



Informal public transport modes in India: A case study of five city regions☆☆☆



Megha Kumar*, Seema Singh, Akshima T. Ghate, Sarbojit Pal, Sangeetha Ann Wilson

The Energy and Resources Institute (TERI), Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi-110 003, India

ARTICLE INFO

Available online 14 January 2016

Keywords:

Informal public transport
Urban transport

ABSTRACT

Traditionally, the provision of public transport is considered to be government's responsibility. Due to resource and capacity constraints in developing countries, however, government-provided public transport is often inadequate; it is the privately operated public transport modes like shared auto-rickshaws, *Vikrams*, mini-buses, and *Tata Magics*, etc., that cater to the mobility needs of the population. This sector, however, is not sufficiently acknowledged for the important contribution that it makes toward mobility supply, in terms of both policymaking and city planning exercises. In addition, government authorities typically perceive these modes as unsafe, highly-polluting and a cause of traffic congestion as there is a complete absence of research and knowledge on these modes.

To address this knowledge gap, an empirical study on informal public transport modes was undertaken in five cities/city regions of India. This paper presents the results of this research study, which provides a stronger understanding of the operational characteristics, roles, and contributions of these systems in meeting the mobility needs of the people. The paper also discusses commonly held perceptions of how these modes relate to safety and pollution.

The paper highlights that these systems bridge a large transport supply gap and play an important role in Indian cities. The modes may follow some illegitimate practices, but they do it to become profitable, which in turn helps them provide the much-needed mobility services. The study also shows that these systems are not as unsafe and polluting as people often perceive them to be. However, there is significant room for improvements in terms of vehicle efficiency and compliance with regulatory provisions related to public transport.

© 2016 International Association of Traffic and Safety Sciences. Publishing services by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Rapid urbanization in developing countries has led to an unprecedented increase in demand for mobility services, which in turn has put tremendous pressure on urban transport infrastructure and services. Increase in supply of public transport services, in particular, has been slow and has failed to meet the mobility needs of the urban population due to several fiscal and institutional constraints [3].

India is no different from rest of the developing world. For an urban population of approximately 377 million residing in 7935

cities and towns (as of 2011), government-provided public transport services in the form of bus- and rail-based transport are present in only 65 cities [5,6]. All other cities in the country are dependent on walking, cycling, non-motorized transport, personal vehicles, and informal public transport services for meeting their mobility needs.

Even in cities where public transport is available, formal public transport services are often inadequate and unreliable, giving rise to the population's dependence on personal mobility options and informal public transport services for meeting their mobility needs.

Informal public transport services, as the term suggests, refer to public transport services that are provided differently as compared to the typical government-provided bus- and rail-based transport in cities.

Existing mostly in the form of shared services, informal transport modes use vehicles with seating capacity ranging from 3 to 20 people. These services are usually provided by private-sector entities, some of which do not comply with the government rules and regulations. The term is often used to refer to all public transport services that are not provided by government agencies [2,4]; the informality of each system in terms of compliance with regulations

* Peer review under responsibility of International Association of Traffic and Safety Sciences.

☆☆ The authors work at the Centre for Research on Sustainable Urban Development and Transport systems (CRSUD&TS), Sustainable Habitat Division, The Energy and Resources Institute (TERI).

* Corresponding author.

E-mail addresses: megha.kumar@teri.res.in (M. Kumar), seema.singh@teri.res.in (S. Singh), akshima@teri.res.in (A.T. Ghate), sarbojit.pal@teri.res.in (S. Pal), sangeetha.wilson@teri.res.in (S.A. Wilson).

on vehicle manufacturing and operations, however, could vary from mode to mode and city to city.

The existing literature highlights the important role played by informal public transport systems in meeting mobility needs by providing frequent, convenient, flexible, and affordable services that either complement the existing public transport systems or fill the gaps left by existing systems [1,2,3,6,8]. There are, however, several negative externalities associated with their operations, and these systems are commonly perceived as sources of traffic congestion, air and noise pollution, and traffic accidents [2,3,6,7]. The negative externalities, some of which may be more along the lines of common misperceptions than actual negative externalities, have created a common negative perception about these modes and thus led to a lack of adequate recognition of the contributions that these systems make in terms of meeting travel the demands of growing cities. The poorly understood cost–benefit nature of informal transport is the key factor behind why policymaking and plan-making processes generally ignore this sector [2,3]. Even when recognized, there is not enough information available on the subject to enable city authorities to make rational policy or planning decisions related to the sector. Informal modes are therefore either completely banned in view of the commonly held perceptions or left to exist in the background of city systems without much attention.

The current lack of policy attention and knowledge related to informal public transport systems indicates the need for policy research on these systems. This paper grew out of this need and had the dual objective of creating knowledge on the existing informal public transport systems in Indian cities and identifying the policy areas that need attention in order to address the sector's problems. The specific objectives were to study informal public transport systems in five cities in India – Amritsar, Jaipur, Noida, Ahmedabad-Gandhinagar, and Sanand-Viramgam – in order to understand the operational characteristics of these systems and the key issues associated with the ways that these systems operate in different cities or under different conditions. The end objective was to identify policy areas that need attention in order to improve these systems and maximize the associated mobility benefits.

