

WORKING PAPER

Assessing the Viability of Using Autorickshaws for Urban Freight Delivery in India

Rohan Rao, Sudeept Maiti, Pawan Mulukutla

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HIGHLIGHTS

- In India, daily commercial deliveries are expected to grow 40 percent annually by 2025. A system for handling loads of different sizes will be needed to meet rising urban demand.
- Currently there is no vehicle category for transporting goods between 30 and 350 kilogram (kg).
- This working paper examines whether three-wheeler autorickshaws can fill this gap.
- These autorickshaws have the maneuverability of a two-wheeler while being designed to carry payloads up to 300 kg.
- This paper examines the potential impacts on driver incomes, safety, and the environment.
- It finds that using autorickshaws to transport freight as well as people could enable drivers to make more productive use of existing vehicles. It could also raise driver incomes by around 15 percent, reduce logistics costs for small and medium enterprises, make vehicle use more efficient, and help mitigate greenhouse gas emissions.
- Amendments made in 2019 to the Motor Vehicles Act of 1988 (MVA) sought to develop schemes for innovative use of transportation assets and greater efficiency in transport of goods. These could provide scope for regulators to allow dual use of autorickshaws.

EXECUTIVE SUMMARY

Context

It is estimated that, between 2020 and 2030, India's freight activity will increase fivefold (NITI Aayog et al. 2021), and this imminent demand needs to be accommodated cost-effectively. Factors such as increased penetration of smartphones and easy access to e-commerce platforms have led to drastic changes in consumer behavior. The government is focused on improving last-mile delivery and urban logistics efficiency while reducing congestion and enabling accelerated economic growth (MOCI 2022). To accomplish this, it may need to explore and optimize new types of micromobility-based last-mile freight modes; low-emissions cargo transportation, especially for smaller payloads; and ways to optimize use of existing vehicle stocks.

As an integral part of urban transportation, autorickshaws can bridge the gap in medium to last-mile connectivity in urban and peri-urban areas. Motorized three-wheeler passenger autorickshaws, considered “intermediate public transport” in India, are more flexible and maneuverable than four-wheeler cargo vehicles; they can navigate the congested roads in cities easily, while also having higher payload capacity for carrying freight than two-wheelers. Dual use of autorickshaws to carry cargo will give drivers an additional source of income and help overcome supply gaps in the freight ecosystem.

While regulations of the Motor Vehicles Act (MVA) of 1988 prohibit transportation of goods in contract carriage like that provided by autorickshaws, unregulated dual use of autorickshaws is already common in India. Amendments to the MVA in 2019 give the central government discretionary powers to develop a national transportation policy in concurrence with state governments, and to exempt specific categories of vehicles from older regulations. This could help nurture innovative applications in mobility and pave the way for formally regularizing dual use of autorickshaws.

As prior research on this subject is lacking, this study explores potential demand for dual use of autorickshaws, the usefulness of such a strategy, the legal implications, and operational constraints that could arise.

About this working paper

This working paper contextualizes India's current urban freight ecosystem with the rapid evolution of its commercial sector while focusing on the need for alternative approaches to cater to smaller payload ranges. It considers the prospect of using various micromobility modes for both passenger and

freight transportation but focuses specifically on the viability of three-wheeler passenger autorickshaws, which appear most capable of moving small loads medium distances in urban and peri-urban areas.

This working paper synthesizes key insights from micro-, small, and medium enterprises; distributors; retailers; and urban freight experts, and assesses the complementarity of the freight and autorickshaw sectors. In the primary survey, we asked 608 autorickshaw drivers in five cities about hours of operation, current earnings, safety, and peak hours of service to develop recommendations. Secondary research included a review of existing literature. Case studies of dual use of two-wheelers and light-utility vehicles were analyzed to better understand how they fit into the transport ecosystem, to inform discussions on a framework for regulating dual use.

Recommendations

Set up an expert committee to deliberate on the various facets of dual use and formulate and define safety standards, as well as regulatory interventions needed for dual use of three-wheeler passenger autorickshaws.

Institute capacity building for drivers. Passenger autorickshaw drivers and owners could adopt good practices from their peers in the cargo-handling industries for safer driving habits when transporting goods.

Develop short- and long-term strategies through careful deliberations among all stakeholders. While the overall benefits may outweigh the challenges, safety—for both passengers and goods—needs to be studied in detail during the trial phase. Pilots can be deployed to analyze key metrics of asset utilization, income, and safety to help iron out variances in implementation.

Transition from internal combustion engine (ICE) autorickshaws to electric autorickshaws to eliminate tailpipe emissions. Switching to electric vehicles would further mitigate emissions. Transitioning to electrification could be a goal in the long term, as emissions from e-autorickshaws (including life cycle emissions) are far less than those from ICE autorickshaws.

INTRODUCTION TO URBAN FREIGHT IN INDIA

Urban freight transport is crucial to the economic vitality of cities, supplying goods and services to both residents and businesses. Today, close to 71 percent of freight in India is transported by road (NITI Aayog et al. 2021), and about 40 percent of shipment volume is driven by India's largest cities and suburbs (GLG Insights 2021).

One of urban freight's chief characteristics is its diversity. Types of vehicles, delivery times, and size of shipments within cities vary according to the demands of individual businesses and commodity types. Consequently, deliveries are rarely consolidated by destination, leaving many carriers simultaneously serving the same location, which drives up operational costs.

Urban freight transportation also fuels urban congestion, pollution, and traffic crashes (MoHUA and RMI 2019). Governments and businesses in India are currently faced with the fundamental challenge of increasing the productivity of urban freight networks while reducing logistics costs and social and environmental harms.

Background on the urban freight ecosystem

Urban freight transport in cities is defined as "all movements of goods in to, out from, through or within the urban area made by small, light or heavy vehicles" (CIVITAS 2020). Urban freight logistics can also be classified based on the sectors served, such as

- retail (including e-commerce);
- food and catering;
- postal services;
- construction; and
- waste management (CIVITAS 2020).

Business-to-business (B2B) transit lies at the core of the urban freight sector in India. It involves transactions between two businesses or companies, transporting, for example, manufacturing materials, clothing, or car parts directly to another business entity. Business-to-consumer (B2C) transactions happen between a company and an individual customer, who may receive a shipment of commodities like fresh produce, packaged food, or beverages. This might also include food deliveries, document shipments, or small parcels that have strict handling and delivery requirements and are transported in small vehicles directly to final consumers. Previously a small segment of the

freight movement in cities, these types of goods have now become a larger contributor to urban logistical movements with the growth of e-commerce.

Impact of e-commerce on urban freight deliveries

Matching the demand

A rapid rise in digital literacy and smartphone penetration, coupled with rising incomes, has fueled the growth of India's logistics sector. With the government allowing 100 percent foreign direct investment in the B2B and marketplace model, the country's overall e-commerce market is predicted to grow annually by 21.5 percent and reach US\$350 billion by 2030 (IBEF 2022).

In India's urban areas, 8 million commercial deliveries were carried out daily in 2021, with variable parcel sizes and delivery times. This is expected to more than triple, to 25 million, by 2025 (GLG Insights 2021). Consumer electronics, furniture and home furnishings, machines and metal equipment, and packers and movers, each account for roughly 11 percent of the logistics movement in cities.

While e-commerce transport is on the rise, traditional commerce enterprises still dominate urban demand. Most traditional deliveries, of perishable goods such as fruits and vegetables and other groceries, as well as garments and bulk commodities like construction materials and ceramics, are still provided by informal operators (Figure 1).

Increased demand for commercial deliveries in Indian cities is expected to drive road freight movement from 2.2 trillion ton kilometer (ton km) in 2022 to 9.6 trillion ton km by 2050, and the associated commercial vehicle stock is also projected to more than quadruple, from 4 million vehicles in 2022 to around 17 million by 2050 (NITI Aayog and RMI 2022). The cumulative effect of these challenges is leading to a cargo transport capacity gap in the urban freight ecosystem that needs to be addressed.

General challenges in the urban freight ecosystem

Increased urbanization and congestion

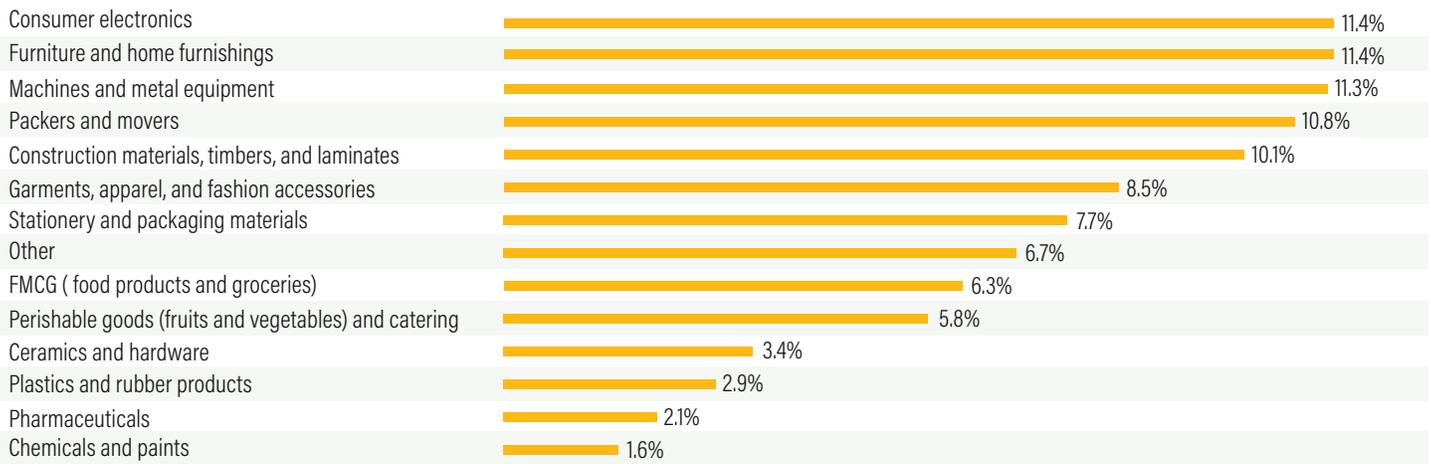
Cities in India are growing rapidly, and by 2050 more than 50 percent of India's population is expected to dwell in urban areas (MoHUA 2017). Urbanization has brought more personalized, hyperlocal freight orders, fragmenting delivery points. India's experience in this regard is not unique, but the impacts are especially pronounced due to the higher traffic congestion levels (Sahu et al. 2022).

High cost and poor route planning

Last-mile delivery is the process of delivering products to stores, retailers, or consumers’ doorsteps and involves different geographic areas, driving patterns, and types of vehicles. While last-mile delivery is typically the shortest link in the logistics supply chain, it accounts for close to 53 percent of the total logistics cost (Rosencrance 2021). Without intervention, the number of delivery vehicles in the world’s 100 most populous cities could increase by 36 percent by 2030, leading to a 32

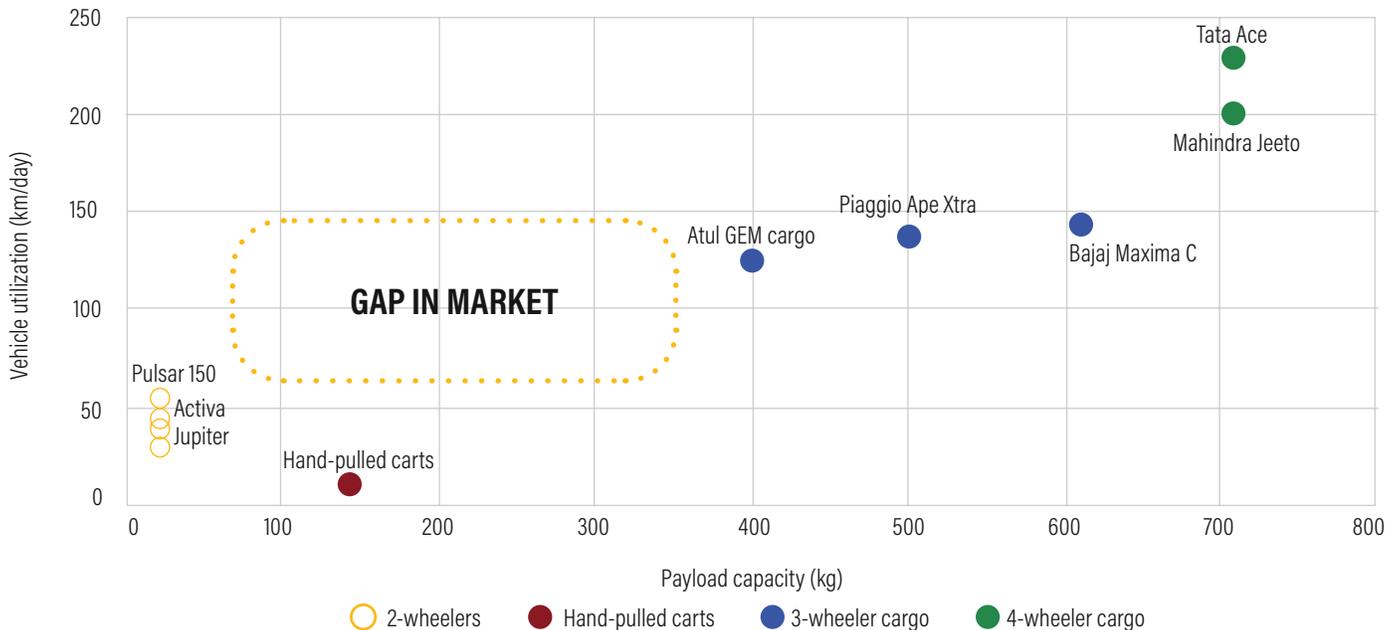
percent increase in emissions and 11 added minutes of commute time for each passenger every day (WEF 2020). Transportation of goods involves a lot of idling due to congestion and has an added impact on the cost and efficient use of fuel. Additionally, when making multiple deliveries, drivers lose track of the optimal route. The extra or out-of-route distance they cover accounts for 3–10 percent of the total distance delivery vehicles travel (Hochfelder 2017).

Figure 1 | Share of various categories of urban freight logistics transport in India (2021)



Source: Author conversations with industry experts.

Figure 2 | Cargo delivery vehicle models in India



Notes: kg= kilogram; km = kilometer.

Sources: WRI India analysis; TrucksDekho (2022).

Lower vehicle utilization and pollution

Fragmented markets push down logistics efficiency, leading to both overloading of commercial vehicles in some cases and low vehicle utilization in others, with many cargo vehicles running half empty, increasing congestion and air pollution (NITI Aayog et al. 2021).

