

MANAGING URBAN LOGISTICS IN AN EXPANDING CITY – CASE STUDY OF AHMEDABAD

Prof. Shivanand Swamy

CEPT University, Ahmedabad, India 380009 (shivanand.swamy@gmail.com)

Dr. Deepak Baidur,

CEPT University, Ahmedabad, India 380009. (baidurdeepak@gmail.com)

ABSTRACT

Ahmedabad city has witnessed a sustained growth in population over the past decades with corresponding growth in passenger and freight movements. This paper analyses the impact of the manner in which policies affect urban logistics networks and urban freight movements within the municipal limits of the city. A review of historic evolution of Ahmedabad's economic activity, existing land use and taxation policies were used to explain the formation of urban logistics networks and operations. Through expert interviews with private stakeholders directly involved in urban logistics, insights on the influence of these policies on their strategic business decisions were understood. Spatial data on land use, road networks and traffic restrictions was used to identify key routes and corridors where different commodity flows were estimated to move. Data from a cordon survey of freight vehicles that was carried out in 2006 was used to develop a static freight distribution model of commodity flows over the city's transport infrastructure. Congestion and accident hotspots due to freight traffic concentration were identified from the above analysis and possible options to mitigate these negative externalities were suggested.

The case study of Ahmedabad characterises the movement patterns of various commodities into and out of the city and identifies commodities whose transport have a stronger influence on the urban transport infrastructure. It indicates that existing zoning laws, tax policies, road network and time restrictions on HGVs impact supply chains, safety and traffic causing system wide inefficiencies. The paper concludes with a set of recommendations to address issues which could form a basis towards developing the city's first Freight Management Plan.

Keywords: urban, freight, land use, transport, policy

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INTRODUCTION

Urban freight transport is receiving growing attention in recent years in many cities world over because of increasing traffic levels, although much of the attention is directed towards passenger transport (Lindholm & Behrends 2012). In Asian cities including India, urban freight transport is getting little attention in policy documents or city management (Timms 2010). However, urban freight transport is important because efficient flow of goods is essential for the effective functioning of the urban economy and fundamental to sustaining our existing lifestyle (Stopher et al. 1977). This efficiency will determine the competitiveness of urban areas and impacts on the costs of products, energy consumption, environment, safety, security and resource use. According to (Oğuztimur & Çancı 2011) urban freight transport typically has an average share of 10%. With the expanding economic activities and globalisation of trade, efficiency and smooth movement of urban freight is becoming increasingly critical for sustained economic growth of the city.

Ahmedabad is the largest city in Gujarat and seventh largest metropolitan area in India with an estimated population of 5.5 million as per the 2011 census. The last decade has seen the highest annual growth rate of 4.7% due to expansion of peripheral areas and sustained economic growth. The city is the administrative centre and financial capital for the state contributing a share of 3.6% (\$16 billion) to the country's GDP. Ahmedabad is divided by Sabarmati river into two physically distinct regions. The east bank comprises the old city area and the west part characterises educational institutions, modern buildings and new retail and commercial centres. The city has witnessed continuous growth in population over the past 4 decades in area and population density.

Table 1: Decadal growth in area and population density – Ahmedabad Municipal Corporation

Year	Population in millions	CAGR
1981	2.16	
1991	2.88	2.9%
2001	3.52	2%
2011	5.56	4.7%

Source: (AUDA 2012)

Taking Ahmedabad as a casestudy, this paper attempts to understand urban logistics activities and linkages between land use activities and urban freight transport. In the process, the paper analyses the trends in urban freight vehicles movements, assesses the location and impacts of freight generators on the neighbourhood and network, and summarises the issues to be

addressed as part of the city's first freight management plan. The paper concludes with recommendations for better managing urban freight movement in Ahmedabad through land use and transport planning measures.

SCOPE & METHODOLOGY

For the purpose of this paper, urban goods or freight transport is defined the delivery, pick-up or both of goods (from retail and manufacturing sectors) within the city of Ahmedabad¹. The urban freight movements are classified as follows:

1. External Flows (External – External (E-E)) include movements which have both origin and destination ends outside the urban/study area.
2. Inter Urban Flows (External –Internal (E-I) Or Internal – External (I-E)) include movements which have either origin or destination outside the urban/study area
3. Intra-Urban Flows (Internal-Internal (I - I)) include movements which have both origin and destination within the urban/study area

The scope of the study was on the assessment of goods flows into the city by road only and hence focussed on the analysis of external and inter-urban freight vehicle movements. Relevant quantitative data on Ahmedabad city's urban freight flows is not available, therefore the results are based on a classified volume count data survey carried out by CEPT in 2006. Classified volume count surveys were conducted for a period of 24 hours for 3 days in both directions of traffic flows at 8 entry points of Ahmedabad along the SP ring road. The details include quantum of inflows and outflows; aggregate as well as by direction, by commodity and type of vehicle. This was supplemented by road side interviews, field observations and discussions with stakeholders which provide an understanding of freight mobility patterns and insights into existing issues.

FREIGHT FLOW ANALYSIS IN AHMEDABAD

The survey revealed that around 34,000 trucks per day enter or exit Ahmedabad through 8 major entry/exit points (Swamy & Sharma 2007). Assuming 6% compounded annual growth rate, presently 48,200 trucks/day are estimated to enter/leave Ahmedabad. Of these, about 29% were internal to external trips and 34% of truck trips were external to internal trips (inflows). A significant number of trips are on transit (37% of total freight trips) add to the

¹ Freight generators of significance are not located within Gandhinagar area and hence not included in the analysis.

urban freight mobility within the city (See Figure 1). In terms of citywide urban freight transport efficiencies, 60% of the trucks run with full load, 10% of the trucks ply with half load and 27% of the trucks involve empty runs. This is comparable to the UK figures where empty run of HGVs over a period 1984-2007 fell from 31.4% to 27.4% (J. Allen & Michael Brown 2010).

A majority share of freight traffic (64%) is carried by heavy goods vehicles (HGVs) which constitute 2-Axle, 3-Axle and MAV vehicles (See Figure 2). These vehicles have restricted access to the city centre during specific times of day as explained in the later sections of freight management measures.