2. Methods

We reviewed the existing literature to develop a robust research framework for the study and then selected five target city/city regions: Amritsar, Jaipur, Noida, Ahmedabad-Gandhinagar, and Sanand-Viramgam. The informal public transport modes in the five selected regions included high-capacity mini buses, medium-capacity *Tata Magics*, *Mahindra Gios* and other similar vehicles, low-capacity, three-wheeled, motorized auto-rickshaws, pedal-powered non-motorized cycle rickshaws, and other locally manufactured modes like

Chakdas and *Kadukas* (Table 1, Fig. 1). The following key components of these informal public transport systems were studied:

- Roles and contributions of informal public transport systems
- Vehicle characteristics (design and manufacture, etc.)
- Ownership patterns
- Operational characteristics
 - o Regulations governing the operations of the modes
 - o Area/zone of operation
 - o Routes and scheduling
 - o Fare structure
 - o Business model and profitability
- Concerns related to safety and environmental performance
- Mini bus: A small bus with a seating capacity of 20 passengers
- *Tata Magic*: A four-wheeled, van-like vehicle with a designed seating capacity of 7 passengers
- Auto-rickshaw: A three-wheeled vehicle with a designed seating capacity of 3 passengers
- *Vikram*: A three-wheeled auto-rickshaw/tempo-like vehicle
- *Mahindra Gio*: A four-wheeled passenger cab with open sides and a seating capacity of 6 passengers
- *Force Cruiser*: A large four-wheeled vehicle with a designed seating capacity of 13 passengers
- *Jeep*: A four-wheeled vehicle, usually with open sides/rear; operate well in rugged topography
- *Maruti Omni*: A typical urban four-wheeled van
- *Kaduka*: A locally manufactured four-wheeled vehicle that runs on diesel generator sets (generally used for irrigation purposes), has a rear passenger trailer made of wooden planks, and carries up to 20–25 passengers per trip (according to drivers)
- *Chakda*: A three-wheeled vehicle comprising a motorcycle chassis retrofitted with a rear trailer; carries up to 20 passengers (according to drivers)
- Cycle rickshaw: A tricycle running on pedal power; generally carries 2 passengers at a time

Existing official statistics and plans were reviewed but found inadequate in terms of providing detailed information on informal public transport systems. Detailed primary surveys were therefore conducted to collect information related to operations of these systems. Three types of surveys (targeting drivers, passengers, and other road users) were conducted in all five selected cities/city regions. Additionally, consultations were carried out with relevant stakeholders like fleet operators, fleet manufacturers, government officials (traffic police, transport departments, municipal corporations, and urban development authorities, etc.), NGO representatives, and academics. Reconnaissance surveys were also conducted to understand the penetration/routes and patterns

Table 1
Informal public transport modes studied in selected case study regions.

City/City region	State	Population (2011)	Informal modes	Setting
Jaipur	Rajasthan	3,646,590 ^a	Mini buses, <i>Tata Magics</i> , Auto-rickshaws, <i>Vikrams</i> , <i>Force Cruisers</i> , Jeeps, Cycle rickshaws	Urban
Amritsar	Punjab	1,132,761	Mini buses, <i>Tata Magics</i> , Auto-rickshaws, <i>Mahindra Gios</i> , Cycle rickshaws, <i>Kadukas</i>	Urban and peri-urban
Noida	Uttar Pradesh	642,381	<i>Tata Magics</i> , <i>Vikrams</i> , Auto-rickshaws, Cycle rickshaws	Urban
Ahmedabad-Gandhinagar	Gujarat	Ahmedabad: 6,352,254 ^b Gandhinagar: 208,299	Auto-rickshaws, <i>Maruti Omni</i> , Jeeps	Urban, peri-urban, and rural
Sanand-Viramgam	Gujarat	Sanand: 41,530 Viramgam: 55,821	Auto-rickshaws and <i>Chakdas</i>	Urban, peri-urban, and rural

Source (Population): Census of India, 2011.

^a Population of Jaipur Metropolitan Area.

^b Population of Ahmedabad Metropolitan Area.



Fig. 1. Photographs of typical informal public transport modes studied in the target cities/city regions (Left to right, top to bottom: Minibus, *Tata Magic*, Auto-rickshaw, *Vikram*, *Mahindra Gio*, *Maruti Omni*, *Jeep*, *Force Cruiser*, *Chakda*, *Kaduka*). Source: Photographs taken by the study team during field visits.

of operation of these systems. Structured observations were also undertaken by taking rides on these modes and conducting focused group discussions with drivers, union heads, and users in order to gather relevant information in each city. Given the nature of the methods used for the

study, qualitative data/information formed a significant input for the research in the absence of adequate data from official sources.

Drawing on the study's data and analysis, this paper discusses the key operational characteristics of informal modes in the selected

Table 2
Average fleet size held by a single owner.