To tackle these problems and improve delivery efficiency, India will need to study cost-effective alternatives. Ever-increasing traffic means that delivery vehicles will need to adapt to and navigate the congestion. Additionally, instead of half-empty cargo vehicles, Indian cities need an alternative that caters to smaller loads of goods. Studies show that shifting to smaller vehicles can increase efficiency by speeding up loading and unloading times. Research in Amsterdam showed that while it took an average of 12 minutes to load and unload from a delivery van, it only took 3 minutes to load an electric bike with the same amount of freight (Amstel et al. 2018).

The market has started looking at substitute vehicle types to bridge this gap. Examples include adoption of two-wheelers for last-mile deliveries of up to 30 kilogram (kg) of goods ranging from electronics, food, and beverages to apparel, as mandated by regulation (MoRTH 2016). However, a chasm remains in the 30–350 kg payload capacity range, as no vehicle type caters to it (see Figure 2). Three- and four-wheeler cargo vehicles that can carry 400–700 kg can also take smaller loads, but it would be an overdesign and underutilization of their capacity.

ASSESSING MICROMOBILITY AND INTERMEDIATE PUBLIC TRANSPORT MODES FOR A POSSIBLE SOLUTION

In their literature review of several types of vehicles that can be used in last-mile delivery of urban freight, Machado de Oliveira et al. (2017) conclude that two- and three-wheelers are the best alternatives, and that delivery companies tend to opt for smaller vehicles in urban freight distribution.

Two-wheeled motorized vehicles account for 74.8 percent of total vehicular operations in India (Statista 2021). While primarily used for passenger transport, motorized two-wheelers are now being designed and retrofitted to carry small loads of up to 30 kg. There are a few variations of three-wheelers, like small commercial vehicles, which are the typical cargo carriers; human-pedaled cycle rickshaws; and motorized passenger autorickshaws, which are often used for dual purposes informally to supplement income.

Supplementing incomes by using vehicles for multiple purposes is a common practice. On the streets of India, it is not rare to see two-wheelers and autorickshaws being loaded with goods. While each has its advantages and disadvantages, it is important to evaluate which is most suitable for urban conditions. While two-wheelers are more agile, they are not suitable for carrying heavy goods. And, while cycle rickshaws can be loaded with comparatively heavier goods, there are limits to how much and how long a rickshaw puller can pull.

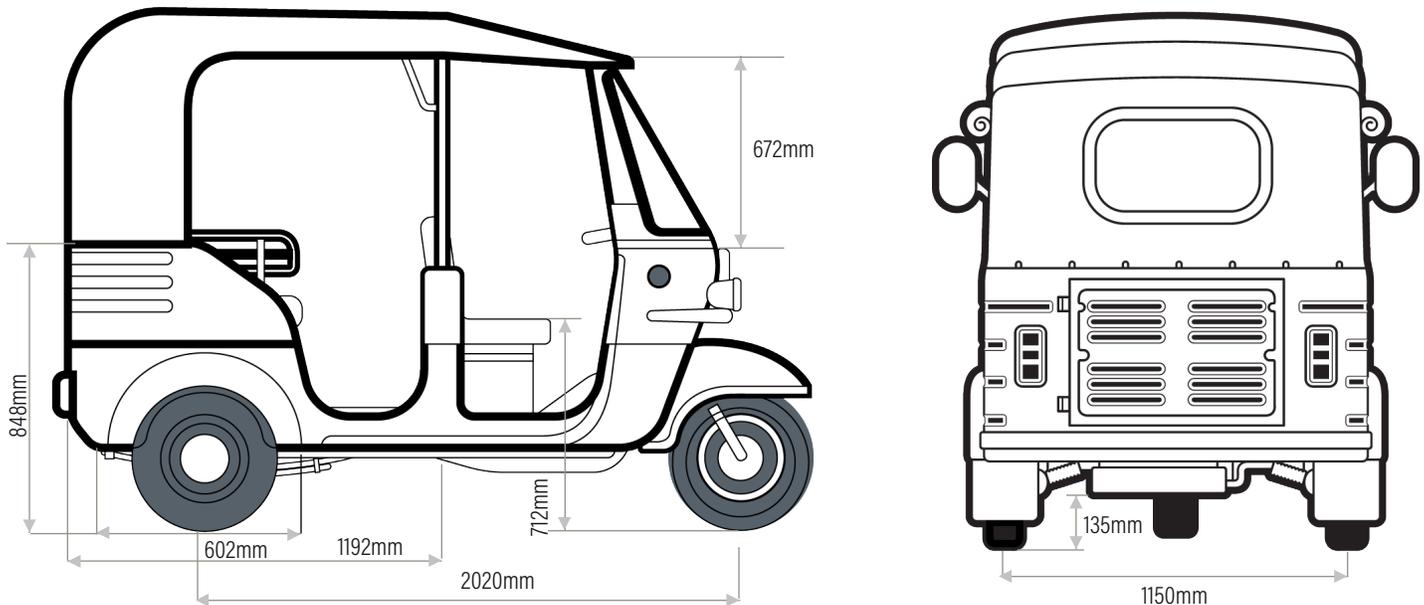
For these reasons, three-wheeler passenger autorickshaws fare better than other micromobility modes in carrying freight. They have the flexibility and maneuverability of a two-wheeler (Bagul et al. 2018) while being designed to carry payloads of up to 300 kg (see Appendix B). Using three-wheeler autorickshaws to fill the gap in cargo transportation could be a cost-effective and productive use of existing vehicles. Dual use for last-mile freight distribution in urban areas avoids adding new vehicles to the roads, which could reduce congestion and emissions.

Current autorickshaw ecosystem in India

Autorickshaws are a quintessential feature of Indian cities and a crucial form of intermediate public transport for millions of urban residents. Especially in areas underserved by public transport, autorickshaws play a key role in providing connectivity to many passengers and account for 10–20 percent of total daily trips in Indian cities (Mani et al. 2012). Autorickshaws provide affordable short- and medium-distance trips in urban areas, where they are predominantly used for commuting to work, school, or recreation. In semiurban and rural areas, they are the main modes for commuting and transporting goods to markets and shops. Their small size helps them navigate narrow and congested Indian roads (see Figure 3). The 6.3 million registered commercial autorickshaws across India provide the primary or only source of income to many families and have great impact on their socioeconomic status (Harding et al. 2016). Despite considerable barriers to entry such as caps on autorickshaw permits in some states, autorickshaws are relatively inexpensive to purchase or rent, compared with other vehicles, and are viable employment generators.

Before the COVID-19 pandemic, demand for three-wheeler transport vehicles rose steadily. Between 2015 and 2018 the number registered in India nearly doubled, from more than 350,000 to 690,000 (see Figure 4). More recently, registrations of e-rickshaws have surged (MoRTH 2023).

Figure 3 | Specifications of a typical passenger autorickshaw in India



Source: Author conversations with industry experts.

The last decade's annual 8.2 percent growth in autorickshaw registrations (WRI India analysis of data in MoRTH 2023) has made service more available, but it has also reduced average earnings for drivers (Agarwal et al. 2014). Because many autorickshaws are purchased through loans—from both formal and informal lenders—falling incomes have made default rates for autorickshaws some of the highest in the automobile sector (BQ Prime 2021) as fares are regulated and slow to get revised. Most drivers drive approximately 100–120 km/day and report earning on average Rs. 7,000–9,000 per month (Tigari and Santosh 2020). After fuel and maintenance costs, drivers' incomes can barely support their families.

The current fare system does not account for the opportunity cost of labor resulting from time lost during off-peak hours, when there is no demand for passenger trips, or between fares, when the drivers are waiting for passenger pickups in “idle time” (Agarwal et al. 2014) that could be used for other purposes, like transporting goods. Supplementing the primary passenger farebox income with other income sources would be beneficial to many employed in this sector. This economic benefit to drivers, the extra income they could earn moving freight during downtime, is another advantage of dual use.

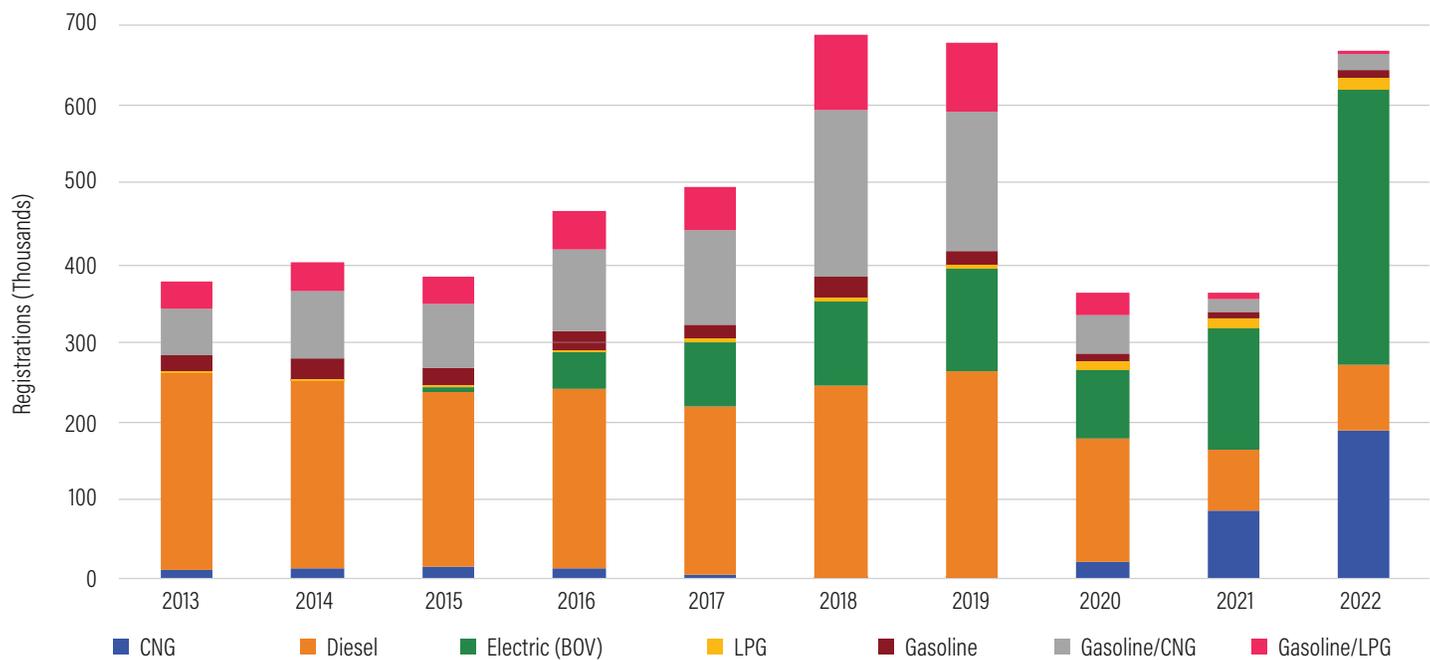
Literature on integration of passenger and freight transportation

The integration of passenger and freight transportation has been heavily discussed among policymakers and is referred to in diverse ways—co-modality, cargo hitching, and collaborative passenger and freight transport being a few of them. Improvements in information and communication technologies (ICTs) have helped enable such integrated usage of transport. ICTs can optimize and improve transport operations across multiple segments, and their widespread use influences demand for transport and mobility, in terms of both spatial distribution and volume.

Studies have explored this phenomenon and its implications for vehicle drivers and owners, passengers (riders), customers (receivers of cargo), and shippers (sellers of cargo), as well as for vehicle design, congestion, and pollution. This working paper reviews some of this literature to understand the benefits and costs of integrating freight and passenger transport.

Intuitively, the benefits of integrating passenger and freight transport are a reduction in emissions, congestion, and improvement in vehicular efficiency. A study of co-modality in Venice (Italy) and Velenje (Slovenia) by Bruzzone et al. (2020) highlighted improved capacity utilization, a boost in operational

Figure 4 | Three-wheeler registrations in India over the years (fuel-wise)



Notes: BOV = battery-operated vehicle; CNG = compressed natural gas; LPG = liquefied petroleum gas; Gasoline/CNG and Gasoline/LPG are hybrid vehicles.
Source: MoRTH (2023) (without AP, TL, and MP data).

efficiency, reduced air and noise pollution, and decreased congestion. In Velenje, the quantity of mail and parcels rose fourfold as shippers offered more frequent service to otherwise isolated areas.

In another study, Ronald et al. (2016) argue that the benefits of such a system could depend on the demand patterns for both passengers and parcels. The authors looked at integrated transportation of passengers and parcels by cars and vans and found that the trip rates were lower in the integrated scenario due to more parcels and passengers being handled in a single trip. Van Duin et al. (2019) concluded that cargo-hitching can reduce emissions, save time, and provide nonmonetary benefits such as increasing social inclusiveness.

ASSESSING THE NEED FOR DUAL USE IN URBAN FREIGHT IN INDIA

This paper builds on existing research. It finds that in India, growing demand for urban freight deliveries in the lower load range causes inefficient utilization of vehicles with higher load-carrying capacities, leading to congestion and pollution. It also finds that the growth of e-commerce and other com-

mercial enterprises adds to the necessity for more efficient and optimized urban deliveries and a framework to ensure delivery modes in smaller load ranges. It examines the feasibility of using an existing vehicle category to address the growing demand for last-mile deliveries without adding new vehicles on the road.

Objective

Assess the viability and complementarity of dual use of passenger transport and goods delivery using three-wheeler autorickshaws.

This working paper will address the following chief research questions:

- Is there a critical market demand for transporting goods between 30 and 350 kg for urban, hyperlocal deliveries, and can the use of autorickshaws help overcome that gap?
- What are the potential safety, socioeconomic, and environmental impacts of dual use of three-wheeler autorickshaws?
- What regulatory and policy measures are needed to support dual use of autorickshaws for last-mile urban freight delivery?

Methodology

To answer these questions, we employed a mixture of qualitative and quantitative methods such as key informant interviews (KIIs), primary survey, and policy analysis.

Key informant interviews

One-on-one discussions were conducted with autorickshaw industry, regulation, and policy experts to understand the inefficiencies and needs of urban freight systems. These included experts from governmental automotive research agencies with three decades of regulatory and safety experience, vehicle design experts from premier academic institutions, private sector logistics leaders, and leading original equipment manufacturers.

The analysis of the KIIs offered insights into how passenger autorickshaws, their design, and regulation have evolved over the decades, and how the needs for freight and passenger transport could be complementary. Additional expert interviews delved into understanding how to leverage the synergy of both sectors to develop dual-use capacity, and questions such as whether dual use would require design changes to existing vehicles.

Review of policies and regulations

Policy review and regulatory landscape analysis included the study of legislation and of regulations in various countries to understand current global practices.

Primary survey

The aim was to reach all critical stakeholders within the commercial goods supply chain and the mobility sphere to inform our research on the viability of dual use to address current gaps and evaluate its potential impacts on the urban freight ecosystem. We sought to understand the specific needs of different stakeholders, their supply chain patterns, and operation models.