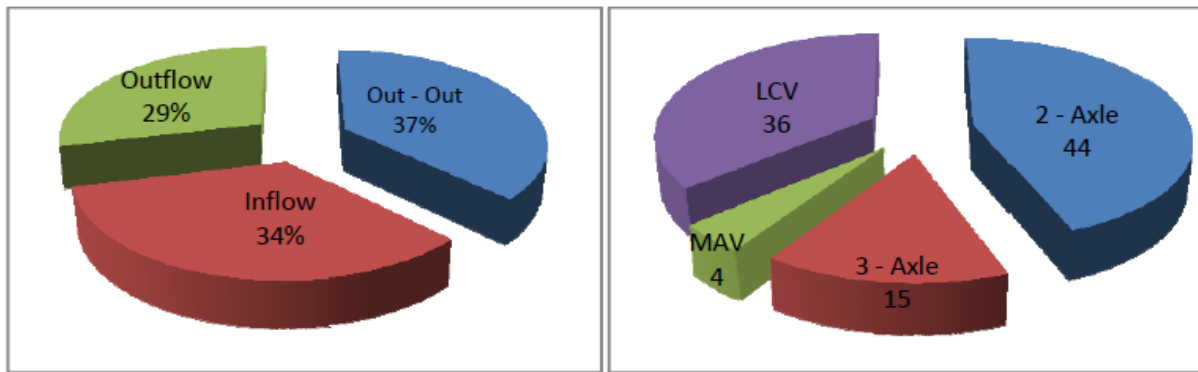


Figure 1 Goods vehicular trips (%) by direction of flows in Ahmedabad

Figure 2: Goods vehicular trips (%) by type of vehicles in Ahmedabad

Freight flows by commodity type

In terms of commodity trade, the origin-destination of trucks indicated that construction materials, food grains, textiles, industrial products, oil and products, and consumer goods were predominant goods traded in Ahmedabad. In terms of exports, the commodities remain same. In case of consumer products, construction material, oil & products and textiles, import is much more than exports. In others import and exports are more or less balanced. This suggests that a significant proportion of truck movement occur for distribution purposes rather than consumption within the city.

Figure 3 shows the major destinations by commodity type of freight vehicles entering Ahmedabad. Clear demarcations by commodity types indicate that urban freight activities within and around the city induce freight vehicular movement in that direction. For example, Jamalpur, Kalupur and Madhupura located near the city centre are the main destinations for agricultural products as major wholesale markets are located there. While Sarkhej on the south western part, Narol, Odhav and Vatva are located on the eastern periphery and Sarkhej

on the south western side form dominant destinations of construction, industrial products, chemical supplies and consumer goods.

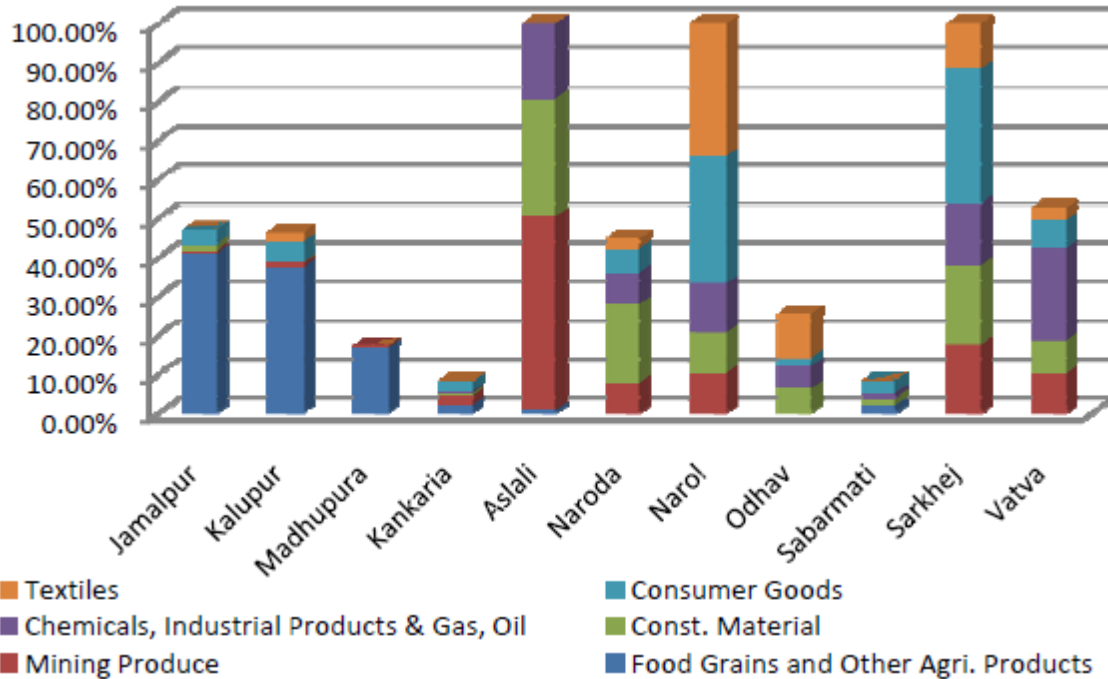


Figure 3: Origins/destinations by commodity type in Ahmedabad

It is also observed that Aslali is a major location with over 1000 trucks coming from long distance and another 1500 trucks coming from other districts of Gujarat. Rajkot and Sanand, considered together, forms second major direction for locating transport parking. Third location in terms of volume of truck mobility is Adalaj. As mobility from these four directions is large, the need for distributions centres would have to be analysed on these corridors/directions.

URBAN FREIGHT GENERATORS

The urban freight generators are the consolidated or individual endpoints that generate or receive freight flows. Their distribution over space was based on data gathered from Ahmedabad Municipality’s property tax data for 2011, CEPT report of 2007 (Swamy & Sharma 2007) and roadside interviews. The major freight generating activity areas in Ahmedabad city were classified as factories & industries, transporter & warehouse clusters and trade centers. Using property tax data, the freight generating activity areas were spatially mapped to identify location patterns and concentration of activities as shown in Figure 5.

Factories & industries

There are about 55,000 properties identified as factory units in the city. The properties are concentrated in fewer numbers of industrial clusters (See Figure 5). These clusters were developed by Gujarat Development Corporation (GIDC) at Naroda, Odhav, Vatva, Rakhial and Behrampura. Each cluster is specialised in specific manufacturing sectors. While there are a few large scale units within each cluster, majority of them are small and tiny units spread over the eastern part of the city. Some are organised as small estates developed by the private sector, while others are large independent units. Amongst these clusters, Vatva, Naroda and Odhav are the largest clusters in terms of area occupied and number of manufacturing units (See Table 2). The o-d survey indicated that the three estates Naroda, Vatva and Odhav together attract over 1,500 trucks/day of which Vatva and Naroda attract about 600 trucks each/day.

Table 2: Largest 3 GIDC estates in Ahmedabad

GIDC Estate	Area occupied	No. of manufacturing units
Vatva	528 Ha	2,500
Naroda	337 Ha	850
Odhav	127 Ha	1,200

Transporter & Warehouse clusters

The city has 29,000 properties occupied under transport and warehousing activities. As expected transport activities are largely concentrated in the outskirts of the city. Aslali and Sarkhej are the major hubs of transport activities (See Figure 5). Some transport activity concentrations exist in Narol, Isanpur and Kalupur. Sabarmati and Kankaria are rail based concentrations.

Table 3: Transport and Warehousing Concentrations – Goods Vehicular Flows

Warehouse/Terminals (Road & Rail)	Vehicles /day	%
Aslali	2180	6.3%
Sarkhej	1133	3.3%
Narol	755	2.2%
Total	4313	12.5%

Aslali, located on the National Highway 8 in the southern part of Ahmedabad is a major transport hub with about 500 godowns and 800 transporter offices. Until the abolition of octroi duties, Aslali was the preferred private warehousing location for private companies because it was located outside municipal city limits. This area developed linearly along the

highway upto 500 meters laterally on either side of the highway.

