng
Table 1: A Breakdown of the 11507 through traffic vehicles indicating in which of the three study areas activities were conducted.

<table>
<thead>
<tr>
<th>Study area</th>
<th>Number of vehicles</th>
<th>KwaZulu-Natal</th>
<th>Western Cape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Gauteng</td>
<td>532</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>KwaZulu-Natal</td>
<td>1014</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Western Cape</td>
<td>100</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>4438</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>690</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>2785</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>1948</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Figure 6: Comparison of the number of activities per chain for the three study areas

(a) Within traffic

(b) Through traffic

Figure 7: Comparison of the average duration of activity chains for the three study areas

(a) Within traffic

(b) Through traffic
with the two maxima found around 8 and 24 hours respectively. Although 8-hour chains can easily be related to the length of a working shift, especially in South Africa where multiple shifts are uncommon, chain lengths of 24-hours seem less intuitive. Since chains end with a major activity lasting 5 hours or more, chains of 24-hours implies a possible three-shift working scheme, but with a significant break acting as a fourth shift.

In the case of through traffic represented in Figure 7b the majority of chains seem to last between 8 and 24 hours, with a slightly more prominent distribution for Gauteng within these limits. But since Gauteng through-traffic represent the majority of through-traffic, figures for both KwaZulu-Natal and Western Cape through traffic (not passing through Gauteng), are inflated, and most probably favour longer chain durations due to the multi-driver teams on long-haul trucking routes.

In his article, eluding to the richness and diversity of freight transport geography, Rodrigue (2006) notes that the transport and logistics corporations are on average a lot more profitable than their (mostly) government-owned counterparts. We believe that freight, being spatially more challenging and diverse than public transit, provides a means to measure the economic productivity of a province. One such measure is to calculate the GDP generated by the province per activity conducted within the province. It may have intuitively been expected from Figure 4 that the large number of activities in Gauteng may yield a low GDP productivity measure, yet Gauteng turns out to produce the highest: South African Rand (ZAR) 151,700 per activity; followed by the Western Cape with ZAR 106,200, and KwaZulu-Natal with ZAR 73,100.

Another metric we proposed to compare the freight productivity of the provinces is distance per activity. For each vehicle, consider the total chain distance of chains that have one or more activities within the study area, and divide it by the total number of activities that the vehicle performed within the study area. We postulate that a low metric value is preferable. Since, from the GDP metric, we can assume that freight activities are an essential component of economic growth, it is preferable that the amount of infrastructure use be limited. The fewer kilometers travelled on the road per activity, the more spendable GDP to invest in new, and maintain existing infrastructure. We acknowledge that the following scenario could exist: a vehicle performing many activities on long chains could yield the same metric value than a vehicle performing very few activities on short chains. Still, the metric yields a valuable indication of GDP per activity. The results are visualized in Figure 8. Within- and through traffic should again be split since they differ in nature. Figure 8a shows KwaZulu-Natal having a significantly lower metric value with a higher percentage of vehicles with low metric values. Two possible explanations could be the large number of container handling trucks around the port area performing many, and shorter, container relocation activities, or the many short sugar cane-related trips performed between fields, mills, and refineries in the province. Gauteng and the Western Cape have similar distributions, with the Western Cape having slightly more high-metric values.

The situation is different for through traffic (Figure 8b). The metric spread is wider, and Gaut-
Figure 9: Comparison of the time of day when activities start in the three study areas

eng appears to perform better. One possible explanation is the small size of the province, resulting in more trucks being considered as through traffic. Many of the 4438 through traffic vehicles in Gauteng, reported in Table 1, only travel fairly short distances to neighbouring provinces—many trips mining related (platinum operations in NorthWest west of the province; and coal and steel operations in Mpumalanga, east of Gauteng). Western Cape’s high metric values could be attributed to its geographic proximity to main industries, and the fact that the majority of through traffic vehicles are long haul trucks visiting Gauteng and KwaZulu-Natal.

5. Activity characteristics

Although the effect of the activity chains are lost, Figure 9 shows how the start times of activities are spread over the day. Figure 9a indicate that the minor activities of within traffic in KwaZulu-Natal are more restricted to normal business hours, while Western Cape activities extend later throughout the day. One possible explanation might be the 13° difference in longitude and South Africa having only one time zone. Sunrise is earlier in KwaZulu-Natal, and it appears that freight activities follow daylight, but the pattern is not present in Figure 9b for minor activities produced by through traffic. Overall, our observations confirm the survey results of Hunt and Stefan (2007) that commercial activities tend to concentrate more during the middle of the workday rather than in the AM and PM peaks.