Modes	Average fleet size held by a single owner
<i>Non-motorized modes</i>	
Cycle rickshaws	35
<i>Motorized modes</i>	
Low-capacity vehicles	1–2
Medium-capacity vehicles	1–2
High-capacity vehicles	2–4

Source: Surveys of drivers and operators of informal transport modes in the selected cities.

cities/city regions, their roles and contributions in meeting mobility needs, and safety and sustainability issues related to their operations.

3. Results and discussion

3.1. Types of vehicles operating as informal public transport modes

A wide range of vehicles was found to be operating as informal public transport modes. All the vehicle types, except for pedal-powered cycle rickshaws, were motorized and had different seating capacity. The vehicles fell into three distinct categories according to seating capacity: low-capacity vehicles with passenger seating capacities of up to 3 passengers, medium-capacity vehicles with seating capacities ranging from 4 to 10 passengers, and high-capacity modes with seating capacities of 10 to 20 passengers.

Low-capacity vehicles: Three-wheeled auto rickshaws with seating capacities of up to 3 passengers and manufactured by automobile manufacturing companies like Bajaj Auto Ltd., Piaggio Vehicles Private Ltd., and Atul Auto Ltd., etc., were commonly found to be operating as low-capacity informal public transport vehicles.

Medium-capacity vehicles: Both three- and four-wheeled vehicles with medium seating capacities of 4 to 10 passengers were found to be in operation. The three-wheeled vehicles included auto-rickshaws manufactured by Piaggio Vehicles Private Ltd. and Atul Auto Ltd. and *Vikrams* manufactured by Scooter India Ltd. and Mahindra & Mahindra Ltd. Vehicles like *Tata Magics*, *Mahindra Gios*, *Jeeps*, *Force Cruisers*, and *Maruti Omnis* were common makes in the medium-capacity four-wheeled vehicle category.

High-capacity vehicles: Mini-buses with seating capacities of 10 to 20 passengers and manufactured by automobile manufacturing companies like Tata Motors Ltd., Force Motors Ltd., and SML Isuzu Ltd. were found to be operating in different study regions.

All the aforementioned motorized modes are formally manufactured on production lines and type-approved in accordance with the required national automobile manufacturing standards and specifications. However, we observed that, in many cases, the operators retrofitted the vehicles with additional seats, handrails, and footboards, etc. to accommodate more passengers. An extreme case of retrofitting was found in the case of *Chakdas* operating in peri-urban and rural regions around Ahmedabad, Sanand, and Viramgam. Manufactured in a formal product line, a *Chakda* is an amalgamation of a motorcycle and a goods trailer: a high-mount vehicle with a motorcycle chassis and a rear carriage (like a trailer) to carry goods and people. Unexpectedly, *Chakdas*, which do not look like typical passenger or goods vehicles, were found to be legal in the study region and registered as three-wheeled light goods vehicles. Discussions with local authorities and manufacturers revealed that the vehicles are formally type-approved¹ by the authorized motor vehicle testing agencies as goods vehicles.

¹ Type-approval is a procedure whereby a government-authorized testing agency certifies that a type of vehicle, system, component, or separate technical unit satisfies vehicle fitness requirements and other relevant provisions of the Central Motor Vehicle Rules issued by the Government of India.

In addition to retrofitted vehicles, the study also identified vehicles that were locally manufactured in small workshops without any type-approvals or compliance with vehicle manufacturing standards and specifications. Locally referred to as “*Kadukas*”, these local vehicles were found operating in peri-urban and rural regions near Amritsar. A *Kaduka* is a four-wheeled vehicle manufactured in local workshops by using an irrigation pump for the engine and attaching a wooden trailer to it. Although these vehicles are used to carry both passengers and goods, they are not type-approved or registered with the local transport offices. *Kaduka* drivers stated the carrying capacity of the vehicle to be 15 to 20 passengers.

3.2. Role and contribution

Informal public transport modes were found to be playing crucial roles in meeting the mobility needs of the populations in all five cities/city regions. They provide mobility services for travel within and between urban, peri-urban, and adjacent rural areas at almost all times of day and bridge the temporal as well as spatial mobility gaps left by the formal public transport services, wherever they exist.

The study observed that these informal systems played diverse roles. While modes like shared auto-rickshaws and *Tata Magics* operated as the main modes of public transport on arterial and sub-arterial road networks, providing connectivity between important demand-generating and demand-attracting points in the city, modes like cycle rickshaws were found to serve intra-city pockets that conventional public transport systems could not reach. The low turning radius and high maneuverability of a cycle rickshaw offered it the flexibility to move through extremely dense urban networks and narrow streets, such as the conditions of the walled city in Amritsar. In cities where formal public transport supply was available, informal modes aligned themselves as feeders or modes providing first- and last-mile connectivity to public transit. The demand base for informal public transport was found to be much larger and more diverse than just for feeder or last-mile trips to line-haul systems like city buses or metro systems.