Sarkhej is located on the south - western part of Ahmedabad. Like Aslali, this area was also developed by private sector as a facility outside city limits to avoid octroi payments. However, with the expansion of the AMC limits, Sarkhej is within the AMC jurisdiction. There are about 300 godowns and 500 transporter offices located in this locality. Narol is an extension of Aslali and much of the warehousing and transport related activities are being done along the highway.

Daily vehicular flows from Aslali and Sarkhej to the city approximate to 2,180 trucks and 1,133 trucks/day (See Table 3). Most of the goods are transhipped into smaller vehicles and delivered by LCVs into the city to avoid traffic restrictions. Wherever consignments are large, HGVs are hired and planned delivery to city areas takes place.

Trade Centres

The property tax data revealed that there are over 200,000 shops and establishments in the city. The wholesale and semi-wholesale markets near city centre generate the highest proportion of vehicular movement in the city (See Figure 5). Hence, the focus is on major concentrations of wholesale/ distributive trades. Entire inner city core is walled and has a vibrant market area where both wholesale and retail activities co-exist. The five wholesale markets around the walled city attract around 1,500 goods vehicles/day (See Figure 4).

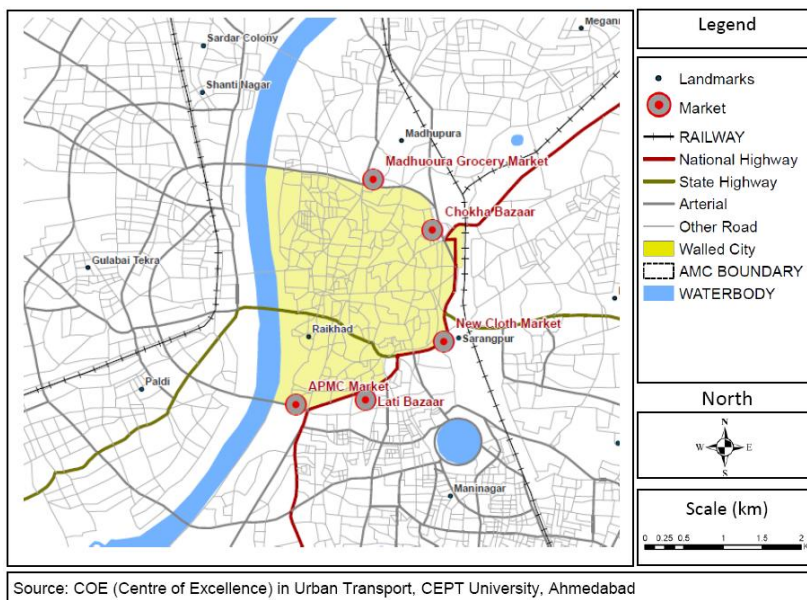


Figure 4: Location of Market near Walled City

1. The APMC market at Jamalpur is located on a site measuring 14,923m². It serves as the main distribution centre for fresh vegetables to semi-wholesale /retail markets. The market operates for 24 hours. Daily average arrivals of vegetables are about

20,000 quintals. Another APMC market at Vasna is a wholesale market for onion and potato distribution. There are total 221 shops in this market which operate from 6 am to 6 pm. On an average 120 trucks bring commodities into the market. Infrastructure facilities like parking bays, loading-unloading platforms, communication, etc. are available within the premises.

2. The Madhupura grocery market has approximately 250 godowns and receives goods from all over the state. The market attracts around 50 trucks/day which is small number compared to other wholesale markets. The lack of storage capacity and poor condition of the godowns is a concern for city authorities.
3. The new cloth market, located near Kalupur railway station has 302 wholesale textile agents operating within the market premises. The new cloth market does not provide any large storage place within the premises. All the storage and loading-unloading activities takes place outside the walled city area mainly in Aslali and Piplaj area, hence does not generate significant freight traffic to the inner city. Some storage facility is available within the premise mainly to keep the samples. Chokha Bazaar, also located near Kalupur railway terminus, has fresh vegetable wholesale and semi-wholesale market and houses offices of food grain brokers and transporters.
4. The area around Chokha bazaar accommodates smaller wholesale markets (bazaars) for sale of ghee, oil and dry fruits market. The market functions from 10 am to 8 pm. HCVs are permitted during night times. It is everyday sight that during the restricted time trucks remain parked for the entire day. At present, the closed mill lands are used as godowns, in defiance of GDCR zoning which does not permit location of godowns within the old city areas
5. The Lathi Bazaar is another private market in the inner city. Currently there are five lathi bazaars. The market functions from 10 am in the morning to 8 pm and truck are allowed to enter only at night, while they leave in the afternoons.

The markets near the walled city attract large number of trucks which easily exceed more than 1,000 HGVs and a large number LCVs on a daily basis, which add to the traffic problems in that part of the city. The traffic conditions have been very severe inspite of existing efforts by city authorities through route and access regulations on larger freight vehicles.