The start time of major activities indicate the end of chains, and is therefore of interest. Traffic chains (Figure 9c) tend to end around the end of normal business hours, with the distinctive outlier between 22h00 and 23h00 for all three areas. The pattern for through traffic has a more distinctive distribution peaking also between 22h00 and 23h00. With little infrastructure provided to act as formal truck stops, long haul vehicles tend to pull off from the road at night and create impromptu
Figure 10: Aerial view of an informal truck stop indicating major activities of a number of vehicles. The start time of 00h10:04 implies a truck pulling off the road for the night. (Source: GoogleEarth at location 22°3′41.14″S, 21°30′20.27″E, accessed on 7 April 2009)

Figure 11: Density comparison for the province of Gauteng

sleep-over stops. This behaviour is confirmed in Figure 4b with near-continuous activities along major inter-province routes, even though very infrequent refuelling stations and formal truck stops exist in the remote areas between Gauteng and the Western Cape, for example. Figure 10 depicts one such a location: a infrastructure-less stop close to a few trees.

5.1. Density comparisons

In this subsection we compare the activity densities with the population density as reported by CSIR Built Environment (2009). We further use the Geospatial Analasys Platform (GAP) mesoframe demarcation (CSIR Built Environment 2007, 2009; Naudé et al., 2007). Each mesoframe is approximately 7 × 7 kilometers, yielding an approximate surface area of 50km². We prefer the equal-area demarcation since it highlights geographic areas of activity density more accurately.

Gauteng, depicted in Figure 11, shows a very similar distribution of minor (Figure 11a) and major activities (Figure 11b). What is insightful is how freight activities and the population (Figure 11c) are practically competing for the same space, and not only the road infrastructure.

The minor activity densities for KwaZulu-Natal and the Western Cape are shown in Figures 12a and 12b respectively. But since the activities are so sparsely distributed, we will focus the reader’s attention to a single metropolitan area within each of the provinces.

For the eThekwini Metropolitan Municipality in KwaZulu Natal (Identified in Figure 12a), we see that activities, both minor and major, are clearly concentrated around the port in Figures 13a
Figure 12: Densities of minor activities indicating the sparse localization around a single metropolitan area.

Figure 13: Density comparison for the eThekwini Metropolitan Municipality in KwaZulu-Natal and the City of Cape Town Metropolitan Municipality of the Western Cape, with the majority of minor freight activities (Figure 14a) around the harbour area. Again, as for eThekwini, major activities (Figure 14b) are scattered wider around the port, notably along the N7 national highway towards the north, and along the N1 highway towards the east. The population (Figure 14c) and freight distribution are again overlapping. The two black mesoframes in Figure 14c are characteristic of low-income, high-density informal settlements found throughout South Africa.

We conclude the density discussion with Figure 15 showing the progression of activity increase in 6-hour increments. The distribution of activities, for all three areas, does not seem to change over the course of the day, but rather only intensifies around the activity centres.
6. Conclusion

We have presented an exploratory paper reporting on the disaggregate freight activities in South Africa. Hesse and Rodrigue (2004) observed that distribution centres, which attract many logistic activities, are concentrated on the fringes of urban areas and beyond. On the contrary, at least in South Africa, logistic activities are centred within the urban areas, especially in the case of Gauteng.

Although Rodrigue (2006) have praised the profitability of the freight transport sectors, such praises may be somewhat dampened if we consider the work of Stander and Pienaar (2002, 2005) noting that freight does not cover the full social and political cost for their road use. The South African government intends to separate the ownership and operation of infrastructure, and so it will remain a challenging task for central transport planning authorities—the custodians of infrastructure investment—to walk the fine line between effective facilitation of economic growth, and stumbling under its own mass and bureaucracy.

Richardson (2005) indicates that business location density plays an important role in freight factors affecting congestion, and the related environmental and fuel consumption effects. Knowing now where activities take place, i.e. where business and freight stakeholders are located; and what the inter-activity distances are, allows us in future to evaluate and compare the activities against underlying land use data. In turn, land use analysis may provide guidelines in predicting future freight activities based on strategic land use masterplans prepared by government.

We have achieved a significant result with this paper in identifying freight activities. The next step would be to map the activities against the underlying land use. The activity locations, along with the activity chain characteristics allows us to generate a representative synthesized population of freight agents. Using a large-scale agent-based transport simulator such as the toolkit by the MATSim Development Team (2009) allows us to incorporate freight movement in dynamic traffic simulations. Decision support on transport infrastructure could then be considered more representative of the infrastructure users.

References


Figure 15: Densities of minor activities for different times of the day

CSIR Built Environment (2007). SA Geospatial Analysis Platform, Version 2: Spatially disaggregated and interpolated socio-economic and accessibility indicators based on 2004 magisterial district data, obtained from Global Insight’s Regional Economic Focus (REX version 2.0c (190)). Collaborative project with the Policy Advice and Coordinating Unit (PCAS) of the Presidency, co-funded by GTZ.