Since there are no existing studies of dual-use autorickshaws, we collected extensive primary data to help evaluate gaps in the current freight system in urban areas, and how those can be bridged by the dual use of autorickshaws. In addition to need and possible usefulness, the primary survey helped to evaluate regulations around the practice and potential operational constraints.

Methodology of survey

We surveyed diverse stakeholders, with separate questionnaires designed to cater to different stakeholders, including micro-, small, and medium enterprises (MSMEs), dealers, distributors, wholesalers, retailers, original equipment manufacturers, and vehicle design experts. We surveyed three-wheeler autorickshaw

owners and drivers to understand vehicle use, current earnings, safety, hours of operations, and peak hours of service. In addition, based on vehicles' operational characteristics, we analyzed their environmental impact in terms of greenhouse gas (GHG) emissions per km.

Our sample size included a total of 1,388 responses collected from demand-side MSMEs (n = 338); retailers, dealers, distributors (n = 442); and supply-side three-wheeler autorickshaw drivers (n = 608). We conducted the survey in five cities—Bengaluru, Delhi, Hyderabad, Lucknow, and Pune (Figure 5). All further assessments of regulatory practices and policy lessons learned will be done for these cities. Samples were collected randomly in a stratified manner, splitting up stakeholders by subgroups based on their shared attributes, like demand-side MSMEs, retailers, and supply-side on-the-ground operators like driver-owners, to get diverse viewpoints in terms of operations, regulations, safety, and income. We conducted these surveys in public areas where autorickshaws congregate, and no personal details were collected for any of the stakeholders surveyed.

The five cities range greatly in size. Delhi, Bengaluru, and Hyderabad have populations of more than 10 million, whereas Lucknow and Pune have around 4 million inhabitants. These differences allowed us to disaggregate survey findings by geographic area.

Furthermore, the identified cities have a high estimated gross state domestic product, signaling economic growth and the rise of industries. Delhi stood at US\$123.90 billion in 2021–22, and increased at a compound annual growth rate of 8.89 percent from 2015 to 2016, while Uttar Pradesh (the state of which Lucknow is the capital) stood at \$294.90 billion in 2021–22 (MoSPI 2022). Systemic industrial growth makes these cities an opportune ground for analysis, as their experience suggests how rapid economic growth will affect other cities across India.

Micro-, small, and medium enterprises contribute significantly to the nation's economy and promote inclusive growth (Sivasree and Vasavi 2020). The identified cities have a high concentration of MSMEs. Lucknow leads with 3.1 million identified enterprises, followed by Hyderabad at 2.6 million, then Delhi, Bengaluru, and Pune with 0.94 million, 0.26 million, and 0.2 million MSMEs, respectively (MSME 2022). These cities are good places to study dual use, because they are already experiencing a surge in MSME demand for deliveries that will spread to other parts of India as well.

Stakeholders' and human subjects' consent

Participating in this survey was completely voluntary and under informed human subjects' consent. Participants were informed that data collected related only to operational, design, and safety characteristics of three-wheeler autorickshaws, and that no personal or sensitive information that could have a detrimental impact on them would be collected. They were given the option not to answer survey or interview questions that made them sad, upset, or nervous and to stop participating at any time. The survey questionnaire was designed to take about 15–20 minutes.

The list of stakeholders surveyed included

- micro-, small, and medium enterprises
- dealers, distributors, wholesalers, and retailers
- three-wheeler autorickshaw owners and drivers
- original equipment manufacturers
- regulatory and design experts

Owners and drivers of three-wheeler autorickshaws were asked about vehicle use, current earnings, hours of operation, peak hours of service, and whether they might be willing to provide logistic services (move cargo) while also catering to passengers. MSMEs and retailers were surveyed to understand their business model and current transportation patterns, and to gauge the need for alternative ways to transport cargo.

Figure 5 | **Cities identified for primary survey**



Source: Authors.

Limitations of the research methodology

The primary survey was conducted in five cities with respondents randomly selected as representative samples of the entire ecosystem. The limited sample size is a limitation of the study.

The research is preliminary in nature and designed to stimulate and inform conversations on all aspects of dual use. However, the understanding of impacts is limited, in particular the environmental effects, since currently GHG emissions are calculated based on emissions factors and fuel types, but the age of the vehicles is not taken into account due to lack of data. This is a further limitation of the study.

ANALYSIS AND CHALLENGES OF DUAL USE

Assessment of market demand

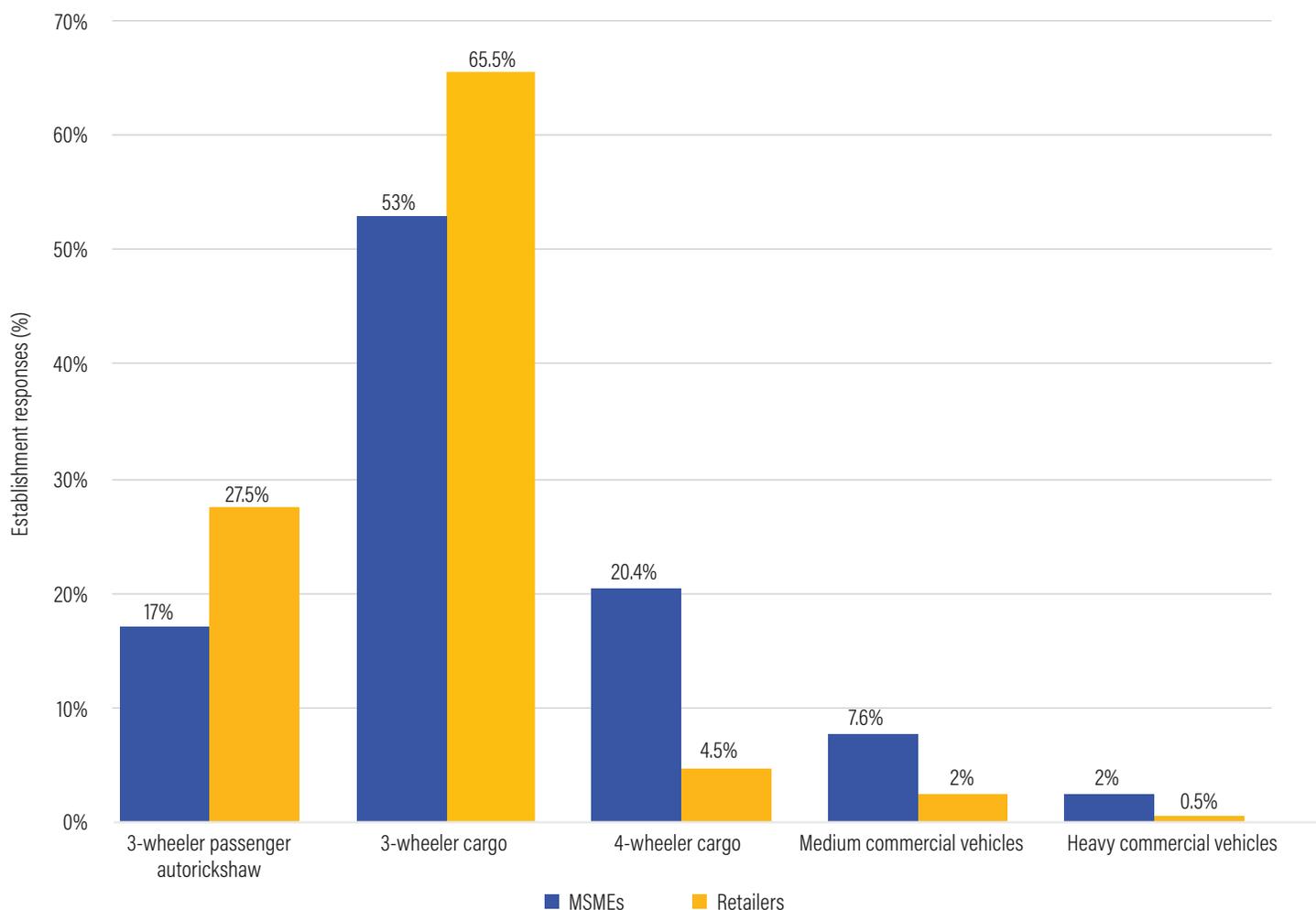
Key research questions for this study are whether there is a need for more ways to transport loads in the range of 30–350 kg, and whether autorickshaws could meet this need while providing additional income for autorickshaw owners and drivers.

For this we need to understand the prevailing scenario of last-mile goods transportation and assess the level of load optimization. The low levels of load optimization due to varied delivery destinations and timing imply the need for lower-capacity vehicles, which can also bring down the often-high cost of last-mile delivery.

In India MSMEs are complementary to larger industries and contributed 30 percent to gross domestic product in 2019–20 (MSME 2021). Our survey of MSMEs and retailers revealed that while most prefer to use three-wheeler and four-wheeler cargo vehicles to transport goods, the vehicles are generally not fully loaded, which raises the per kg cost of freight transport (see Figure 6).

The overall urban logistics sector is currently disaggregated, which makes it hard to consolidate loads. Orders delivered may also be time-sensitive—due to short shelf life or the need for immediate delivery—leading to partial utilization of bigger cargo vehicles. Establishments across MSMEs and retailers reported in the survey that they partially load cargo vehicles regularly, with two-thirds of both categories saying they partially loaded on 50 percent or more of their trips (Figure 7).

Figure 6 | Modes used by MSMEs and retailers for goods transport



Notes: MSMEs = micro-, small, and medium enterprises.

Classification by gross vehicle weight: four-wheeler cargo = < 3.5 tons; medium commercial vehicle = > 3.5 and < 12 tons; heavy commercial vehicle = > 12 tons.

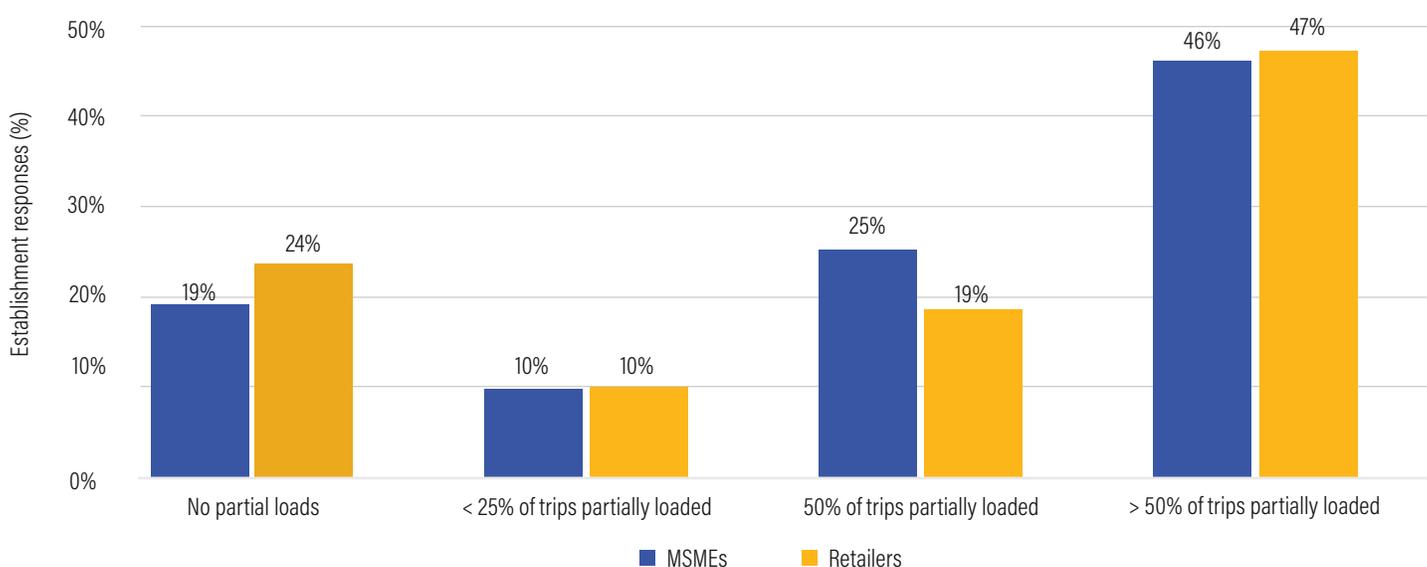
Source: Vahan (2023).

Table 1 | Maximum permissible payloads standardized by Ministry of Road Transport and Highways for different vehicle categories

VEHICLE TYPE	EXAMPLE VEHICLES	MAXIMUM ALLOWABLE CARGO WEIGHT
Two-wheelers	HCD India NPS Cargo, Zypp Cargo Electric Scooter	30 kg
Three-wheeler cargo vehicles	Piaggio Ape, Bajaj Maxima, Mahindra Treo	400 kg
Four-wheeler mini trucks	Tata Ace, Mahindra Supro, Maruti Suzuki Super Carry	750 kg

Table 1 compares loads that can be carried by various two-, three-, and four-wheeled cargo vehicles. Three-wheel autorickshaws, which can safely carry loads up to 300 kg, could fill the gap between currently available transport modes.

Figure 7 | **Loading profile of cargo three-wheeler vehicles by MSMEs and retailers (one-way)**



Note: MSMEs = micro-, small, and medium enterprises
Source: Authors.

Table 2 | **Analysis of fare variations between 3W passenger autorickshaws and 3W cargo vehicles, Delhi**

DISTANCE	VEHICLE TYPE	9 a.m.	12 p.m.	3 p.m.	6 p.m.
5 km	3W autorickshaw (L5M)	Rs. 91	Rs. 99	Rs. 90	Rs. 115
	3W cargo (L5N)	Rs. 475	Rs. 468	Rs. 575	Rs. 575
10 km	3W autorickshaw (L5M)	Rs. 119	Rs. 127	Rs. 120	Rs. 119
	3W cargo (L5N)	Rs. 426	Rs. 405	Rs. 526	Rs. 526
15 km	3W autorickshaw (L5M)	Rs. 180	Rs. 188	Rs. 181	Rs. 180
	3W cargo (L5N)	Rs. 582	Rs. 532	Rs. 678	Rs. 678
25 km	3W autorickshaw (L5M)	Rs. 255	Rs. 263	Rs. 256	Rs. 254
	3W cargo (L5N)	Rs. 863	Rs. 863	Rs. 1,029	Rs. 1,029

Source: Porter Blog (2022).