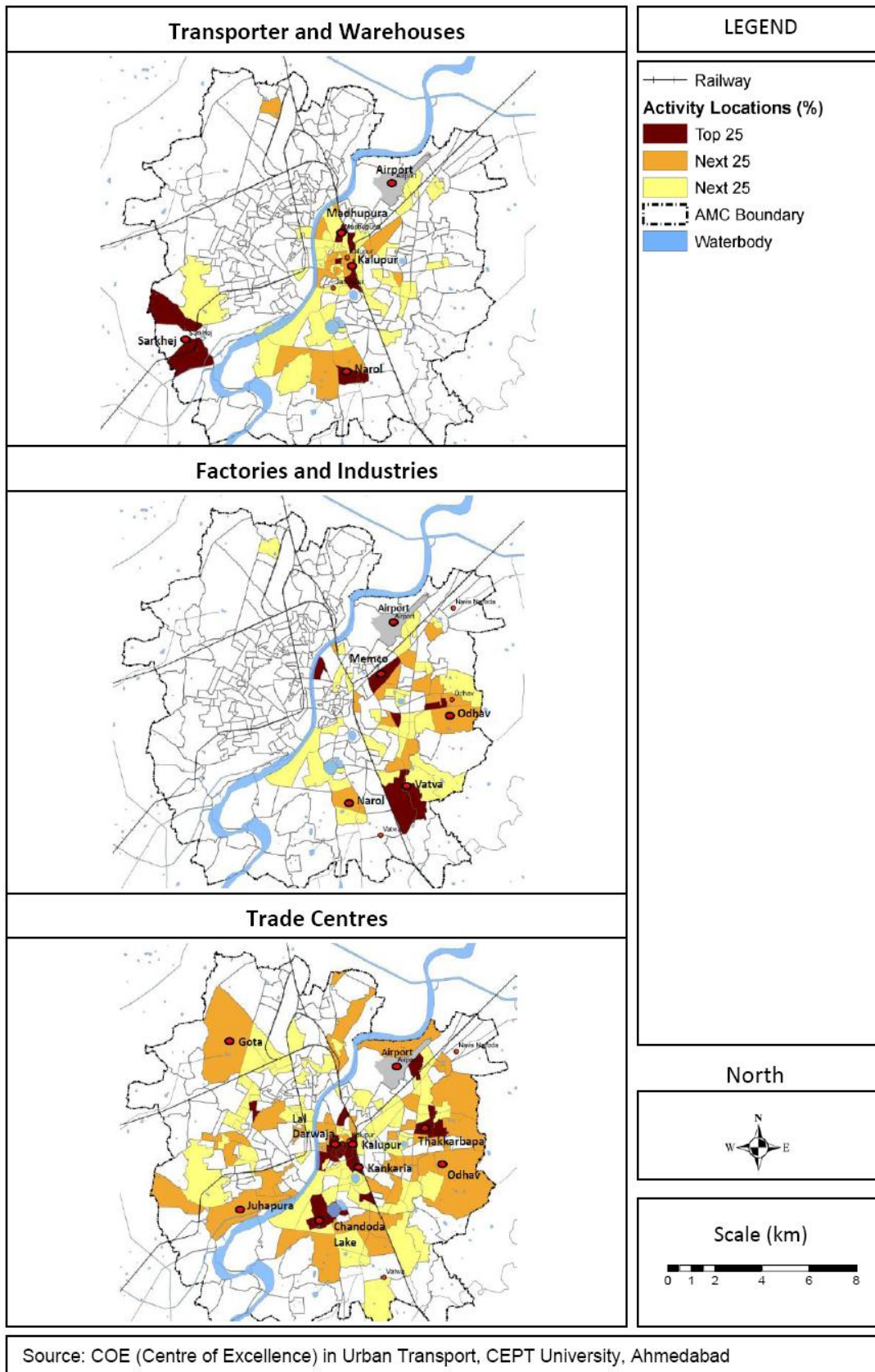


Figure 5: Location of urban freight generators in Ahmedabad

EXISTING FREIGHT TRANSPORT MANAGEMENT MEASURES

Essentially freight movement is governed by land use (and related development Control Regulations) decisions in terms of location of production, storage and distribution facilities, and road network design and related regulations. Historically, the city walls defined the limits of the city and wholesale markets were then allowed to develop just outside the walled city area. In the past few decades, as the city steadily expanded and urban sprawl increased due to sustained high economic growth, the wholesale markets became part of the inner city area. At present, these wholesale markets continue to exist and are occupying prime lands adjacent to the old city.

Urban freight movement in Ahmedabad is primarily governed by regulations relating to transportation and to a limited extent by way of creation of transport related facilities by the municipal corporation. Additionally, freight movement is governed by traffic police regulations in terms of facilitating mobility- including assigning routes and timing of movement.

Urban Freight Routes and Time Zones

In Ahmedabad, urban goods transport planning, management and enforcement is carried out by city traffic police department. This authority regulates entry and exit of freight vehicles by imposing time restrictions on goods vehicular flows. The map below indicates the time zones and the roads on which freight vehicles are permitted. While time restrictions are imposed only on heavy commercial vehicles (MAVs, one axle and multi-axle HGVs), no time restrictions limits on movement of light commercial vehicles (LCVs) exist. Zones are classified into three types:

1. No restriction zone: On these roads trucks are allowed to ply all through the day
2. 9 pm to 9 am delivery: On these roads, trucks are allowed to ply between 9 pm to 9 am².
3. 12:30 pm to 4:30 pm delivery: On these roads trucks are allowed to ply between 12:30 pm to 4:30 pm.

As indicated in Figure 6, HGVs are allowed to ply on the outer ring road and on the Naroda-Narol National Highway all through the day and night. HGVs are allowed to access the city centre during night hours (9 pm to 9 am) and also during the afternoon hours (1 pm to 4pm).

The effectiveness of these measures to mitigate excess traffic and encourage better organisation of freight vehicles are debatable. On the one hand it restricts entry of HGVs during peak hours of the day has a positive impact, the night entry of the HGVs into the city

² Recently Ahmedabad Police Commissioner has issued a notification extending the restriction hours. Trucks are allowed between 11pm to 7am & 1 pm to 4 pm.

force them to be parked for extended periods of time as most wholesale markets are open during the daytime only. Secondly, most of the HGVs receive return loads from the city centre for deliveries elsewhere and therefore these vehicles are encouraged to park at available parking spaces in the neighbourhood of the markets. Frequently, it was observed that the severe shortage of legal parking areas in the city center force them to park on the main roads. This parking behaviour not only attracts fines from traffic police but also further reduces the right of way for traffic flow in the already congested roads in the city centre.

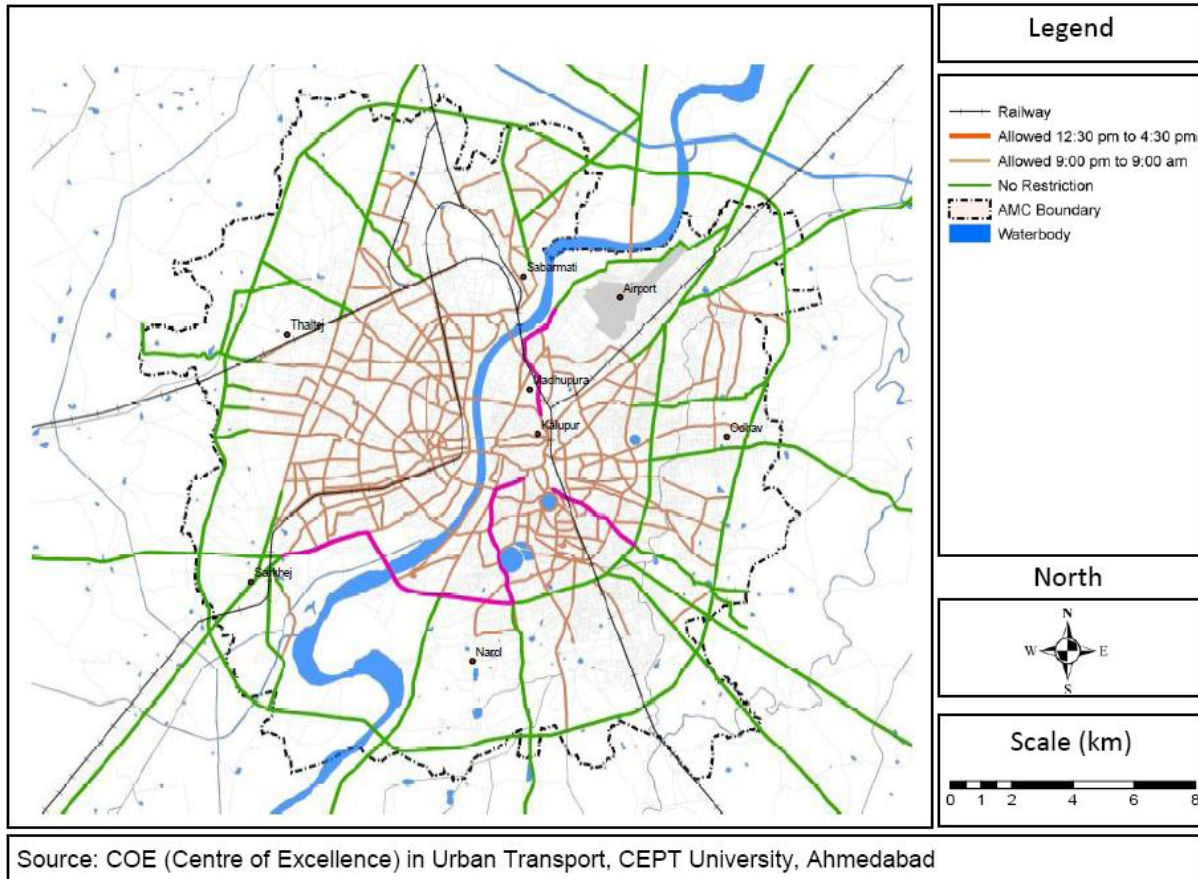


Figure 6: Ahmedabad Freight Routes & Time Zones

URBAN FREIGHT FLOW ISSUES

The stakeholder interviews and primary surveys indicated several issues of freight movements in Ahmedabad. The main issues were as follows:

High congestion levels and long waiting time

The hourly variation of goods vehicular traffic at the cordon points show that the inflow/outflow are large during the day and seems to peak around the passenger traffic peak period. The flow of HGV trucks in and out of the city is generally uniform throughout the day

except during the period 10.00 pm to 6 am (See Figure 7). HGVs that enter the city area before time restriction period (between 9 pm – 9 am) and are not loaded / offloaded before time restriction take effect, are forced to park till 9 pm on the city roads due to limited organized parking space availability within the estates or wholesale market areas in the city causing immense traffic and transport problems.

Essentially, on all roads with unrestricted access for LCV vehicles, the flow is high all through the day averaging 400 trucks/hour. From Figure 8, the entry of LCVs into the city have 2 peak periods – once during morning when the markets open and once in the evening before the markets close for the day. The congestion effect on streets of LCVs that enjoy unrestricted access is visible. The overall proportion of goods vehicle ranges from about 13-14% of the total vehicular traffic in the city. This number, though a small proportion, in terms of absolute numbers, is quite significant. During the peak hour there are more than 110 trucks plying in one direction, i.e. a truck every 50 seconds. This adds to congestion and also to safety and security issues.

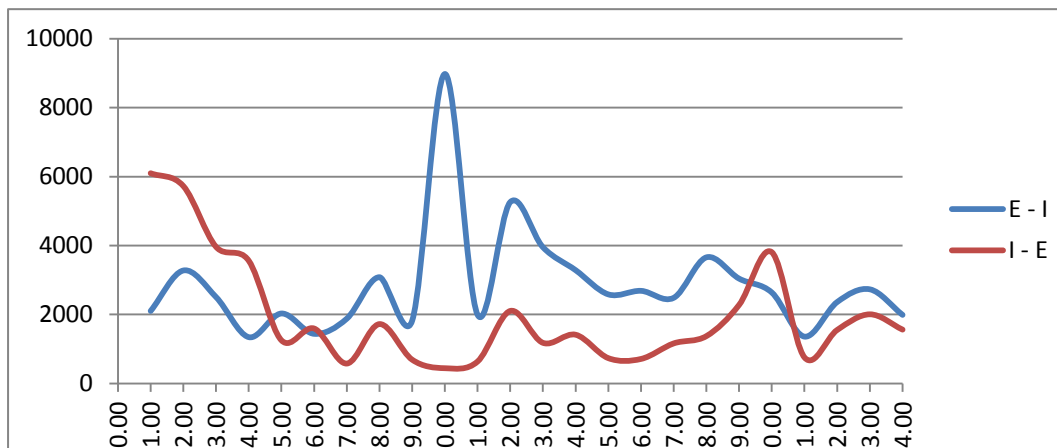


Figure 7: HGVs entry at cordon points by time of day

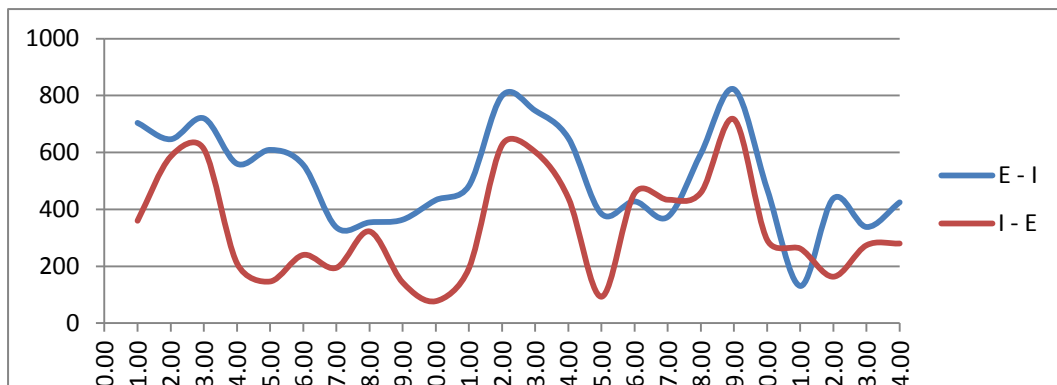


Figure 8: LCV entry at cordon points by time of day

Due to lack of real time information on truck movements and availability of consignments, the freight traffic has been inefficient. Shippers and transporters rely on a large number of

transport agents that match demand and supply. The system is at best adhoc and arbitrary, using mobile communication to connect shippers and transporters.

Land use conflicts in the old city area

The suitability of each market and industrial location with respect to land use has changed over time resulting in land use activity and transport conflicts. The five major markets along with ancillary activities such as warehousing and transport agencies in and around the old city attract over 1,500 trucks every day. Besides the regional railway station as well as regional bus station, two urban bus terminals are also located in this area. Over and above these, about 1,000 handcarts ply in the area carrying textile products, grain etc are major players in local distribution. Accumulation of all of these activities has caused large freight flows and congestion. Traffic problems are further compounded by haphazard parking, of buses, auto-rickshaws and goods vehicles on the existing narrow roads in the old city. Besides loss of comfort to the road users, the impact is also high on the air quality.

Existing wholesale markets in the old city and its periphery of Ahmedabad were developed many decades ago through the initiative of the municipality or local trade associations of respective commodities on municipal land/private land outside the walled city. The markets were developed and rented or leased to traders of the respective trade associations at prevailing rates. The prevalent Rent Control Act effectively put a ceiling on the increase in rent rates over time and has protected the traders from eviction making traders defacto owners of the property. The low rent levels have discouraged routine maintenance of the built up spaces in the market areas resulting in gradual dilapidation of the infrastructure in and around the existing market areas. Zoning laws have also not changed ever since the markets were constructed with the result that this prime land continues to be put to sub-optimal land use, viz. wholesale markets and warehousing. As these activities continue to operate from these areas, entry of freight traffic has become inevitable to these areas.

Lack of freight facilities in industrial areas of the city

All the industrial estates/areas excepting large units, are devoid of any freight facilities such as loading/unloading areas, parking, warehouses, transporters' offices, rest rooms, canteen etc.,. Loading and unloading happens on the road side and is dependent on availability of labour as well as on-road parking space adjacent to the shipper's commercial establishment. Due to the lack of sufficient parking space, truck loading/unloading activities spill over to the entire Naroda-Narol highway, ring road and the inner streets disturbing smooth flow of passenger traffic and residential localities.