Informal public transport modes assumed an even more important role in peri-urban areas mainly due to the extremely low or non-existent availability of formal public transport in said areas. Due to minimal formal public transport and lax enforcement conditions, the use of retrofitted and locally manufactured informal public transport modes was found to be more common in peri-urban areas. These modes operated along the main highways connecting smaller towns and settlements. In areas surrounding Amritsar, for example, *Kadukas* served the rural, peri-urban regions. In the smaller towns of Sanand and Viramgam, meanwhile, there was no formal public transport to speak of; auto-rickshaws and *Chakdas* thus formed the backbone of the public transport supply in these regions.

3.3. Operational characteristics

3.3.1. Service types and regulatory compliance

The informal public transport systems offered either shared or personal-hire services to commuters. Low-capacity modes like the three-seated auto-rickshaws and cycle rickshaws usually provided personal-hire services, while the medium- and high-capacity modes provided shared services. Discussions with the State Transport Departments (Regional Transport Offices (RTOs)) indicated that permits² are issued to vehicles to provide them with legal permission to operate in a given area or on a particular route. RTOs issue contract carriage permits to personal-hire modes. A contract carriage permit specifies the zone in which the corresponding vehicle can operate, an area that

² Permit is an instrument issued by a State or Regional Transport Authority authorizing the use of a motor vehicle as a transport vehicle in a specified manner as per the relevant provisions of the Motor Vehicles Act and Rules. The Motor Vehicles Act, 1988 mandates the necessity of permit for transport vehicles.

Table 3
Average vehicle route lengths and user trip lengths for different modes studied.

Area of operation	Mode	City/City region	Average route length (km)	Average user trip length (km)
Urban	Auto-rickshaw, Mahindra Gios	Amritsar	12	6
	Shared Auto, Tata Magic and Vikram	Noida	15	10
	Tata Magic and Vikram	Jaipur	20	6
Peri-urban	Mini bus	Jaipur	45	14
	Shared Auto	Sanand-Viramgam	18	18
	Shared Auto	Ahmedabad-Gandhinagar	20	19
	Omni	Ahmedabad-Gandhinagar	35	30
	Force Cruiser	Jaipur	40	27
	Jeep	Sanand-Viramgam	30	33 ^a
	Jeep	Ahmedabad-Gandhinagar	32	22
	Mini bus	Amritsar	32	26
	Chakda	Sanand-Viramgam	15	24 ^a
Kaduka	Amritsar	10	8	

Source: Surveys of drivers and operators of informal transport modes in the selected cities.

^a The average trip lengths for users in these cases are longer than the route lengths of the corresponding modes, indicating that these modes cover only a portion of the average user trip.

often conforms to the administrative boundaries of the town/city/district. RTOs issue stage carriage permits for shared services, as well. A stage carriage permit allows a vehicle to make stops at various locations to pick up and drop off passengers. The permit also specifies the route and the different stops where the vehicle can pick-up/drop-off passengers. The field studies in the selected cities/city regions revealed large-scale violations of permit regulations, most widespread of which was the operation of contract carriage permit-holding vehicles as a shared service.

In many cities, authorities also issued contract carriage permits to vehicles without taking seating capacity into consideration. Vehicles like *Tata Magics*, *Mahindra Gios*, and *Vikrams*, which are designed to have seating capacities of 7 to 8 passengers, were found to be holding contract carriage permits, which allow them to seat only 3 to 4 passengers. All these vehicles were thus violating the terms of the contract carriage permit and operating as shared services that seated far more passengers than the permits allow. On the one hand, these violations can be attributed to purported profit-seeking measures on the part of vehicle operators. On the other, they could also be tied to an insufficient understanding of local mobility demand on the part of government authorities. Either way, the operation of contract carriage modes as shared services underlines the presence of a significant demand for such mobility modes; government authorities need to take cognizance of the local demand while designing permit schemes for cities.

Another common permit violation was the operation of vehicles outside their permitted zones or routes. Operators often infringed on route or zone rules to maximize revenue gains by operating in high-demand areas; the spatial boundaries defined by permits did not deter the operators from going into areas where they found more demand.

Some vehicles were operating without any permit whatsoever. These cases were more prevalent when the vehicles operated outside urban boundaries. Many vehicles operating in the peri-urban regions

Table 4
Average daily rent charged by owners.

Informal public transport mode	Average vehicle rent per day
Cycle rickshaws	Rs 30–50
Low-capacity motorized modes	Rs 300–400
Medium-capacity motorized modes	Rs 500–700
High-capacity motorized modes	Rs 500–1000

Source: Surveys of drivers and operators of informal transport modes in the selected cities.

Table 5
Cost per km and earning per km of informal public transport modes.