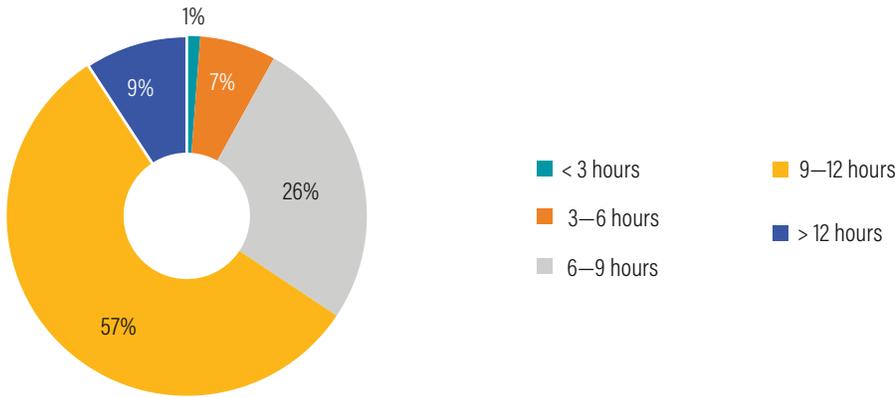
Table 2 shows transportation costs in different areas of Delhi at varying distances and different times of day. On average, passenger fares in a three-wheeler autorickshaw cost half as much as using cargo vehicles. Autorickshaw transport can therefore lower costs and reduce logistical burdens for MSMEs.

But do three-wheeler passenger autorickshaw drivers have time to devote to moving goods? Our survey suggests that, while

more than half of the drivers reported 9–12 hours of net operational time in a day (excluding meal and rest breaks), the average daily utilization of autorickshaws was lower (see Figure 8).

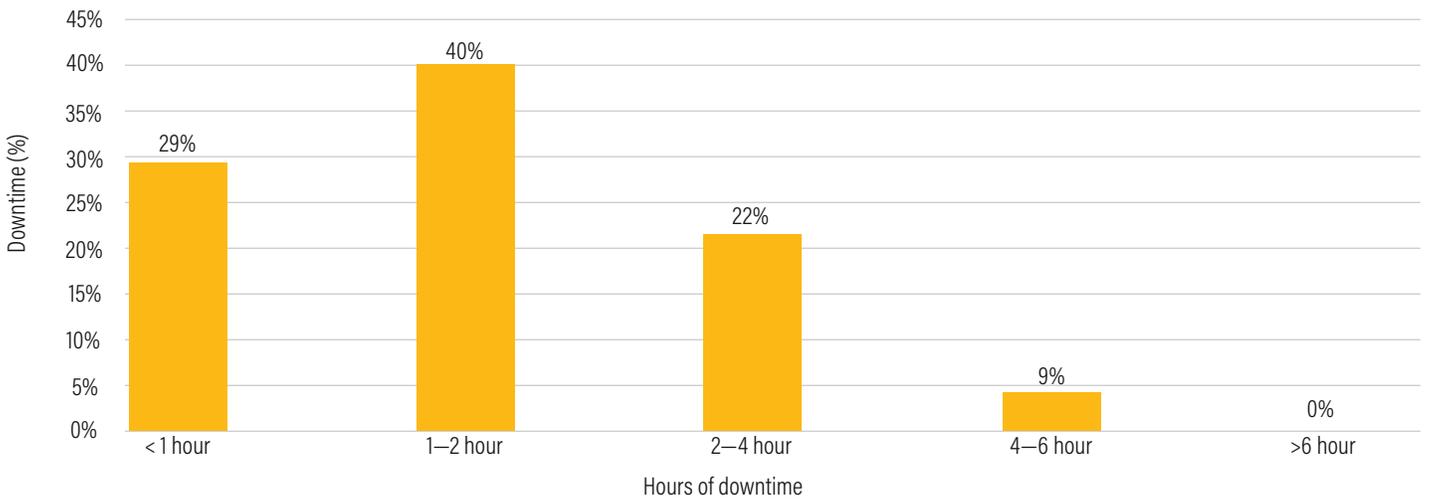
Among drivers working 6–9 hours a day, 40 percent reported an average of 1–2 hours of downtime spent waiting to pick up and drop off passengers; drivers working 9–12 hours a day reported 2–4 hours of downtime (see Figures 9 and 10). This is time they could put to other uses.

Figure 8 | Operational hours of passenger autorickshaws (excluding meal and rest breaks)



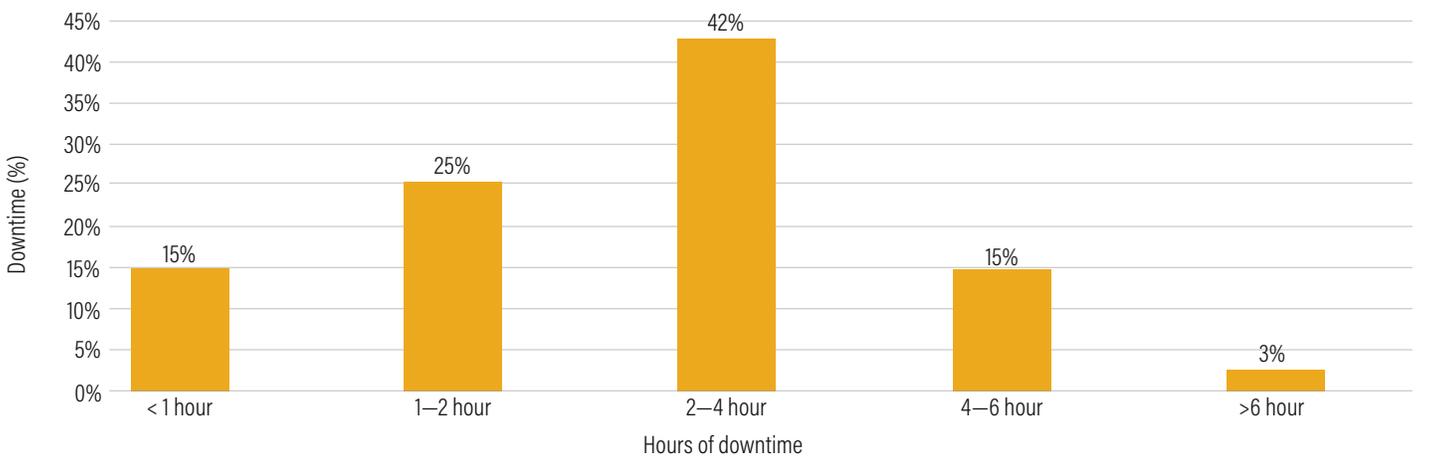
Source: Authors.

Figure 9 | Downtime for 6-9 hours of operation



Source: Authors.

Figure 10 | Downtime for 9-12 hours of operation



Source: Authors.

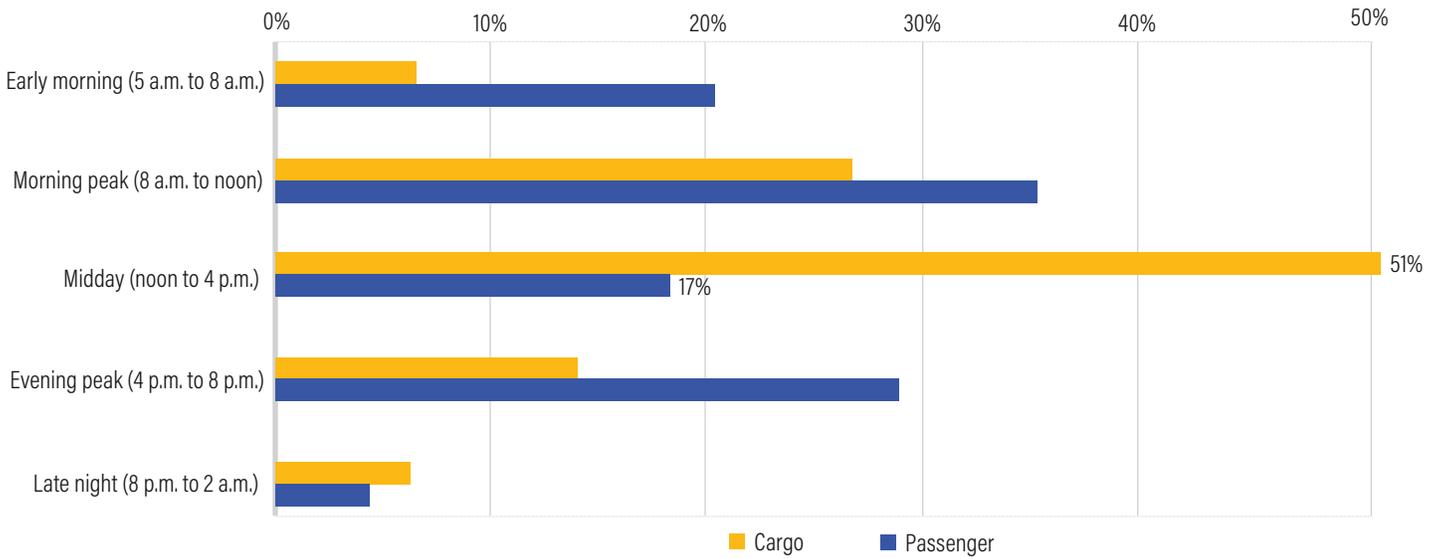
Most important, the peak demand times for transporting passengers and cargo are complementary. More than half of goods are delivered between noon and 4 p.m. This could be due to traffic restrictions in a few major cities that do not allow delivery vehicles inside the urban center during rush hours.

Findings summarized in Figures 11 and 12 corroborate expert opinion that most autorickshaw drivers would not take up deliveries of goods when there is high demand from passengers.

Since maximum demand occurs during the morning and evening commutes, the time bracket between 12 p.m. and 4 p.m. is most convenient for goods order pickups (Porter Blog 2022).

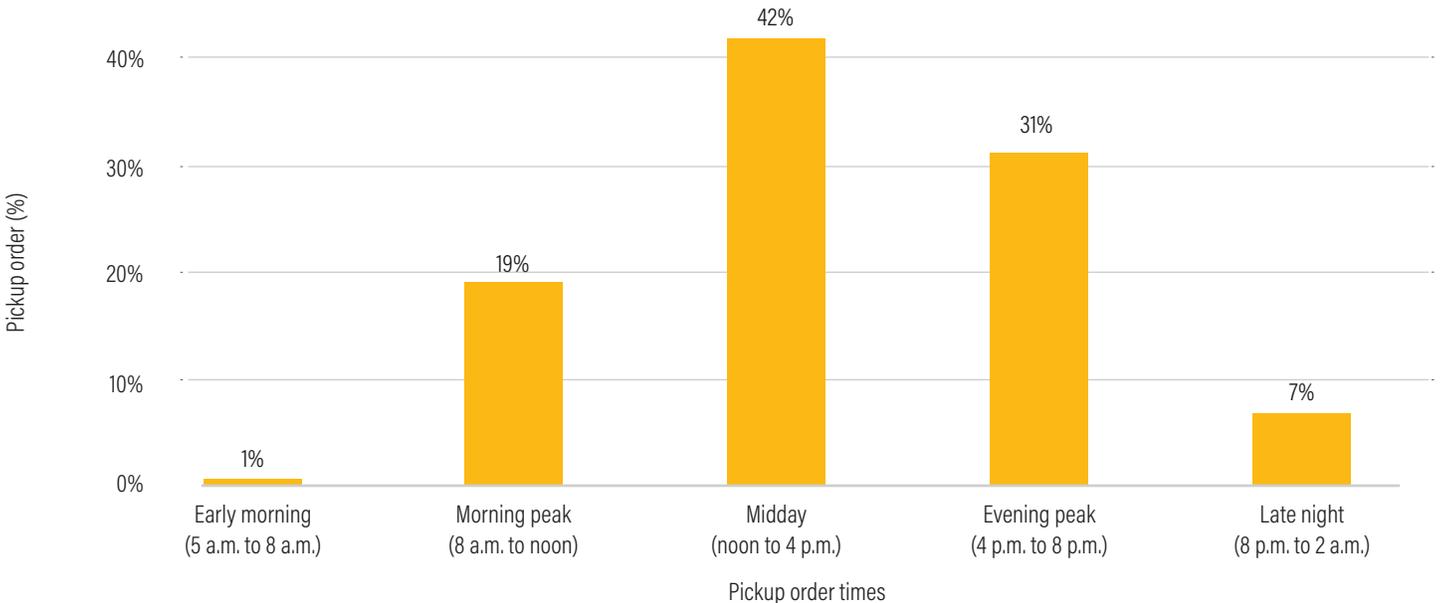
Over the course of the primary survey, autorickshaw drivers were asked whether they made dual-use trips; that is, both passenger and goods trips in a day. An overwhelming majority, 72 percent (458), answered that they made dual trips (Figure 13).

Figure 11 | Typical delivery times for goods by three-wheeler passenger autorickshaws versus peak passenger trips



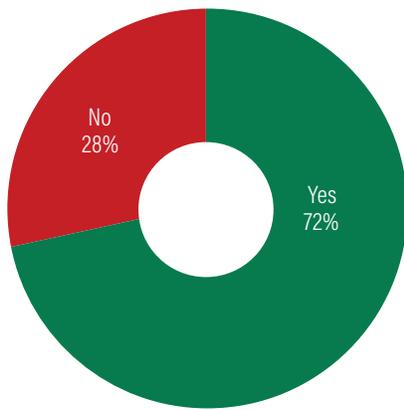
Source: Authors.

Figure 12 | Typical pickup times for goods booked on the platform



Source: Porter Blog (2022).

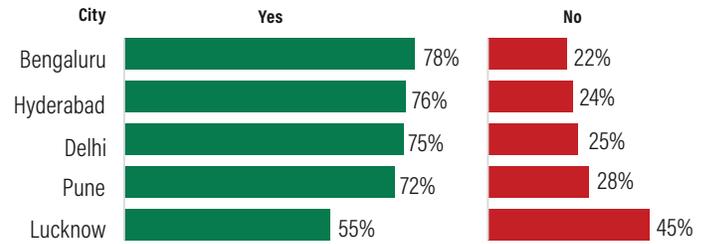
Figure 13 | Do you make dual-use trips with passenger three-wheeler autorickshaws?



Source: Authors.

This held true across regions, with close to three-quarters of respondents practicing dual use in Bengaluru, Hyderabad, and Delhi. Only in Lucknow was the share far lower (55 percent) (Figure 14). Potential reasons could be the predominance of other micromobility options, like the hand-drawn carts and cycles used for transporting goods over short distances in that city.