The lack of properly planned transport terminals, warehousing sites has led to unplanned growth of such facilities at Aslali and Sarkhej. Most of the private warehouse facilities had sprung up to avoid octroi duties and have ever since continued to exist even after they are

within municipal limits. Most of these private freight facilities lack good access, paved roads and proper road design causing major problems.

Non-availability of parking spaces for trucks, lack of security (rising cases of theft of fuel and goods) are some of the other concerns highlighted by the users in these areas. As there are many small players operating in an unorganized manner, coordination problems exist resulting in longer waiting time to get return consignments. It is estimated that around 35% of the trucks return empty and the average waiting time for the truck for consignment to the city is 1-2 days. This justifies the need for establishment of transport terminal and better organisation for matching demand and supply.

Road safety problems

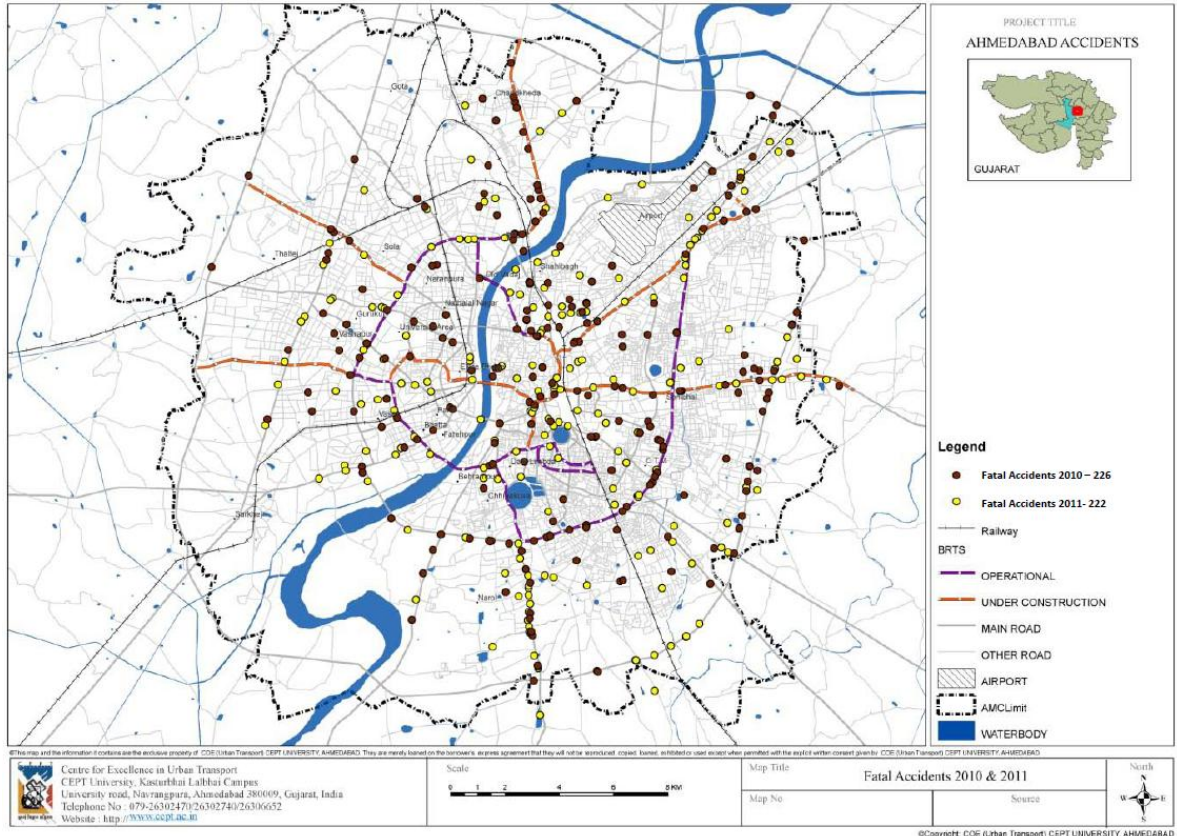
The urban freight corridors pose potential safety hazards to urban inhabitants. Due to the large size of vehicles, large loads the severity of accidents generally tends to be very high. Accident data of 2010 and 2011 for Ahmedabad city has confirmed this. Although the total number of accidents has reduced by 25% to 2,020 in 2011, they are still very high to international benchmarks (See Figure 9). Nearly 30% of the accidents involve freight vehicles. Mapping of the accident spots show that urban freight corridors are more prone to accidents. As seen in the maximum road accident rates occur on Narol-Naroda road and radials leading to the old city area where freight traffic conflict with passenger flows. Poor road and footpath design, narrow right of way, lack of road maintenance and signages have been identified as causes for high fatalities in the old city area.

Vatva and Odhav industrial estates get access from the Narol-Naroda ring road. Because of this, trucks bound for these industrial estates have to enter Narol-Naroda ring road to enter these GIDC estates. The prevalence of high passenger traffic and pedestrians on the Narol-Naroda ring road has contributed to the incidence of high road fatalities on this ring road (See Figure 10).

Excess costs of deliveries to old city area

For goods vehicles entering the old city a number of issues influence the efficiency of their operations that lead to additional costs termed here as excess costs. A few studies attempt to measure full costs of urban freight transport (Govinda Hari & Timilsina Dulal 2011)(Mayeres et al. 1996). For this study, excess costs per trip was defined as the difference in total transport costs for delivery to markets in the old city to the delivery to hypothetical markets located on the city's periphery. To estimate the excess costs incurred per trip a random survey of 93 truck drivers entering the old city was carried out to characterise the excess costs incurred by transport operators for pick up and deliveries of goods to the old city by vehicle size and o-d distance. From interviews with truck drivers, excess costs were observed to be caused by:

- Time losses due to access restrictions to HGVs for inner city access, road congestion and waiting for return loads
- Extra runs in the city to find parking space close to shippers' commercial spaces in the old city
- Empty runs due to lack of return loads originating from city.



- **Figure 9: Location of fatal accidents in 2010 & 2011 (Swamy & Bhakuni 2011)**

Truck drivers are levied fines for a variety of offenses such as driving without valid permits, driving licences, overloading, illegal parking, talking on mobiles while driving, etc. Interviews with truck drivers revealed that bribery to the enforcement agencies patrolling in the city is common to escape harassment, fines and legal action. Costs to the transporter due to payment of bribes amounts to considerable sum and vary from one trip to the other.

The survey (Maniar 2012) made an effort to measure excess costs incurred by transporters if they enter old city. The survey observed that all goods vehicles entering the old city incur excess costs averaging approximately 23%. However, excess costs vary depending on whether the trip is a short or long haul trip or are involving LCV, MCV or HGV. Long distance trips by HGVs & MCVs incur higher excess costs when compared to short haul LCVs.