Motorized modes	Average earnings per km (Rs per km)	Average costs per km (Rs per km)
Low-capacity modes	8	5
Medium-capacity modes	9	6
High-capacity modes	14	10

Source: Surveys of drivers and operators of informal transport modes in the selected cities. Notes:

- For some modes, costs and earnings per km could not be estimated due to a lack of data. The modes excluded from the above analysis were shared auto-rickshaws operating in Sanand-Viramgam, Jeeps operating in Sanand-Viramgam and Ahmedabad-Gandhinagar, and mini-buses operating in Amritsar.
- The operational costs of cycle rickshaws were found to be negligible, and drivers' daily earnings were estimated to be Rs 6 per km.

of Ahmedabad, Sanand, Viramgam and Amritsar, for example, were found to be carrying no permit. As informal public transport rarely followed any permit regulations in peri-urban areas, the services offered by these modes varied according to local demand: vehicles operating in peri-urban areas provided shared passenger services, personal-hire services, and goods transport services, as well.

3.3.2. Operational characteristics

3.3.2.1. Vehicle ownership patterns. The ownership patterns of informal public transport modes were highly fragmented (Table 2). Typically, an operator would own and operate only a single vehicle. Cycle rickshaws were the only real exception: a single operator's fleet size was often as high as 100 to 150 vehicles. However, even among cycle rickshaw operators, instances of single operators owning large fleets were very rare.

3.3.2.2. Fares. Informal public transport systems are operated by private individuals and operators. Providing transportation services is a business activity, which means that maximizing profit is the key objective of operating a vehicle. Although RTOs set the fares for both personal-hire and shared services, the majority of the drivers surveyed charged passengers at their own discretion. Personal-hire auto-rickshaws, which are required to charge passengers according to the fare meter, usually did not have meters installed on their vehicles. Driver groups or unions operating shared services on the same routes usually decided the fare to be charged. In addition to the drivers' and operators' profit-seeking motivations, a lack of timely fare revisions by government authorities was another root cause of over-charging by drivers.

3.3.2.3. Scheduling of informal public transport services. Informal public transport systems are characterized by a high degree of flexibility and an ability to adapt to changing demand patterns, a quality evident in

Table 6
Comparison of designed seating capacity and average occupancy on informal public transport modes.

Mode	Designed seating capacity ^a	Average occupancy	Ratio of average occupancy and designed seating capacity
Auto-rickshaw (Piaggio/Atul)	3	9.5	3.2
Vikram	6	14	2.3
Tata Magic	7	13	1.9
Mahindra Gio	6	8	1.3
Chakda ^b	10	14	1.4
Kaduka ^b	20	30	1.5
Maruti Omni	7	12	1.7
Jeeps	10	14	1.4
Mini bus ^b	20	30	1.5

^a Designed capacity does not include additional capacity after retrofitting.

^b Designed seating capacity as stated by the driver; for the rest of the modes, the designed capacity was assumed to be the number stipulated in their respective permits.

Table 7
Vehicles types responsible for accidents (2013).

Vehicle type	Total number of accidents (2013) Number (percentage share of total)	Fatalities (2013) Number (percentage share of total)
Personal vehicles (cars and two-wheelers)	656 (47%)	77 (25%)
Jeeps	81 (6%)	15 (5%)
Auto-rickshaws	111 (8%)	18 (6%)
Cycle rickshaws	0 (0%)	0 (0%)
Buses	192 (14%)	45 (14%)
Trucks and tempos	216 (15%)	77 (25%)
Others	138 (10%)	79 (25%)

Source: Jaipur Police Department.

the services' dynamic routing and pricing patterns. The demand responsiveness of these systems is also reflected in the manner in which the services are scheduled. Two scheduling approaches were common in the cities studied. The most common approach involved a queue system in which vehicles lined up in queues and began operating only when the first vehicle in the queue was holding a certain number of passengers—usually the threshold number that would make it possible for the provider of the trip to recover the corresponding operational expenses. Under the other approach, the operators followed a fixed service frequency. The shared services operating in Jaipur adopted this scheduling scheme. In such cases, unions played a proactive role in managing the services by not only determining the frequency but also ensuring compliance with service frequency. In Jaipur, the unions had employed managers along the routes to ensure driver conformance. The unions also penalized violators by imposing fines and impounding the vehicles if the drivers were repeat offenders. The union-determined frequency responded to changing demand patterns during the day, with peak-hour frequency intervals as short as 3 to 5 min and off-peak-hour frequency intervals around 10 to 15 min.

3.3.2.4. Routing of informal public transport services. Our field surveys also examined the route lengths of informal public transport modes. In peri-urban areas, informal mode route lengths were comparatively longer than those of similar modes operating in urban areas. Table 3 shows the average route lengths and average trip lengths for users of different modes.

3.3.2.5. Business model and profitability of operations. The informal public transport modes were found to be either operated by the owners of the vehicles themselves or by drivers employed by the vehicle owners; in the majority of cases, vehicle owners drove their vehicles themselves. Vehicle rentals were also popular among these modes. In such cases, vehicle owners loaned vehicles to drivers at fixed rental fees. The driver was responsible for fueling the vehicle and making any necessary minor repairs, and the vehicle owner was responsible for any major vehicle repairs. The driver would take home all the fare-box revenue for the day. Under this operational model, the profit-making risk was with the driver—a model of operation commonly known as the “net-cost model.” An owner normally set his or her vehicle rental charges based on vehicle condition, age, and the route/zone in which the vehicle

had permission to operate. Vehicles with a permit to operate on high-demand routes/zones called for higher rents. Table 4 shows the rental fees charged for different vehicle types.