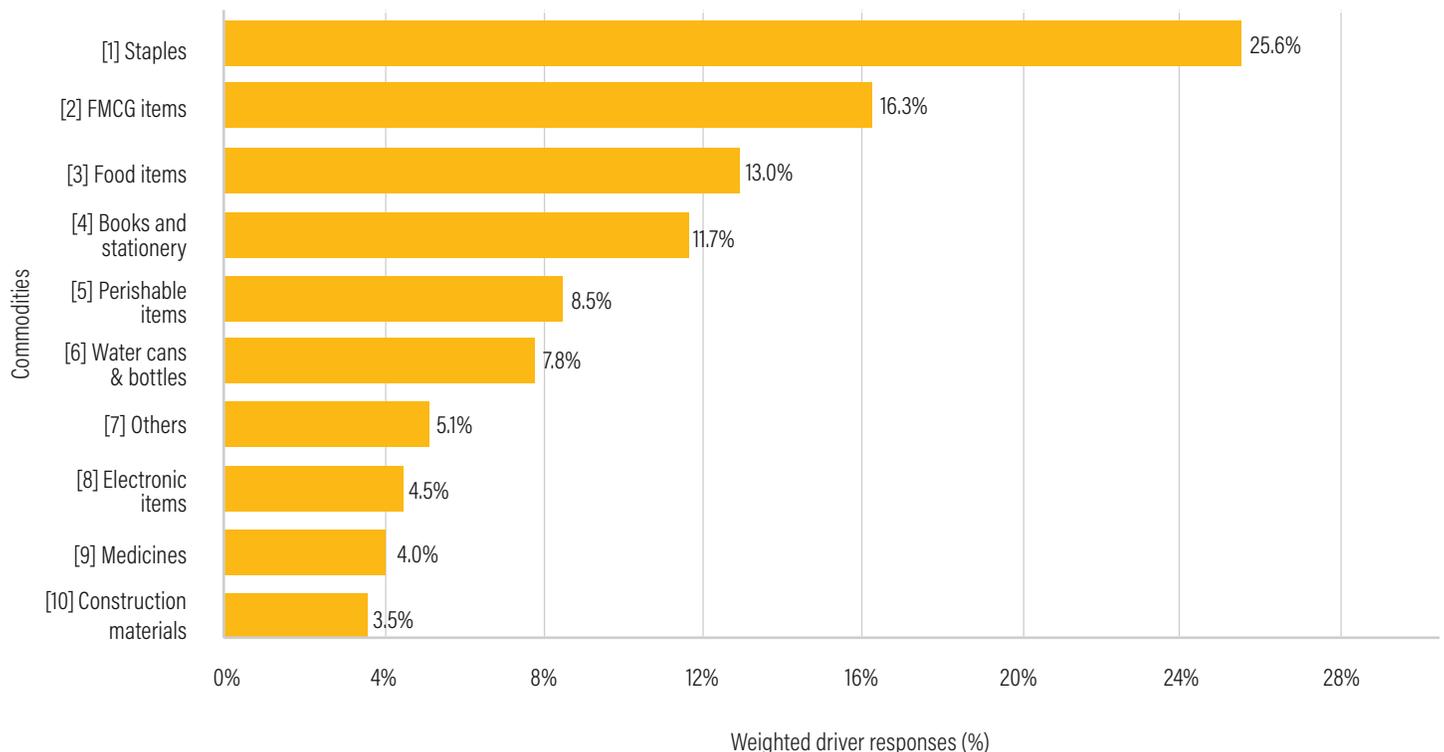
Figure 14 | Dual-use practices recorded in different cities across India



Source: Authors.

We also asked autorickshaw drivers what types of freight they carried, ranking the commodities on a scale of 1 to 10, from the most (1) to the least frequently transported (10) (Figure 15). These responses were then weighted on arithmetic mean scores and tabulated.

Figure 15 | Commodities most frequently transported by three-wheeler autorickshaws



Note: FMCG = fast-moving consumer goods

Source: Authors.

Around 26 percent of drivers ranked staples (bags of rice, wheat, dal, and other grains) as the most frequently transported commodity. They were followed by consumer goods like condiments, toiletries, consumables, and food items like catered meals and sweets. Construction materials like steel, bricks, and cement bags were the least frequently transported commodities by three-wheeler autorickshaws.

Assessment of safety, income, and environmental impact

Safety assessment

Both establishments (businesses such as MSMEs and retailers) and drivers surveyed provided key insights into safety precautions that will be needed if dual use is adopted more widely.

Among establishment respondents, 85 percent said safety measures are absolutely necessary before they will consider transporting goods on three-wheeler autorickshaws (Figure 16). Protective mesh and ropes are one of the top safety features requested by manufacturers and retailers. Some also stress the need to maintain optimum payload capacity, and limit speeds at which autorickshaws travel.

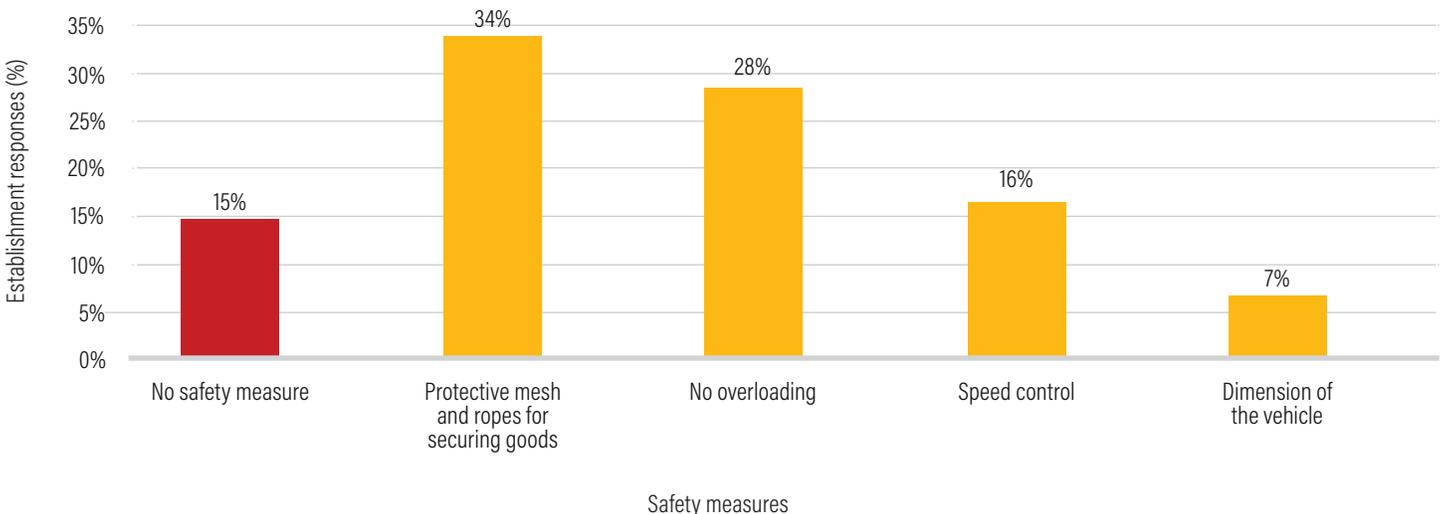
Most of the drivers surveyed were very particular about their safety and the safety of goods they transport, with 67 percent using some form of harness to secure the commodities (Figure 17).

The harnesses ranged from mesh or safety nets for the goods to having lashing points affixed to the vehicles, for attaching ropes to anchor goods in place.

In a passenger autorickshaw, a maximum of three passengers is allowed. Assuming an average weight of 70–75 kg per passenger, the cumulative weight of three passengers would be in the range of 200–250 kg. Around the same weight of payload capacity could be allowed for cargo. However, a bigger limiting factor than weight would be shape. Current regulations do not permit anything to protrude beyond the vehicle’s width, where it could hinder visibility or pose other safety hazards for other vehicles.

In addition, the cargo’s weight distribution matters. For example, turning a vehicle transporting a big liquid-filled vessel would be a challenge due to a shifting center of gravity, which could cause the autorickshaw to topple, posing significant risk not just to the driver but also to other vehicles. Studying the morphology of goods that could be transported in autorickshaws is therefore crucial.

Figure 16 | Essential safety parameters for establishments to transport goods in three-wheeler passenger autorickshaws



Source: Authors.

Safety challenges

INSTABILITY

In India, three-wheeler autorickshaws are predominantly of the delta configuration, with one wheel in the front and two wheels in the rear. Despite their multiple advantages, these vehicles are perceived to be at some risk of rolling over. Researchers have examined these perceptions and suggested best practices to improve three-wheeler rollover stability.

The major difference between three-wheelers and four-wheelers is in the axis about which the vehicle rolls. The axis of a four-wheeler lies at its center, whereas the axis of a three-wheeler lies along the line joining the single front wheel to one of the rear wheels on the two-wheeler axle. Skrucany et al. (2019) argue that the vehicle's center of gravity and where commodities are loaded directly influences braking. They concluded that a higher load on the rear axle than the front, to even out the load, improves braking deceleration and reduces braking distance (Skrucany et al. 2019).

Mukherjee et al. (2004), who compared public perception and the statistical probability of injury, concluded that a shield on the chassis of a three-wheeler passenger autorickshaw can stop a rollover because the shield hits the ground first if the vehicle tips, thus stabilizing it. This was also accepted by the committee of technical experts constituted by the Government of India in 2012 to address the safety issues of autorickshaws (MoRTH 2012).

Replacing passengers with cargo, especially voluminous or liquid, impacts the vehicle's momentum and center of gravity. The designed center of gravity in passenger autorickshaws handles the weight variation and distribution of one to three seated passengers. But during goods operations there is no assurance that the cargo will be stacked

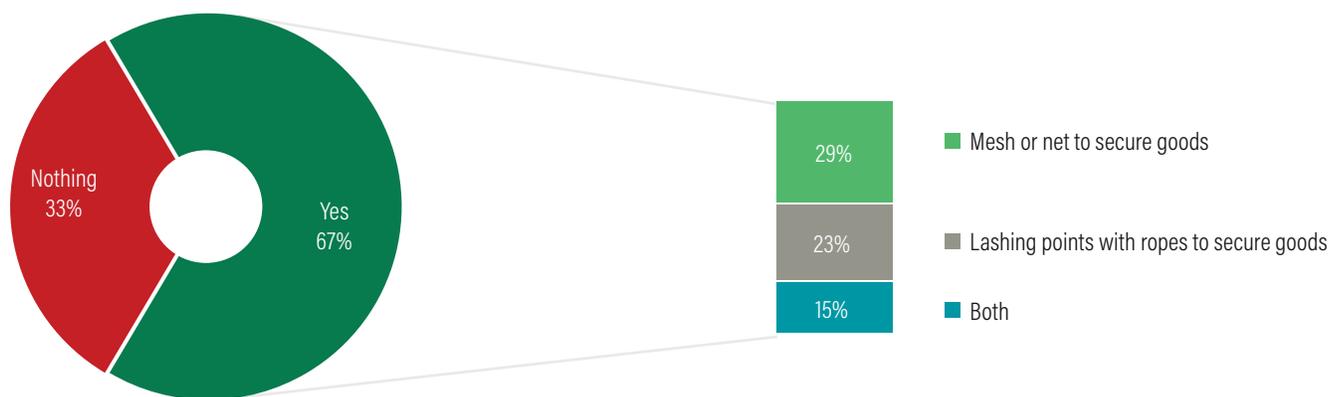
systematically to maintain the required weight distribution. In all likelihood, the driver will arrange the cargo based on form, fragility, or the delivery schedule, and not the load intensities.

This fact is also reflected in the driver survey responses. When drivers were asked whether transporting goods affected their autorickshaws' operational ability while maneuvering in traffic, responses were almost evenly split. While 56 percent did not experience any difference, 44 percent observed some increased instability (Figure 18). However, it was impossible to verify the weight being carried and how that influenced stability. Weight thresholds therefore need to be tested and defined.

The drivers who did report differences in operational ability most commonly cited slower acceleration and more instability while rounding sharp curves or braking suddenly. Some also pointed to reduced braking capacity and ability to climb steep gradients while carrying goods (Figure 19).

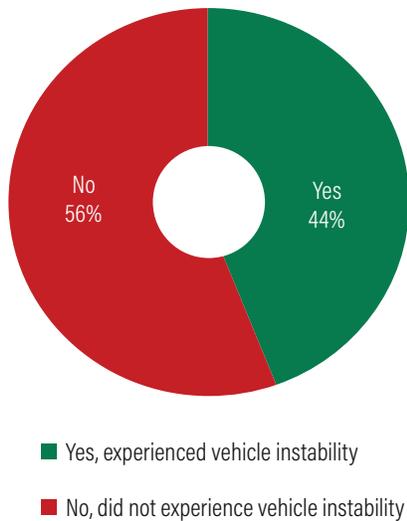
Three-wheeler autorickshaws in India are designed for top speeds of 45–65 kilometer per hour (kmph) (MoRTH 2012). Because they have smaller engines of 200–300 cubic centimeters and are generally slower than four-wheelers, they are considered inherently safer. Many respondents to the survey also indicated that they favored traveling at 20–30 kmph when carrying goods. While safety could be one of the main reasons for this preference, we should also note that the mean average road speed in major cities in India is only around 23.6 kmph (Akbar et al. 2021). Trouble with steep hills could stem from overloading cargo, not just from carrying it. Therefore, not just perceived issues but actual reasons also need to be studied further.

Figure 17 | Safety measures employed by autorickshaw drivers while practicing dual use



Source: Authors.

Figure 18 | Drivers' experience of operational ability while carrying goods in autorickshaws



Source: Authors.

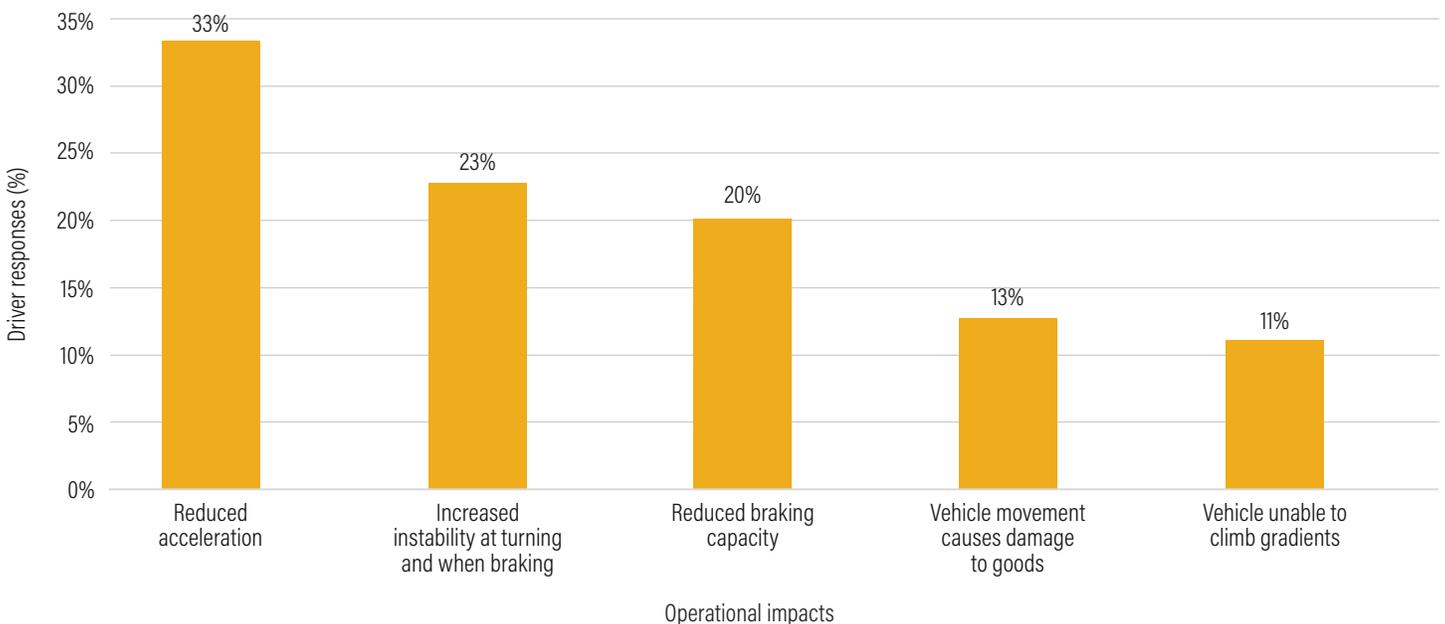
OVERLOADING

One of the foremost causes of crashes and fatalities on Indian roads is the overloading of cargo vehicles. A recent report by the Ministry of Road Transport and Highways (MoRTH) found that overloaded vehicles were responsible for 6.1 percent of total accidents, 7.2 percent of fatalities, and 6.6 percent of injuries in 2021 (MoRTH 2021). Vehicles' tires burst from excess weight, brakes wear out due to excessive friction, and shifting excess weight heightens the risk of a rollover. While existing regulations like the Motor Vehicles Act Section 194 (1) define permissible limits for autorickshaw operation when transporting passengers, new thresholds for dual use would need to be defined.