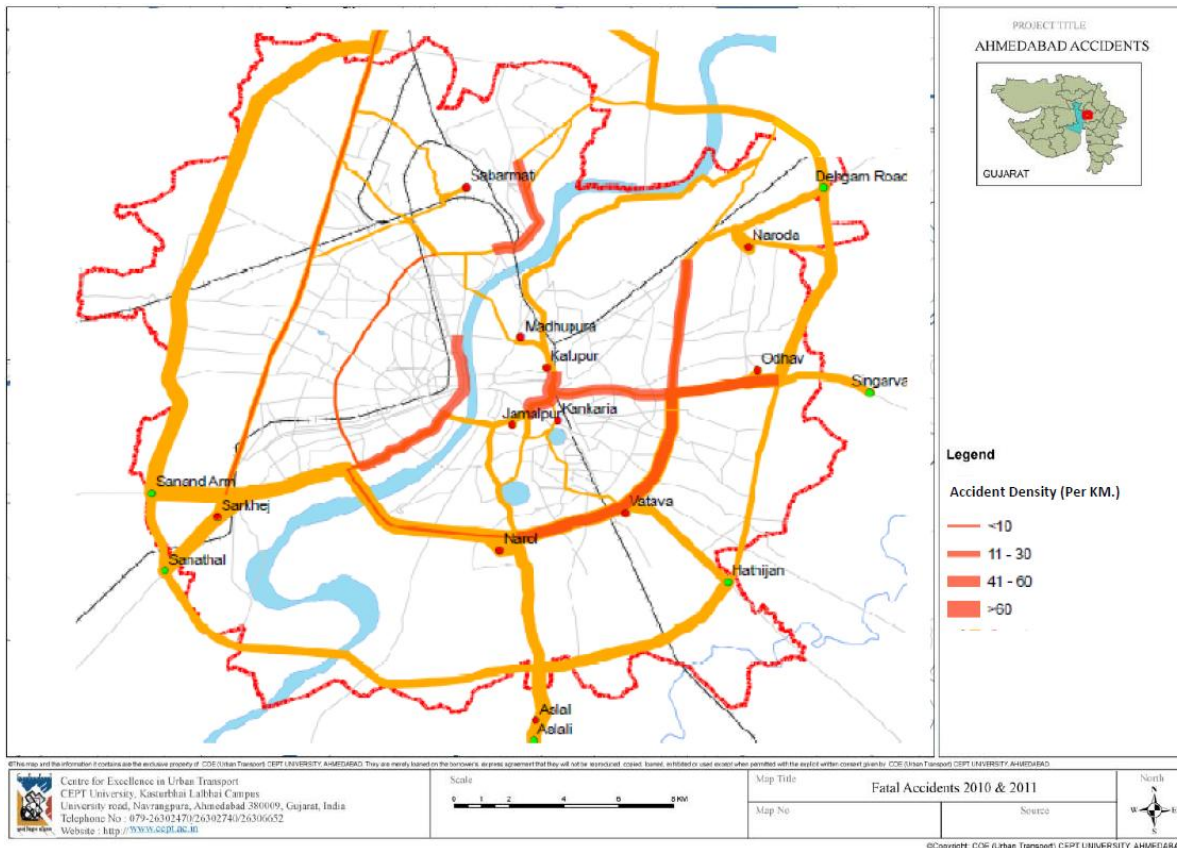
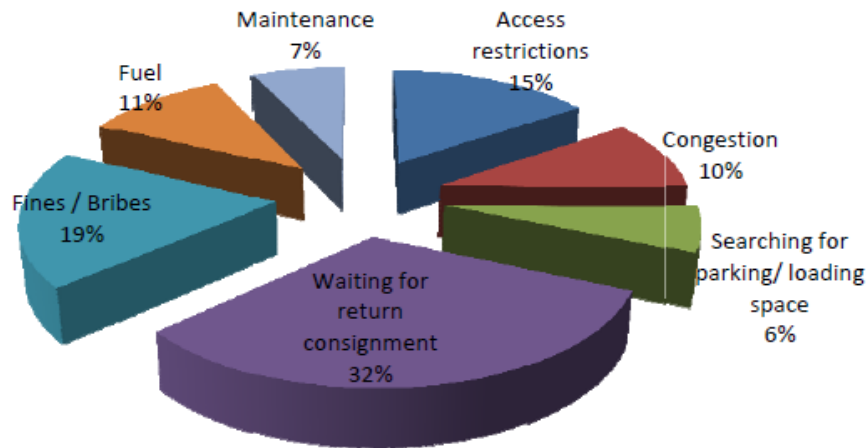


Figure 10: Accident rates per km in Ahmedabad (Swamy & Bhakuni 2011)

Figure 11 shows the breakup of average excess costs per trip imposed on vehicles that deliver in the Ahmedabad city markets. It indicates that waiting time for return consignment contributes to a third of the excess costs per trip to the city markets for the transporters. Sometimes, shippers reimburse truck waiting charges for return consignments for long distance trips. Fines and bribes paid by transporters to enforcement agencies in the city constitute the second most significant excess cost for the transporters per trip. Although it is in the interest of all stakeholders to avoid fines and bribes, the existing conditions of lack of adequate parking infrastructure and pressure from shippers to deliver during day working hours force operators to resort to illegal parking and infringement of access restrictions.

Other time related costs due to waiting times outside city during time restrictions or congestion delays during entry/exit to city markets or additional runs to search for parking together contribute for a third of the excess costs. Better planning of vehicle entries to the outskirts of Ahmedabad could help avoid or mitigate the latter excess costs. Appropriate market incentives to change the behaviour of transport operators for better planning of their trips will be effective in this scenario. Secondly, the substantial increase in excess costs of deliveries to the city markets offers a sound argument to relocate some or part of the wholesale markets presently located in the city centre to the periphery either in totality or a part of it.

Figure 11: Excess cost breakup per trip of HGVs entering the Ahmedabad's wholesale markets



Source: (Maniar 2012)

RECOMMENDATIONS

With the objective to improve freight mobility and efficiencies in urban logistics as well as segregate freight and passenger traffic to prevent road accidents, a number of strategies have been recommended for Ahmedabad. The strategies have been developed contextually and are specific to the freight generating areas. They are as follows:

OLD CITY AREA

In order to address the issues of congestion and excessive waiting time of HGVs in the old city as well as limit the intrusion of HGVs in the old city, 2 specific strategies have been proposed. A short term measure to further restrict entry of HGVs to the inner city and encourage better efficiencies in freight movements is to further restrict entry of HGVs during daytime by discontinuing off-peak time zone (from 1 pm to 4 pm) as traffic on many of these streets is high even during afternoon hours.

In the long term, the freight activities in the existing market areas in the old city are forecasted to increase. The adverse impacts of freight movements in old city such as congestion, noise, air pollution and safety are already major issues. Built structures in the market areas and their surroundings are dilapidated and pose threat to those living in the area. Moreover, efforts by city authorities and citizens to conserve historical resources and preserve the area are underway. The study therefore recommends declaring the entire old city area as a Heritage site and demarcates it as a pedestrian friendly zone. To limit the intrusion of freight activities and related traffic in this area, it is proposed to encourage wholesale markets especially, wood, vegetable and grain markets to relocate outside the city as it does

not contribute to the heritage theme of the old city. On the other hand, retail activities, handicrafts and small scale manufacturing businesses that add value to the tourism sector should be encouraged to develop there. Supportive measures to encourage use of cleaner fuel driven vehicles for local goods transport during off peak hours and provisions for restoring and improving the built environment should be simultaneously encouraged.