We also estimated the operational costs and earnings of informal public transport mode operators. The per-km operational costs and earnings are shown in Table 5. Per-km earnings were found to be higher than the per-km costs in most cases, indicating that the informal public transport modes are usually profit-making in their operations (Fig. 2).

3.4. Safety aspects

3.4.1. Compliance with safety standards

To understand the issues related to the safety of informal public transport modes, we looked at factors like vehicle design, overloading, capacity utilization, and physical infrastructure. Due to the absence of adequate rule enforcement, the operators of informal transport modes often retrofit their vehicles to carry more passengers than the manufacturers originally intended the vehicles to hold. Examination of vehicles across the study regions revealed that the majority of the vehicles were formally manufactured. This implied that they were in compliance with the vehicle safety standards, as vehicle manufacturers have the vehicles tested and type-approved by authorized testing agencies before selling them in the market. The problem in this case, therefore, was not necessarily compliance with vehicle safety standards but rather the modifications that vehicle operators made after acquiring their vehicles. Typical retrofits were additional seats in the driver, passenger, and luggage compartments of the vehicle and additional handrails and footboards. These modifications were made with the sole aim of increasing the passenger-carrying capacity of the mode and thereby increasing the profitability of operations. As the vehicles are not tested after retrofitting, there is no way of knowing whether they are roadworthy from the perspective of road accidents.

A few categories of vehicles were also found to be locally manufactured. The *Kadukas*, operating in the border regions near the city of Amritsar, were an example of locally manufactured modes. These vehicles are not subjected to any roadworthiness testing or type-approved against vehicle standards. These modes were usually found to be operating on highways in mixed traffic conditions and alongside heavy vehicles moving at high speeds. Poor vehicle design and precarious road conditions rendered these modes highly vulnerable to road accidents, posing a high risk of injury to the onboard passengers. However, there was no data to establish the vulnerability of these vehicles and their involvement in traffic accidents; the study was thus unable to provide any conclusion concerning the safety of these locally manufactured vehicles.

3.4.2. Overloading and capacity utilization

High levels of demand for transport services, coupled with inadequate rule enforcement and the profit-making motives of operators, make overloading a common practice in informal modes. The phenomenon of overloading was found to be prevalent across all the cities/city regions. A comparison of the designed seating capacity of the vehicles with the average number of passengers carried per trip indicates overloading on all modes (Table 6). On average, informal public

Table 8
Ages of informal public transport mode vehicles.

Area of operation	Modes	Diesel/Petrol vehicles (age in years)	CNG/LPG vehicles (age in years)
Urban	Auto-rickshaw (personal hire)	6.4	4.1
	Shared services like <i>Tata Magics</i> and <i>Mahindra Gios</i> , etc.	3.1	2.9
	Mini-buses	8	–
	Shared auto-rickshaws	4.4	5.4
Peri-urban	<i>Maruti Omni</i> , <i>Force Cruisers</i> and Jeeps	11.5	3.9
	Mini-buses	14.7	–
	<i>Kaduka</i> and <i>Chakkda</i>	7.2	–

Source: Surveys of drivers and operators of informal transport modes in the selected cities.

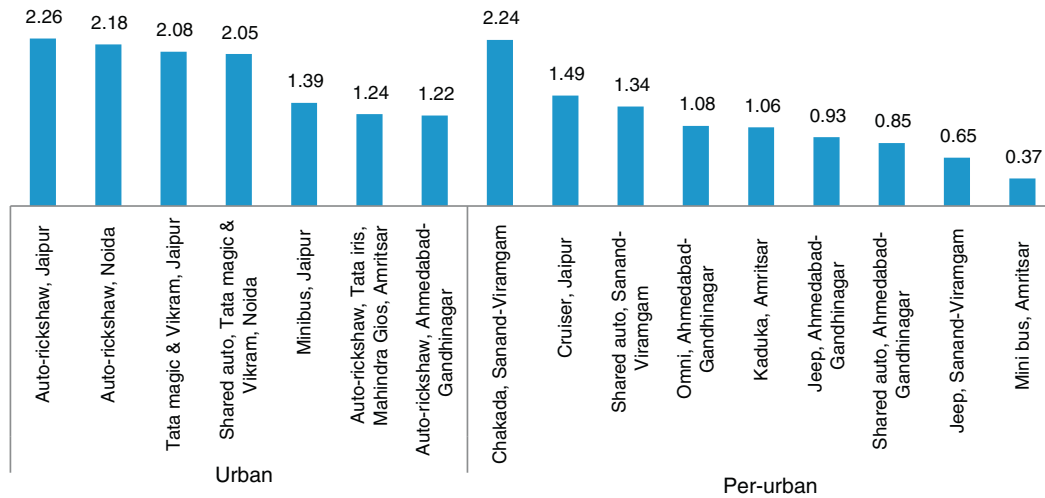


Fig. 2. Ratio of earning per km and cost per km for different modes. Source: Surveys of drivers and operators of informal transport modes in the selected cities.