Our survey asked autorickshaw drivers a series of questions about safety and their loading inclinations, especially when carrying commercial goods. Respondents who made dual trips mostly reported placing commodities in the back passenger compartment (76 percent). A small fraction (10 percent) placed goods on the top of the vehicle when carrying commodities with dimensions that could not be accommodated inside the vehicle (Figure 20).

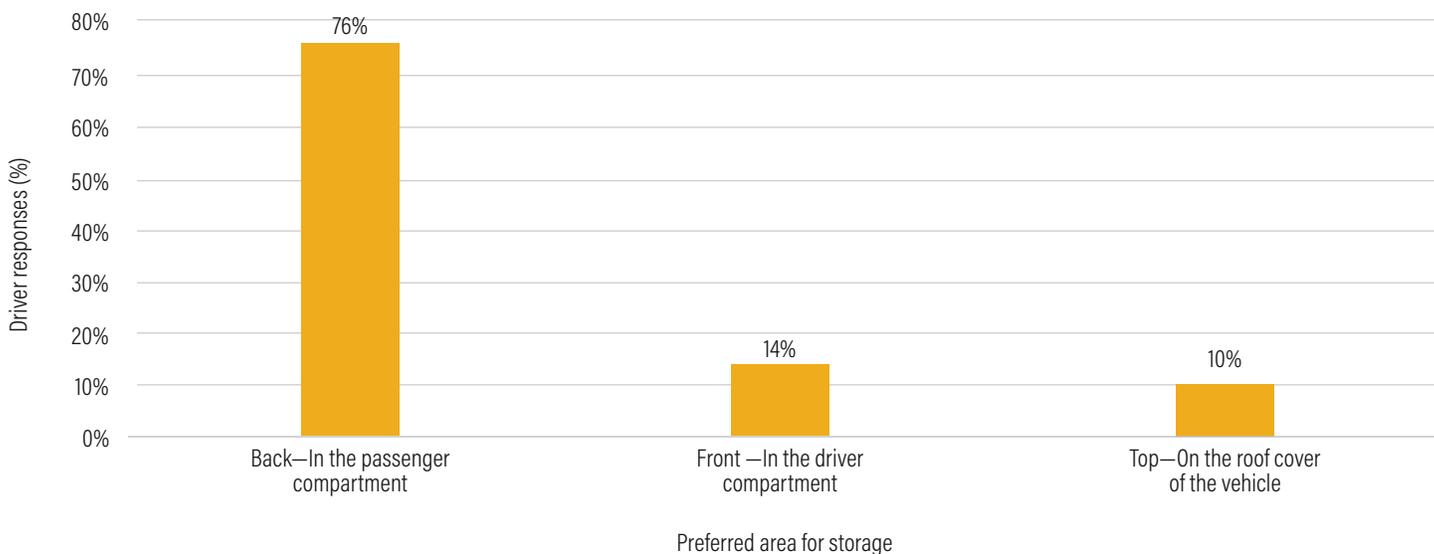
In India, the payload capacity of the top-selling three-wheeler autorickshaw models ranges from 300 to 320 kg (see Appendix B). While the survey showed that most drivers rarely or never overload their vehicles, a significant subset of drivers (29 percent) are inclined to carry goods way above the limits, highlighting the need for a stringent regulatory structure with safety directives for dual use (Figure 21).

Figure 19 | Impact on operational ability caused by carrying goods in autorickshaws



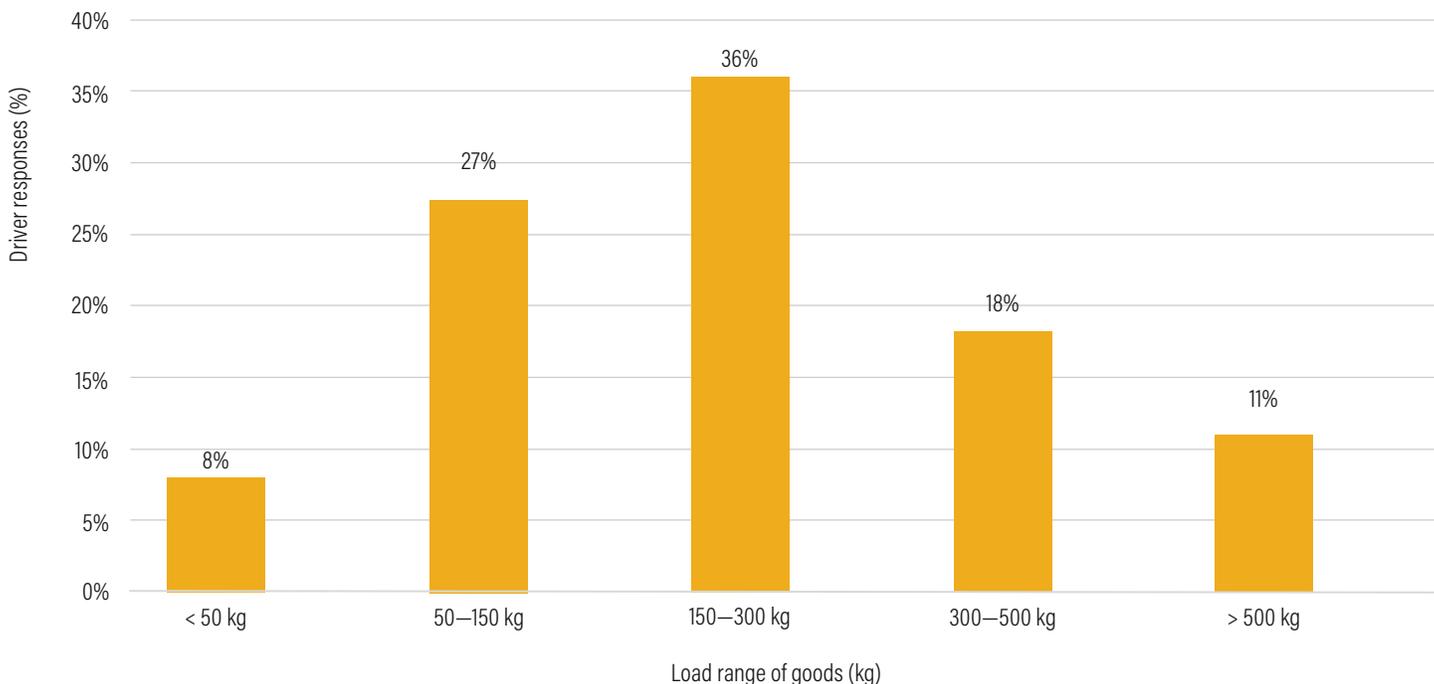
Source: Authors.

Figure 20 | Preferred area for storage of goods in three-wheeler passenger autorickshaws



Source: Authors.

Figure 21 | Average quantity of goods transported per trip in three-wheeler passenger autorickshaws



Note: kg = kilogram.

Source: Authors.

Table 3 details safety parameters that experts we interviewed identified as needing to be instituted before dual use could be formalized.

Table 3 | **Experts' opinions on required safety parameters for dual use of autorickshaws**

SAFETY PARAMETERS	EXPERTS' OPINIONS
Dimensions of goods to be allowed	<ul style="list-style-type: none"> ▪ The allowable dimension of the goods would vary according to the volume of a given autorickshaw model's passenger compartment but would be in the range of 3 ft (length) x 4 ft (width) x 2 ft (height) = 24 ft³. ▪ Goods should be contained in proper packaging with no pointed edges or loose ends, so as not to damage the vehicle. ▪ Goods should be restricted to the passenger compartment and should not be allowed to jut out of the vehicle.
Range of speed	<ul style="list-style-type: none"> ▪ Average operating speeds of 40–45 kmph could be feasible, but maximum speed will depend on the type of goods carried and would require vehicle dynamics tests. ▪ Care must be taken to ensure controlled braking and acceleration so that the vehicle does not become unstable during transportation of goods.
Loading capacity range	<ul style="list-style-type: none"> ▪ A few experts suggested allowing a range of 250–300 kg for normal goods and around 210 kg for voluminous goods. But they added that to establish a definitive range of load capacity, further vehicle dynamics studies, under various loading patterns, might be needed, with uniform grading of weight categories along with different types of goods. ▪ Some experts argued that allowable loading capacity should be fixed at not more than 225 kg.
Types of goods NOT to be carried	<ul style="list-style-type: none"> ▪ Goods at high temperature, liquids, or products like glues, acids, and chemicals that, if spilled, could cause irritation for passengers and damage the vehicle should be prohibited. ▪ Flammable materials must not be allowed. When transporting goods, BIS IS 18149:2023 guidelines should be followed. ▪ Only goods that do not affect the vehicle's center of gravity should be allowed. Some experts remarked that voluminous goods like water bottles and canisters, which could cause rapid shifts in the center of gravity during sudden braking or turning, should be evenly spaced and individually anchored.
Safety measures that can be used	<ul style="list-style-type: none"> ▪ Most experts agreed that meshes or a harness can be used to protect cargo. They also stressed that this mesh is needed not only at the doors but also between the driver compartment and the passenger or cargo compartment so goods do not fall on drivers during hard braking or turning. ▪ Some experts suggested securing cargos with locking mechanisms. ▪ Standard cargo netting fabric like polyester could be used to secure goods and be fixed at ends. BIS IS 11927:1987 (specification for netting and fiber rope load restraint systems) and IS 11521 (cargo handling nets) standards could be referred to define corresponding parameters for 3W autorickshaws. ▪ A few experts suggested that safety belts made of nylon filament yarn or high-tensile polyester filament yarn (similar to ones used in passenger cars) could be used to keep goods in place. Here AIS-005/2000 (safety belt assemblies) can be referred to develop similar specifications to retain the operational safety of the autorickshaw. ▪ While some experts believed thin tarpaulins affixed to lashing or vantage points could secure goods without reducing visibility for the driver, others disagreed, believing that tarps would only provide weather protection and not prevent goods from falling out of the vehicle. ▪ Most experts recommended minor design changes like foldable or movable seats with hinges to make the goods space more flexible.
Other safety practices / comments	<ul style="list-style-type: none"> ▪ Goods must be stacked systematically, with heavier items loaded first and kept at heights below the seat (passenger leg-room area) for a lower center of gravity. ▪ Autorickshaws should have markings on the side indicating the allowable dimensions for goods, to help in quick visual enforcement. ▪ New standards might need to be created along with a fresh type of approval for dual use. ▪ To ensure effective enforcement, substantial fines should be levied for overloading and improper loading.

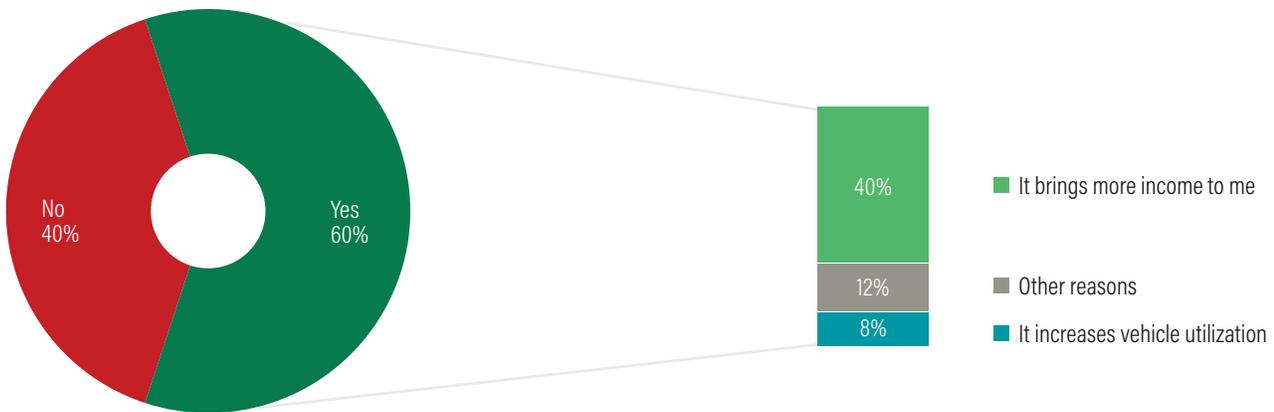
Source: Author conversations with industry experts.

Additional income

Prior research indicates that dual use can increase autorickshaws' utilization value per unit, as each vehicle would spend less time idle. Utilization is projected to rise from 30–35 percent to 60 percent (CDEP 2022). The added trips may be profitable for drivers as well.