INDUSTRIAL ESTATES

Naroda, Narol and Vatva industrial estates are accessed through Narol-Naroda highway. Developing direct access with appropriate design standards from the ring road to these three industrial areas is recommended. The recommendation is to design and build a direct and dedicated access road for each of the estates to connect them from the adjacent highways and expressway for the seamless movement of freight vehicles. This will significantly reduce conflicts between passenger and pedestrian travel with freight activities, eventually mitigating the risk of road accidents caused by freight vehicles.

Long haul trucks need legal parking spaces and facilities for truck servicing. Therefore it is recommended to allocate land for developing Truck Terminals at each industrial estates above a particular size.

SARKHEJ & ASLALI WAREHOUSING FACILITIES

Freight facilities at Sarkhej and Asali, lack common amenities and facilities and most of the development have been happening in an unorganised manner. Therefore it is proposed to develop an area plan which would redevelop these two sites in an appropriate way. Similarly for Sarkhej, haphazard private development of warehouses has resulted in many traffic and transport related issues such as rise of accidents, theft and parking problems in this area. For Aslali and Sarkhej, it is recommended to develop a transport plan for the area that should focus on building adequate access roads linking national highway to the private warehouses.

To improve the overall efficiency in freight vehicular movement and better match transport demand and supply, the use of an information communication system is proposed. This would provide trucks at entry point of the city, information on availability of parking facilities in the industrial estates, optimal routes to follow, latest information on traffic conditions and information on return shipments in the city. Such a system would reduce idling time of trucks in the estates. Also, would provide truck drivers to plan their entry into the city based on demand and availability of parking slots. For this initiative to succeed, it will be important for stakeholders like AMC, market committees and transporters to actively participate.

CONCLUSIONS

The paper investigated urban freight flow vehicular movements in Ahmedabad's urban areas to understand the pattern and intensity of freight flows. Findings were that a third of the trucks entering city limits constituted transit traffic that used the city's road infrastructure and added to the city traffic. In terms of total urban freight inflows and outflows, there was a relatively good balance of goods entering and leaving the city which is unlike most large cities in India. Thirdly, a significant amount of goods traffic entered the old city area causing immense traffic problems to the city at large. In spite of existing traffic management measures of access restrictions, congestion and traffic accidents have been on a steady rise involving freight vehicles.

The analysis of freight generating areas indicated that wholesale markets in the old city areas, industrial estates and warehousing facilities near the city's periphery contribute to the majority of goods vehicular trips. From the accident data of 2010-11, it was found that radials leading to the old city area and Narol-Naroda ring road had the highest incidence of road fatalities involving goods vehicles. Though it was argued that wholesale markets need to be relocated from old city areas to the city's periphery because of high excess costs and accident data, the complex land ownership rights and existing regulations would pose as major barriers for this to be implemented.

The 3 largest industrial estates (Vatva, Naroda and Odhav) do not have direct access roads from the highways and therefore are forced to use the ring road that has a high passenger and pedestrian traffic. This has been an important reason for the high occurrence of traffic accidents involving freight vehicles on the Naroda-Narol ring road. Hence it was proposed to provide direct connectivity through access roads from national highway – 8 to these estates.

The transshipment of goods onto smaller vehicles at city's periphery and dependence on transport agents to match freight transport demand and supply add to considerable logistics inefficiencies due to empty running and add to the traffic volumes and congestion levels on the city's networks. Therefore a recommendation was towards developing a citywide freight traffic communication and information system.

Parking capacity and management was also seen as a major issue in almost all freight generating areas. In the 3 largest industrial estates and Aslali, the development of truck terminals was proposed to cater to the parking needs and vehicle servicing requirements especially for long haul trucks.

Although these above recommendations are more of possible strategies, they would have to further investigated in the context of existing regulations, resources and stakeholder consultations. This will be the future direction of ongoing research in this area.

- P6 : You present the number of manufacturers by area. It could be interesting to detail the types of industries, because some industries send more shipments than others. Do you have the same data for the wholesalers or distributive trade?

???

- What is the part of rail in Ahmedabad's urban freight?

???

- P.11 : Problem with the map, the colours of the legend doesn't match with the map.

Do we have another map in COE. I dont seem to have it with me.

- □□P.12 : the figure7 titles "HGVs entry" but there is also exits because there E-I flows. Why the curve of E-I flows is almost higher than I-E flows? Is there different routes?

This is especially true for LCVs, and I cannot think of a convincing answer except that empty vehicles were not counted in the cordon survey. Thus implying that Ahmedabad has higher volume of consumption.

REFERENCES

- AUDA, 2012. City Development Plan - Ahmedabad. *Ahmedabad Urban Development Authority*. Available at: http://www.auda.org.in/library/auda_cdp.pdf [Accessed October 22, 2012].
- Govinda Hari & Timilsina Dulal, B., 2011. Urban Road Transportation Externalities: Costs and Choice of Policy Instruments. *World Bank Research Observer*, 26(1), pp.162–191.
- J. Allen & Michael Brown, 2010. Road freight transport and sustainability in Britain 1984-2007. *Green Logistics*. Available at: <http://www.greenlogistics.org/themesandoutputs/wm9/downloads/Sustainablefreighttransport-nationalfinal.pdf> [Accessed October 20, 2012].
- Lindholm, M. & Behrends, S., 2012. Challenges in urban freight transport planning – a review in the Baltic Sea Region. *Journal of Transport Geography*, 22, pp.129–136. Available at: <http://dx.doi.org/10.1016/j.jtrangeo.2012.01.001> [Accessed July 25, 2012].
- Maniar, A., 2012. *Impacts of intrusion of trucks in urban areas*. CEPT University, Ahmedabad.
- Mayeres, I., Ochelen, S. & Proost, S., 1996. The marginal external costs of urban transport. *Transportation Research Part D: Transport and Environment*, 1(2), pp.111–130. Available at: [http://linkinghub.elsevier.com/retrieve/pii/S1361-9209\(96\)00006-5](http://linkinghub.elsevier.com/retrieve/pii/S1361-9209(96)00006-5).
- Oğuztimur, S. & Çancı, M., 2011. Urban Logistics in Master Plan and a Review on Istanbul Master Plan. *Middle East*, pp.1–14.
- Stopher, P.R., Verkehrsexperte, P.R.S. & Meyburg, A.H., 1977. *Urban Transportation Modeling and Planning*, Heath. Available at: <http://books.google.com/books?id=9GCxQwAACAAJ&pgis=1> [Accessed October 18, 2012].
- Swamy, S. & Bhakuni, N., 2011. *Freight Management Plan in Ahmedabad*, Consultancy Report prepared for AUDA.
- Swamy, S. & Sharma, U., 2007. “*Interim Report for Transport Nagar*”. Consultancy report submitted to Gujarat Industrial Development Board (GIDB) by CEPT University, Ahmedabad.
- Timms, P., 2010. TURBLOG - D1-A worldwide overview on urban logistic interventions and data collection techniques.