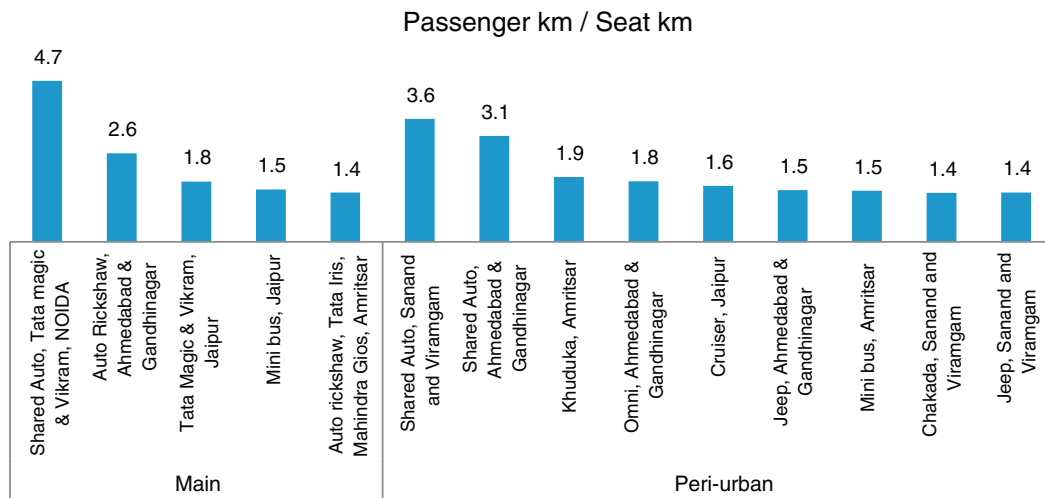


Fig. 3. Capacity utilization rates: Ratio of passenger km to seat km. Source: Surveys of drivers and operators of informal transport modes in the selected cities Note: The ratio of passenger km and seat km for personal-hire modes could not be calculated due to insufficient data.

transport modes were found to be carrying twice as many passengers as the designed seating capacity of the corresponding vehicles.

The capacity utilization rates of informal transport modes also offer evidence of overloading. Capacity utilization is the ratio of the passenger kilometers operated to the seat kilometers offered by the modes. This ratio compares total transport demand (passenger kilometers) on a mode to the total supply (seat kilometers) provided by the mode. Capacity utilization rates were found to be more than one for all the modes studied (Fig. 3). For some of the modes, such as shared auto rickshaws, *Tata Magics*, and *Vikrams*, the ratio of passenger kilometers to seat kilometers was found to be as high as 4 to 4.5 in certain locations.

3.4.3. Physical infrastructure availability

Not only do these modes demonstrate intense usage levels, but most of the vehicles also operate without the benefit of any dedicated/supporting physical infrastructure such as official pick-up/drop-off stops. In the absence of designated stands and stops, the vehicles pick up and drop off passengers at the convenience of the passengers.

3.4.4. Are these modes safe?

While factors such as vehicle design, overloading, high usage rates, and a lack of adequate physical infrastructure appear to compromise

the safety of both passengers and drivers of informal public transport modes, there are not enough statistics on road accident to comment specifically on the safety of the modes. Although accident data was recorded in every city, the manner in which the data was recorded and subsequently compiled varied significantly from city to city. Due to the lack of a standardized method for recording and compiling data, we were unable to construct a common rubric for analyzing the conditions in different cities. There was not even a standard format for recording the basic classification of accidents by mode type.³ Due to the incoherence of the data, we analyzed the accident data for the city of Jaipur only. The analysis showed that, despite the overloading and retrofitting practices, informal public transport modes were safer compared to other formal modes of transport. In 2013, only 8% of all accidents in Jaipur were caused by informal modes (auto-rickshaws; Table 7). The low accident rate among informal modes could be attributed to their slow operating speeds, which are caused by overloading and frequent stops.

³ For instance, all the four-wheeled passenger and personal modes in Jaipur were recorded as “cars,” irrespective of whether the mode was a *Tata Magic* or a personal car. In Amritsar, meanwhile, *Tata Magics* were recorded as auto-rickshaws.

3.5. Environmental performance

Environmental concerns such as high levels of pollution and congestion are often cited as reasons for restricting the use of informal public transport modes or altogether banning them from operating in the cities. Observers usually assume that operators of informal public transport modes not only overload their vehicles but also employ older vehicles and resort to fuel adulteration, all in hopes of turning better profits. All these factors can significantly affect the environmental performance of these vehicles.