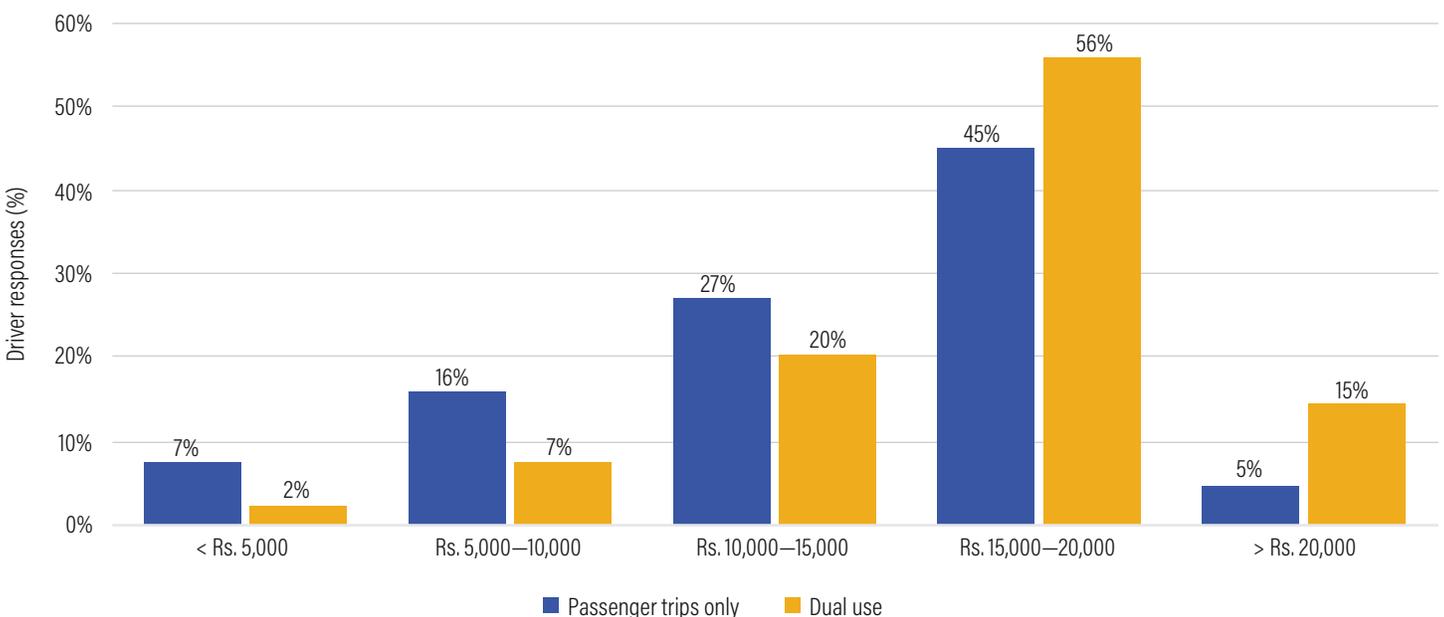
To gauge the likelihood and size of potentially increased earnings, our survey asked respondents already transporting small consignments of cargo whether this practice is beneficial to them. Sixty percent of these drivers felt it was beneficial to them, with around 40 percent stating that it brought them more income, and 8 percent indicating it increased their vehicle utilization (Figure 22). Those who did not find it beneficial mainly cited the inconvenience of additional loading and unloading of goods and worries about damage to their autorickshaw.

Figure 22 | Drivers' response on the practice of dual use : Is it beneficial to you?



Source: Authors.

Figure 23 | Net income of drivers between passenger-only trips and dual-use trips



Source: Authors.

Subsequent analysis of all drivers’ net income—their earnings after fuel expenses, rent, and maintenance—revealed that drivers who practiced dual use earned more. About 71 percent of them earned more than Rs. 15,000 per month, compared to 50 percent of those who made only passenger trips (Figure 23).

Also, our analysis showed that drivers making dual trips earned around 15 percent more than drivers who only made passenger trips. When disaggregated by geographic area, Delhi had the highest net income gap (22 percent), followed by Bengaluru and Hyderabad, with differences of 20 and 16 percent, respectively. Earnings differences in Pune and Lucknow were 11 and 9 percent, respectively.

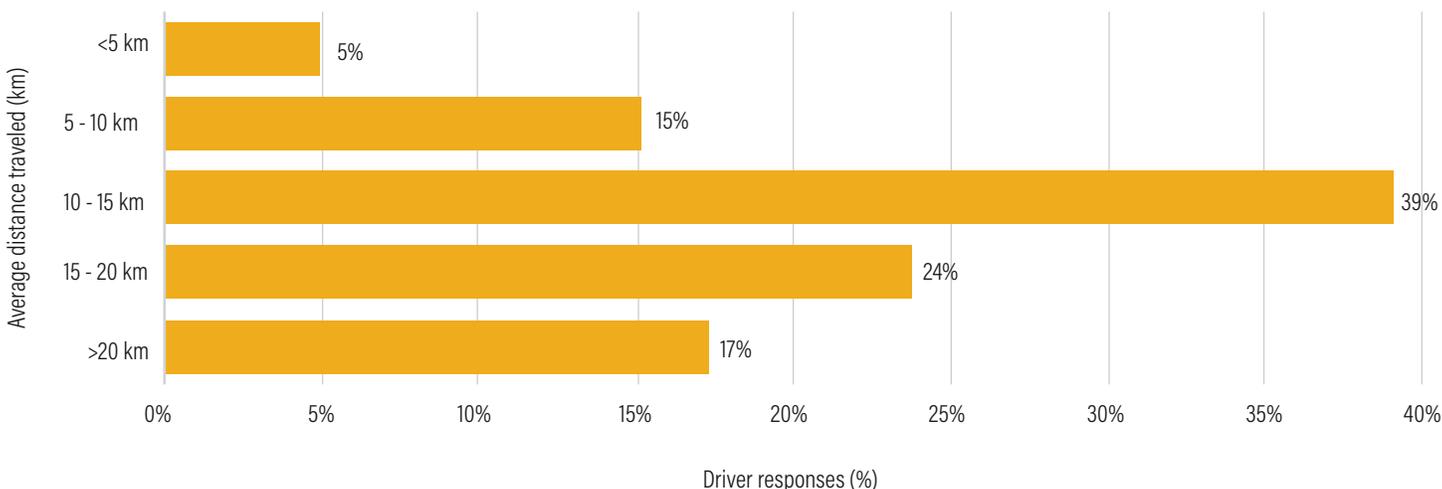
Other analysis, based on limited surveys, suggests that dual use of autorickshaws can increase drivers’ earnings by as much as 60 percent (Porter Blog 2022).

Impact on GHG emissions

India’s transport sector has the fastest-growing emissions of any sector (Kamboj et al. 2022) and is responsible for 13.5 percent of total energy-related carbon dioxide (CO₂) emissions (Climate Action Tracker 2020). Any innovative mobility models proposed must strive to align with the country’s larger decarbonization target of net zero by 2070.

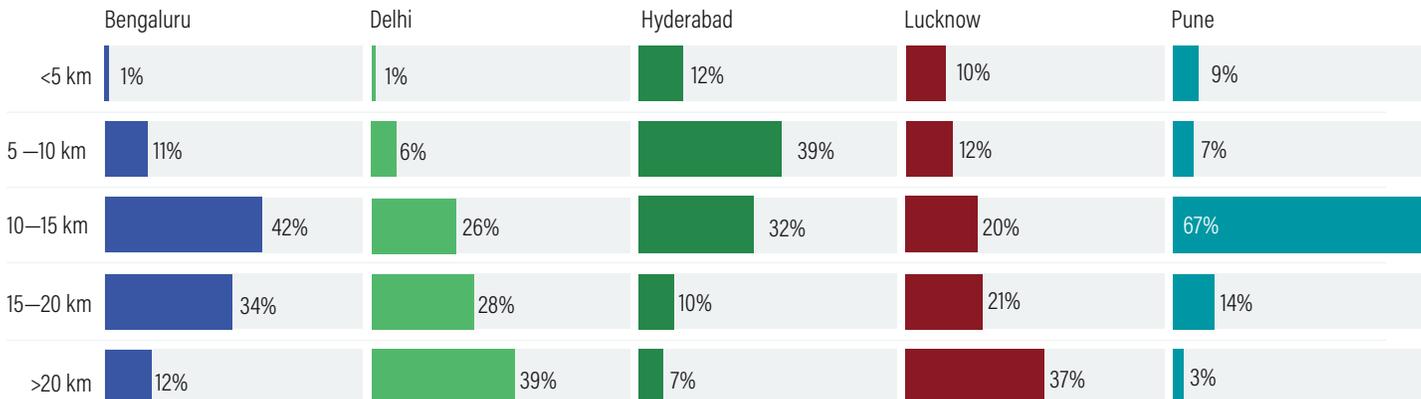
To analyze the environmental impact of dual use on cities, autorickshaw drivers were asked various operational questions like which fuels they use and how often they refuel, as well as the average distance they travel per trip to transport goods. Two-thirds of the respondents across five cities reported traveling from 10 to 20 km per trip (see Figures 24 and 25).

Figure 24 | Average distance traveled per trip by three-wheeler passenger autos to transport goods



Note: km = kilometer.
Source: Authors.

Figure 25 | Average trip length, by city



Note: km = kilometer.
Source: Authors.

In 2022, of the total three-wheeler passenger vehicles registered in the country, 64 percent used close compressed natural gas as fuel (MoRTH 2023). Many states, like Maharashtra and Delhi, have enforced restrictions to allow only CNG autorickshaws on their roads. A three-wheeler CNG autorickshaw releases about 77.7 grams per kilometer (g/km) of CO₂, while a larger three-wheeler diesel cargo vehicle, with a payload capacity of 500 kg, releases nearly twice as much, 131.61 g/km of CO₂ (ARAI 2008).

Assuming the average single trip length to be 15 km, a three-wheeler CNG autorickshaw loaded at 250 kg would emit 4.66 g of CO₂ emissions per km/kg of goods carried compared to a partially loaded three-wheeler cargo, which will emit 7.90 g of CO₂ emissions per km/kg of goods carried for the same trip (Table 4). In other words, optimum utilization of passenger autorickshaws could reduce CO₂ emissions by 51.5 percent on each trip.

Further research (Melo et al. 2014) suggests that adoption of electric variants to supplement internal combustion engine (ICE) autorickshaws could reduce energy consumption and overall CO₂ emissions by 3–4 percent, thereby providing one of the optimum avenues for decarbonizing the urban freight sector in the near future.

Assessment of current regulations

In India, the principal regulatory instruments governing the automotive sector are the Motor Vehicles Act of 1988 (MVA) along with the Central Motor Vehicles Rules of 1989 (CMVR).

Motor Vehicles Act of 1988 (amended in 2019) regulates all aspects of road transport vehicles and consolidates the law pertaining to motor vehicles in India. It has provisions for registration of motor vehicles, emissions norms, vehicle insurance, traffic regulations, permits, and penalties. To make roads safer, the Government of India, in consultation with state transport departments, drafted the Motor Vehicles (Amendment) Bill in 2019. This amendment, among other key changes, provided for a National Road Safety Board, to be created by the central government through a notification. This board will advise

the central and state governments on all aspects of road safety and traffic management, including standards for motor vehicles, registration and licensing of vehicles, standards for road safety, and promotion of new vehicle technology.

The **Central Motor Vehicles Rules of 1989** explain the MVA in detail.

From a regulatory standpoint, two categories of state-level permits apply to three-wheeler vehicles. Goods carriage permits are issued to three-wheelers used for transporting a certain maximum load within a specified area, generally within a state. Contract carriage permits are issued for “a motor vehicle that carries a passenger or passengers for hire or reward and is engaged under a contract, whether expressed or implied, for the use of such a vehicle for the carriage of passengers on a time basis, or from one point to another, and in either case without stopping to pick up or set down passengers not included in the contract.” Vehicles in the three-wheeler segment (categorized as L5 in the CMVR) can have either of these permits but not both.

Typically, three-wheeler cargo vehicles operate under goods carriage permits, and three-wheeler passenger autorickshaws hold contract carriage permits. To enable hybrid use, states would need to consider allowing passenger autorickshaws to operate under the provisions of both permits. However, should autorickshaw owner-operators be asked to pay extra to acquire a supplementary license for dual use, it would add a financial burden for many.

There is a precedent for regulatory interventions that address changing requirements on the ground to ease the movement of cargo. In 2016, MoRTH issued a notification to amend the Central Motor Vehicles Rules of 1989 and allowed for dual use of two-wheelers to carry up to 30 kg of goods (MoRTH 2016). The authorization of dual use of two-wheelers required an amendment to the CMVR due to the external modification required to equip a two-wheeler with a cargo box, whereas enabling dual use in autorickshaws requires no additional modifications not already permitted by previous amendments. This may allow dual use with a minimum set of guidelines from the central government.

Table 4 | Environmental impact of different vehicle types carrying 250 kg payload for average trip length of 15 km

VEHICLE TYPES	MODEL	FUEL TYPE	CO ₂ (emissions per km/kg)	PM	CO
3W autorickshaw	Bajaj RE	CNG	4.66 g	0.9 x 10 ⁻³ g	0.06 g
3W cargo	Bajaj Maxima	diesel	7.90 g	2.8 x 10 ⁻³ g	0.012 g
4W cargo	Tata Ace	diesel	24.08 g	4.9 x 10 ⁻³ g	0.159 g

Notes: CNG = compressed natural gas; CO = carbon monoxide; CO₂ = carbon dioxide; 4W = four-wheeler; g = grams; kg = kilogram; km = kilometer; PM = particulate matter; 3W = three-wheeler. Source: ARAI (2008).

In addition, there are enabling provisions in the form of 2019 amendments to the Motor Vehicles Act of 1988, particularly in Section 2B, Section 66A, and Section 67 (see Appendix C). The amendments seek to foster innovative schemes and develop a national transportation policy, which could give state regulators leeway to allow dual use of autorickshaws in cities to improve logistics efficiency in the last mile, promote social equity, and enhance upward income mobility for millions of drivers working in this ecosystem.

Another point for consideration is insurance. Currently, insurance for autorickshaws covers the passengers. If transportation of cargo is also permitted, businesses could insist, while this is not mandated by law, that their cargo also be insured against any mishaps. This also could create financial burdens for autorickshaw drivers and owners.

RECOMMENDATIONS

Autorickshaws' versatility on Indian roads, their lower environmental impact compared to underutilized cargo vehicles, their complementarity with passenger trips, and their potential to generate higher income make them a viable proposition for dual use. But the transition would require careful consideration. This section delves into the findings and suggests remediations that could help address this deficit.

Next steps

Working group/expert committee

A working group or an expert committee must be set up to formulate and define necessary safety standards and suggest regulatory interventions for dual use of passenger autorickshaws.

The working group could be chaired by a Cabinet-level official of a central government agency like MoRTH. The working group should include

- senior officials from the parliamentary constituency committee on road safety;
- vehicle safety standards, dynamics, and homologation experts from the National Automotive Testing and R&D Infrastructure Project and the Automotive Research Association of India;
- state transport commissioners of transport departments, as they are the state nodal agencies responsible for implementation and enforcement of various statutory provisions;
- representatives of the Unified Metropolitan Transport Authority to facilitate coordinated planning and implementation of innovative urban transport programs; and

- mobility-based tech start-up CXOs, prominent transport researchers, academics, and civil society representatives.

While experts may favor exploring the potential of autorickshaws for intracity urban freight movement, retailers and MSMEs might approach this with trepidation for the safety of their commodities. So the working group's deliberations might be strengthened by instituting a small pilot, in which trips could be limited to moving cargo during off-peak hours. The pilot could assess impacts on asset utilization and driver income, as well as offer feedback from traffic police, to help the working group understand implementation challenges.

The working group must also discuss viable visual enforcement and nonintrusive policing options to cut down on overloading. One solution could be using weigh-in-motion (WIM) devices to identify overloaded autorickshaws quickly and effectively. WIM spots overloaded vehicles with 95 percent accuracy, allowing for focused inspection of overloaded autorickshaws without impacting traffic flow (U.S. DOT 2007). Care must also be taken to sensitize the transport department against undue penalties and improve the regulators' outlook toward this transition to encourage compliance by drivers, MSMEs, and retailers.

The committee should also consider potential measures in two other important areas:

Safe operation

Previously an expert committee on safety, constituted by the Government of India, recommended side doors to protect occupants (MoRTH 2012). This has been adopted by a few autorickshaw manufacturers for newer models. In some areas with heavy monsoons, drivers temporarily add doors to keep rain out. The expert group could suggest similar light-touch interventions to protect the safety of goods. It could also consider other operational parameters that affect safety, such as the weight and dimensions of loads, as well as how fast autorickshaws can travel.

Capacity building

The expert committee on safety considers three-wheelers as currently designed considerably less prone to toppling or rolling over than other vehicle types. This conclusion is consistent with road accident data, which indicates that autorickshaws account for only 4 percent of the total accidents in the country (MoRTH 2021). But the distribution of cargo in the vehicle is critical, and this heavily depends on how the commodities are loaded. Therefore, capacity building exercises that provide clear instructions to drivers must be offered as part of a holistic

regulation. Drivers need to understand how to drive safely when fully loaded and how to stack cargo properly, loading heavier goods first, at the bottom, and lighter ones on top.

Long-term interventions

Adoption of standards

The government can adopt a light-touch approach, similar to its intervention strategy in the case of two-wheelers, which were allowed to carry goods beginning in 2016, with MoRTH providing guidelines on the placement of goods and on the dimensions of their containers.

Interviewed design experts suggested that a foldable seat could be proposed that would alternate between being a seat for passengers and a flatbed on which to load goods. They recommended that heavier goods be loaded first and kept at heights below the seat (in the passenger leg-room area) for a lower center of gravity and increased stability. Studies might be required to test the safe thresholds for this kind of usage. While current norms do not specify minimum seat dimensions, leg space, and so on, the Automotive Industry Standards Committee could collaborate with the working group to develop technical standards conducive to dual use in the future.

Transition to electric vehicles (EVs)

The last two years have witnessed the rapid adoption of electric vehicles in India, primarily because they cost less to run than internal combustion engine vehicles. In fact, in May 2022 a total of 23,321 e-3Ws were sold, as opposed to 18,187 ICE variants (MoRTH 2023).

Electric autorickshaws will also be more stable than ICE versions. Since the heavy battery in an e-autorickshaw is closer to the ground, the center of gravity is lower, increasing stability. The lower center of gravity means every corner of the vehicle can be used to load goods (Tian and Whitfield 2021).

Switching to EVs will eliminate tailpipe emissions and noise. Urban freight vehicles' trips are generally short, enabling the use of smaller batteries, and the vehicles spend long stretches of time in parking stands or depots, where charging stations could be located. Employing ICTs with modern three-wheeler EVs could facilitate planning of more precise delivery routes and improve fleet upkeep, while also being environmentally sustainable and cost-effective.

SCOPE FOR FURTHER RESEARCH

This working paper has laid the groundwork to enhance awareness of the concept of dual use of three-wheeler autorickshaws for urban freight operations and provided initial solutions for its implementation, but there is room for further study, especially regarding safety parameters, design of autorickshaws, and other micromobility options to facilitate goods transportation.

Future research could also cast a wider net in collecting primary data. A large, diverse participation strategy could be employed across multiple other geographic areas to improve sample size and ensure adequate coverage of the intended stakeholder population.

APPENDIX A. CURRENT CENTRAL MOTOR VEHICLES ACT AND MOTOR VEHICLES RULES OF STATES

SALIENT FEATURES	CENTRAL MOTOR VEHICLES ACT	KARNATAKA MV RULES	MAHARASHTRA MV RULES	TELANGANA MV RULES	UP MV RULES	DELHI MV RULES
Carriage of goods in stage carriage	Section 66 permits the use of stage carriage as goods carriage even when passengers are transported.	Section 70 permits carriage of goods in stage carriage, with conditions for safety of passengers and weight of goods.	Section 79 permits transportation of goods in stage carriage, with conditions such as that the transport of goods not be detrimental to public convenience.	Section 204 allows for transportation of goods in stage carriage as long as goods are properly packed and secured, and within the weight limit stated by the authority.	Section 78 permits stage carriage to transport goods under conditions such as that only nonhazardous goods can be carried, and they must be packed properly.	Section 69 permits transportation of goods in stage carriage with conditions such as that goods not be detrimental to others' safety.
Carriage of goods in contract carriage	According to Section 74(2)(iv), the regional transport authority can permit contract carriage where goods are carried with or without passengers..	Section 72 prohibits transportation of goods in contract carriage except for special reasons on particular occasions.	Section 80 prohibits carriage of goods in contract carriage.	Except for personal luggage, Section 203 prohibits transportation of goods in contract carriage.	Section 78 permits contract carriage to transport goods under conditions like that of stage carriage.	Section 69 permits transportation of goods in contract carriage provided that weight of goods does not exceed $(N - X) * 75$, where, N = maximum number of passengers for which the vehicle might be registered under these rules; and X = number of passengers carried in the vehicle, or number of passengers for whom seats are kept free and unimpeded by goods, whichever is greater.
Carriage of persons in goods vehicles	Power is given to state governments to decide whether they want to allow carriage of persons in goods vehicles or not.	Carriage of persons in goods transport vehicles is prohibited. With RTA permission, a larger number of people (in connection with the work for which the vehicle is used) can be transported free of charge, only if no goods are carried.	Carriage of persons in goods carriage is allowed—however, it cannot be for hire or reward. Only people who have seating accommodation can be carried.	Not defined	Not defined	Not defined

Notes: MV = motor vehicle; RTA = regional transport authority; UP = Uttar Pradesh.

APPENDIX B. TECHNICAL SPECIFICATIONS OF TOP FIVE PASSENGER THREE-WHEEL AUTORICKSHAW MODELS ON THE MARKET

MODEL	MARKET SHARE	FUEL TYPE	SEATING CAPACITY	LENGTH	WIDTH (MM)	HEIGHT (MM)	GVW (KG)	PAYLOAD (KG)
 Bajaj Compact RE	35%	Gasoline	D+3	2,635	1,300	1,700	672	310
 Piaggio Ape City+	11%	Gasoline	D+3	2,880	1,435	1,920	757	300
 Mahindra Alfa DX	3.8%	Diesel	D+3	3,025	1,480	1,930	835	320
 Atul GEM Paxx	3.4%	Gasoline	D+3	2,990	1,460	1,830	849	320
 TVS King Deluxe	2%	Gasoline	D+3	2,647	1,329	1,740	-	-

Notes: D = driver; GVW = gross vehicle weight; kg = kilogram; mm = millimeter. The table highlights the five top-selling models available in all regions of India.

Source: Statista (2022a).

APPENDIX C. EVOLVING REGULATORY AMENDMENTS IN INDIA

Motor Vehicles (Amendment) Act of 2019—Section 2B

In 2019 a significant amendment was made in the Motor Vehicles Act (MVA) to promote innovation, research, and development in transportation in general. The amendment gives the central government discretionary powers to exempt certain types of motor vehicles from the MVA's provisions.

Motor Vehicles (Amendment) Act of 2019—Section 66A

These salient points from the amendment pertain to passenger and goods movement:

The central government may develop a national transportation policy consistent with the objects of this act, in concurrence with the state governments and other agencies, with a view to

- establishing a **planning framework for passengers and goods transportation** within which transport bodies are to operate;
- establishing the **framework of grant of permits and schemes**;
- identifying **strategic policies and specifying priorities for the transport system** that address current and future challenges;
- **promoting competition, innovation, increased capacity, seamless mobility, and greater efficiency in transport of goods or livestock or passengers**, as well as the economical use of resources; and
- **safeguarding the public interest and promoting equity**, while seeking to enhance private participation and public-private partnership in the transport sector.

Motor Vehicles (Amendment) Act of 2019—Section 67

This subsection grants power to state government to control road transport, with state government having authority to develop schemes for the transportation of goods and passengers and to issue licenses under such a scheme for the promotion of development and efficiency in transportation. Such schemes focus on the following goals:

- strengthening last-mile connectivity
- reducing traffic congestion
- improving urban transport
- increasing safety of road users
- better utilizing transportation assets
- enhancing economic vitality of the area, through competitiveness, productivity, and efficiency
- increasing accessibility and mobility for people

APPENDIX D. CASE STUDY OF DUAL-USE TWO-WHEELERS IN INDIA

In the last decade India has seen tremendous growth in the transportation service industry, especially with the advent of online ride-hailing aggregators. These aggregators have tweaked their business models to cater specifically to Indian markets and provide ride-hailing services for multiple vehicle types, including three-wheeler autorickshaws and two-wheelers. According to recent reports, the ride-hailing segment accounted for revenue of US\$11.42 billion in 2019, which is expected to grow to \$13.77 billion by 2025, making it the third-largest in the world (Statista 2022b). Recognizing this expansion, the government issued a draft notification in April 2016 to permit two-wheelers to install boxes on their vehicles to carry commercial goods and first-aid medical kits.

In 2020, the Ministry of Road Transport and Highways amended the 1989 Central Motor Vehicles Rules, providing strict guidelines on the dimensions of the lightweight cargo box fitted to carry the goods on two-wheelers, and setting the following safety standards for such containers (MoRTH 2020):

- The dimensions of the container shall not exceed 550 millimeters (mm) in length, 510 mm in width, and 500 mm in height.
- The weight of the container, including its mounting and load carried therein, shall not exceed 30 kg.
- If the container is fitted on the pillion rider space, no pillion rider shall be allowed. The weight of container, including its mounting and load carried therein, shall be within the permissible gross vehicle weight in kg, specified by the manufacturer and also approved by the test agency referred to in Rule 126.
- If the container is fitted behind the pillion rider space, a pillion rider shall be allowed provided that the weight of the vehicle, passenger, and container, including its mounting and load carried therein, is within the permissible gross vehicle weight in kg, specified by the manufacturer and approved by the test agency referred to in Rule 126.
- Motorcycles manufactured on and from January 1, 2022, shall comply with the stand requirements specified in AIS 146:2018, as amended from time to time, until the corresponding BIS specifications are notified under the Bureau of Indian Standards Act of 2016 (11 of 2016).
- Motorcycles manufactured on and from January 1, 2022, shall comply with the external projection requirements specified in AIS 147:2018, as amended from time to time, until the corresponding BIS specifications are notified under the Bureau of Indian Standards Act of 2016 (11 of 2016).

Additionally, a new category, two-wheeler ambulance, was created to be used in emergency medical situations and in congested and crowded zones that conventional ambulances cannot reach. Such a service can only provide immediate medical aid and cannot transport patients.

APPENDIX E. DUAL USE IN PRACTICE: INTERNATIONAL CASE STUDIES

Singapore

In Singapore, the Land Transport Authority (LTA), under the Ministry of Transport, has defined goods-cum-passenger vehicles (GPVs) as vehicles with a maximum laden weight of 5,000 kg that are meant to transport both goods and passengers (LTA 2022). Figure D1 shows one example of a passenger vehicle used to transport (and sell) goods.

The LTA has also defined special safety regulations for GPVs and trucks. The special standards are for GPVs or trucks transporting workers. These GPVs are restricted to a speed limit of 60 kmph and must have the front passenger seats occupied before workers are ferried on the rear carriage deck.

The goods being transported must be properly secured so they do not endanger the passengers or other road users. The LTA requires that GPVs used to transport workers be fitted with canopies and side railings of at least 700 mm from the carriage deck and at least 300 mm from the top. For light trucks (maximum laden weight not exceeding 3,500 kg), the height of the canopy must not exceed 1.35 times the height of the truck's cabin when measured from the road surface to ensure the stability of the vehicle. The number of workers permitted to be transported decreases if goods are transported simultaneously.

Figure D1 | **Tuk tuk as a food van in Singapore**



Source: Mister Donut

United States

In California, under the vehicle industry registration procedures manual published by the Department of Motor Vehicles, multipurpose vehicles (MPVs) are defined as passenger vehicles that also have

a limited cargo-carrying capability (California DMV 2022). Vehicles with a permanently attached top may be issued auto or commercial license plates.

In its U.S. plants, automaker Nissan produces the Altima, a midsize sedan (Figure D2), and Kicks, a subcompact sport utility vehicle. These are offered as both passenger and business vehicles for food catering and delivery.

Figure D2 | **Nissan Altima registered as an MPV in the United States**



Source: Nissan Motor Co. (2023).

Thailand

In Thailand, while the Thai Civil Law enumerates the rules and regulations for carriage of goods and passengers, the rules do not mention anything about three-wheelers. Tuk tuks, as three-wheeler autorickshaws are called in Thailand (as in Singapore), are generally used to transport fresh products or other goods around the city in the absence of passengers (see Figure D3). Tuk tuks are used for marketing events or even as ice cream vending carts. As vehicles, they are also used as minitrucks by vendors to transport goods from markets.

Figure D3 | **Tuk tuk serving as dual-use vehicle in Thailand**



Source: Milkovasa (2018).

ABBREVIATIONS

B2B	Business-to-business
CMVR	Central Motor Vehicles Rules
CNG	Compressed natural gas
CO	Carbon monoxide
EV	Electric vehicle
4W	Four-wheeler
GHG	Greenhouse gas
GPV	Goods-cum-passenger vehicle
ICE	Internal combustion engine
ICTs	Information and communication technologies
KII	Key informant interview
LPG	Liquified petroleum gas
LTA	Land Transport Authority (Singapore)
MoRTH	Ministry of Road Transport and Highways
MPV	Multipurpose vehicle
MSMEs	Micro-, small, and medium enterprises
MVA	Motor Vehicles Act
PM	Particulate matter
3W	Three-wheeler
WIM	Weigh-in-motion

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ABOUT THE AUTHORS

Rohan Rao is Program Manager, Electric Mobility, Sustainable Cities and Transport, WRI India.

Sudeept Maiti is Associate Program Director, Integrated Transport, Sustainable Cities and Transport, WRI India.

Pawan Mulukutla is Director, Integrated Transport, Electric Mobility and Hydrogen, WRI India.

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.



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