3.5.1. Vehicle age

Our examination of vehicle fleet showed that the average age of the vehicles studied was 6.2 years, indicating that most of the vehicles were relatively old (Table 8). Peri-urban areas had predominantly older fleets, with an average age of 8 years. This was almost double the age of fleets operating within urban limits (3.9 years). Some of the vehicles, such as Jeeps operating in peri-urban areas like Ahmedabad-Gandhinagar, and Sanand-Viramgam and minibuses providing connectivity between Amritsar and nearby smaller towns, were as old as 15 years. The higher age of vehicles operating in the peri-urban areas also indicates that fewer new vehicles are being added to this stock of vehicles as compared to those in urban areas.

3.5.2. Fuel types

The penetration of clean fuels among the informal public transport modes surveyed was quite significant. Almost 40% of drivers surveyed stated that they used CNG/LPG in their vehicles. The penetration of vehicles running on CNG/LPG was higher in urban areas than in peri-urban areas (Fig. 4). The higher penetration level of clean fuels in urban areas could be attributed to regulations mandating the use of cleaner fuels in cities, the widespread availability fueling facilities, and the lower prices of CNG/LPG compared to petrol or diesel across most of the urban areas studied, among other reasons. In addition to using clean fuels, 99% of the drivers said that they did not use any form of adulterated fuel to power their vehicles. However, local police officials claimed that *Kaduka* drivers often adulterated diesel with kerosene to bring down fuel costs.

3.5.3. Compliance with vehicular pollution-related regulations

To understand whether informal public transport modes were polluting, we analyzed the compliance of these modes with the Pollution Under Control (PUC) certification system. A PUC certificate ensures compliance of a vehicle with the national emission standards. Carrying a valid PUC certificate is a mandatory requirement for all categories of on-road vehicles. Our investigation of informal public transport vehicles showed that a significant proportion (36%) of the vehicles surveyed did not carry a valid PUC certificate. Compliance varied within and outside the urban boundaries: the overall compliance rate was 71% in urban areas and only 37% in peri-urban regions, indicating stricter enforcement in urban areas.

4. Conclusion

With government-provided public transport services failing to meet public demand, the informal public transport sector is playing a crucial

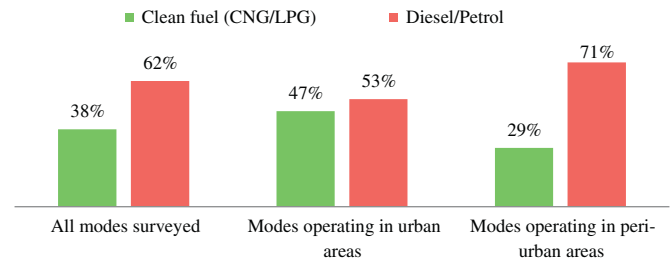


Fig. 4. Penetration of clean fuels among informal modes. Source: Surveys of drivers and operators of informal transport modes in the selected cities.

role in providing mobility services to Indian cities, towns, and peri-urban areas. These systems, which emerge and evolve to meet local mobility needs, are highly flexible and customized to suit local conditions. At times, they adopt practices which are not entirely legitimate, but help them to sustain their operations and function profitably. The modes may not be the most comfortable ones for passengers to use, but they sometimes represent the only choices that people have. Indian cities cannot wish away these modes on account of the negative perceptions associated with these modes, which this paper has argued may not be entirely true. Moreover, the provision of adequate formal public transport services in the near future may not be easy for the cities, given their financial and institutional limitations. Cities should, in fact, recognize the existence of informal public transport modes, understand the policy and regulatory issues related to their operations, and formulate strategies that can help improve their service performance. These steps will go a long way in ensuring better public transport services in Indian cities.

Acknowledgement

The authors would like to thank the Department for International Development (DFID), Government of United Kingdom (UK) for assisting with the funding of this study.

References

- [1] B. de la Pena, R. Albright, Catalyzing the new mobility in cities: A primer on innovative business and service models, The Rockefeller Foundation, U.S.A., 2013
- [2] R. Cervero, Informal Transport in the Developing World, United Nations Centre for Human Settlements (Habitat), Nairobi, 2000.
- [3] R. Cervero, A. Golub, Informal Transport: A Global Perspective, *Transp. Policy*, 14 (6), Elsevier, 2007 445–457 November.
- [4] K.M. Gwilliam, Cities on the Move: A World Bank Urban Transport Strategy Review, World Bank Publications, 2002.
- [5] Government of India (GoI), NTDP (National Transport Development Policy Committee), India Transport Report: Moving India to 2032, Planning Commission, GoI, 2014.
- [6] Institute of Urban Transport, Improving and Upgrading IPT Vehicles and Services: A Study, 2014 New Delhi.
- [7] T. Kurokawa, S. Iwata, Characteristics of Jeepney operation and demand in Metro Manila, The Philippine, *Infrastructure Planning and Management* 1984, pp. 175–184.
- [8] T. Shimazaki, M.M. Rahman, Physical characteristics of paratransit in developing countries of Asia, *J. Adv. Transp.* 30 (2) (1996) 5–24.