**Balancing Residents' Aspirations with Sustainable Transport Goals: A Case Study of Shimla, India**

# Abstract

*With an increase in income, changing lifestyles, and people’s aspirations, managing sustainable transportation has become a challenge for policymakers, management authorities, and planners. Shimla, a hill city in India, is facing acute stress on water availability, green cover, housing, and transport infrastructure due to its rapid urbanization and population growth. Mobility patterns are closely linked to existing land-use patterns and socio-economic characteristics of the city residents. Mobility patterns not only impact the environment but also impact access to various facilities, safety, and security of city residents. This paper presents data from a household survey covering 400 households, including 1763 inhabitants of Shimla city in India. The existing travel patterns of the city residents are compared with the goals of the sustainable transport system. While many existing travel patterns align with the goals of a sustainable transport system discussed in the international literature, the aspirations of city residents conflict with these sustainable transport goals. Future mobility patterns are unlikely to meet the goals of sustainable transport unless major policy interventions are implemented.*

**Keywords:** Aspirations; sustainable transport; eco-sensitive, mobility, travel pattern

1. **Introduction**
   1. Importance of Sustainability in Eco-sensitive Areas

Shimla is located in the fragile Himalayan region, and hence, sustainability becomes a critical concern amidst urbanization. A fragile ecosystem[1](#_bookmark0) is unstable and vulnerable, making it more prone to hazards such as landslides and erosion (Pandey, 2002). The creation of large-scale infrastructure further enhances this process. Due to the geotectonic process, the Himalayas remain structurally unstable and susceptible to rapid collapse and, therefore, highly vulnerable to natural or human disturbances (Supply, 2011). The built-up area of Shimla increased manifold due to changing requirements and aspirations of people, and policies that encouraged retentions affected the planned and sustainable development of Shimla. Increased urbanization has led to an increase in the built-up area and a reduction in green cover in the city (Thapliyal, 2016). Construction sites around green areas have already caused significant damage to the precious coniferous Deodar green cover. Steep slopes are burdened with residential and other built structures. Several landslides are observed during the rainy season. Water availability for city residents has reduced over the years. The limited road space is occupied by motorized vehicles (Thapliyal 2016 and 2024).

# The Concept of Sustainable Transport

Various scholars and organisations have defined sustainability, sustainable development, and sustainable transport in their own ways and different contexts. But a general acceptance is finding a suitable balance between environmental, social, and economic conditions for present and future generations (WCED, 1987; Emina, 2021; Elsawy & Youssef, 2023; Mezentseva et al., 2024). The concept can be related to the first formal definition of sustainable development, given by the Brundtland Commission (WECD, 1987), which gave equal importance to all three dimensions, i.e., environmental, social, and economic. Similarly, for policies and working on the parameters of sustainable transport, a conference was organized in 1996 by the OECD (Organization for Economic Cooperation and Development). Since then, “the discussion has centered around the question of whether efforts should be made to put societies towards a sustainable path with the help of sustainable transport or whether it should be envisioned as an end-state” (Goldman and Gorham, 2006: 263)[2](#_bookmark1). Environmentally Sustainable Transport (EST) project defined sustainable transport as “transport that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes” (OECD 1996 cf. Goldman and Gorham, 2006: 264). Sustainable transport includes several measures such as understanding developmental needs, planning and protecting urban land, reducing emissions and pollution, protection of ecosystem,

1 Fragile ecosystem is understood in terms of vulnerability and the increasing and irreversible stress on the physical environment that includes land, water, forest, air quality, and so on. The frequency of hazards like mass wasting, large-scale erosion, landslides, etc., also increases in the process of infrastructure creation. This can be devastating in the case of the Himalayas, which are still changing and yet not fully stabilised. For more details, refer to Pandey (2002).

2Please refer to Goldman and Gorham, 2006:263-264 for details of various programmes and approaches related to sustainable transport. They have covered details of various conferences and programmes initiated at the global level.

safeguarding health of inhabitants, equal access to resources and their judicial use (Corvalan et al., 1999; Goodman and Tolley, 2001; Hart, 2003; Richardson, 2005; Goldman and Gorham,

2006; Jabareen, 2006; Hickman and Banister, 2007; Cupples and Ridley, 2008; Hamilton- Baillie, 2008; Woodcock et al., 2009; Hickman et al., 2011). Mohan and Tiwari (1999) have stressed that “a sustainable transport system must provide mobility and accessibility to all urban residents in a safe and environmentally friendly mode of transport”. Focus on improvement in accessibility and mobility, reduction of travel distance and time, has been put for developing a sustainable transport system. Richardson (2005) tried to define the sustainability of transportation as a “cumulative effect of five indicators, namely safety, congestion, fuel consumption, vehicle emissions, and access”. Similar to the definition and concept of sustainable development, which gives equal weightage to social, economic, and environmental issues, the focus of sustainable transport remains on the development of infrastructure, which helps in sustaining the economy and protecting the environment while bringing social equity. According to Tomita et al. (2003), “sustainable accessibility seeks concentration of activities, decreasing average travel distance, and developing environment-friendly transport modes where possible”. The security and safety of citizens have been considered an important dimension of sustainable transport. The strategy of compact urban development with smart growth has been discussed as New Urbanism and sustainable urban development. Most researchers claim that “a compact city with characteristics like high residential and employment densities, mixed land uses, multimodal transportation, and high street connectivity is more energy-efficient hence less polluting and sustainable” (Banister, 2008; Echenique and Saint, 2014; Thapliyal, 2024). According to Crane et al. (2003) “New Urbanism has aimed to achieve sustainable development by providing compact, socially, and functionally mixed neighbourhoods that are pedestrian-friendly at the local scale while offering the choice of public transport or transit at the city or regional scale”. The central objective is to reduce car use by developing high densities of mixed uses that favour pedestrian and transit travel over the car[3](#_bookmark2). The new urbanism aimed to bring social and economic opportunities within walking, bicycling, and transit distances (ibid., 2003). The focus has been to encourage active travel, like walking and bicycling, instead of private motorized modes. Recent research links reductions in long-term health outlooks and obesity with the decline in active travel (Cavill, 2007 cf. Hamilton-Baillie, 2008: 164). A new concept of 'shared space' also emerged from various street designs in the fields of behavioural and environmental psychology in Europe (Adams, 1995 cf. Hamilton-Baillie, 2008: 162). The concept of shared space is crucial because it provides prospects to residents “to shape and influence the built environment in ways that encourage diversity, distinctiveness, urban quality, and civility” (Hamilton-Baillie, 2008: 162). Butler et al. (2020) have also talked about shared mobility systems for transportation services where vehicles are shared at different times or with other riders for all, or part of the duration of the trip.

In summary, the following three concepts emerge as the central theme of sustainable transport.

1. Reduction in car use by developing high densities of mixed land uses that favour pedestrian and transit travel over the car.
2. To bring social and economic opportunities within walking, bicycling, and transit distances.
3. Promoting social equity amongst city residents.

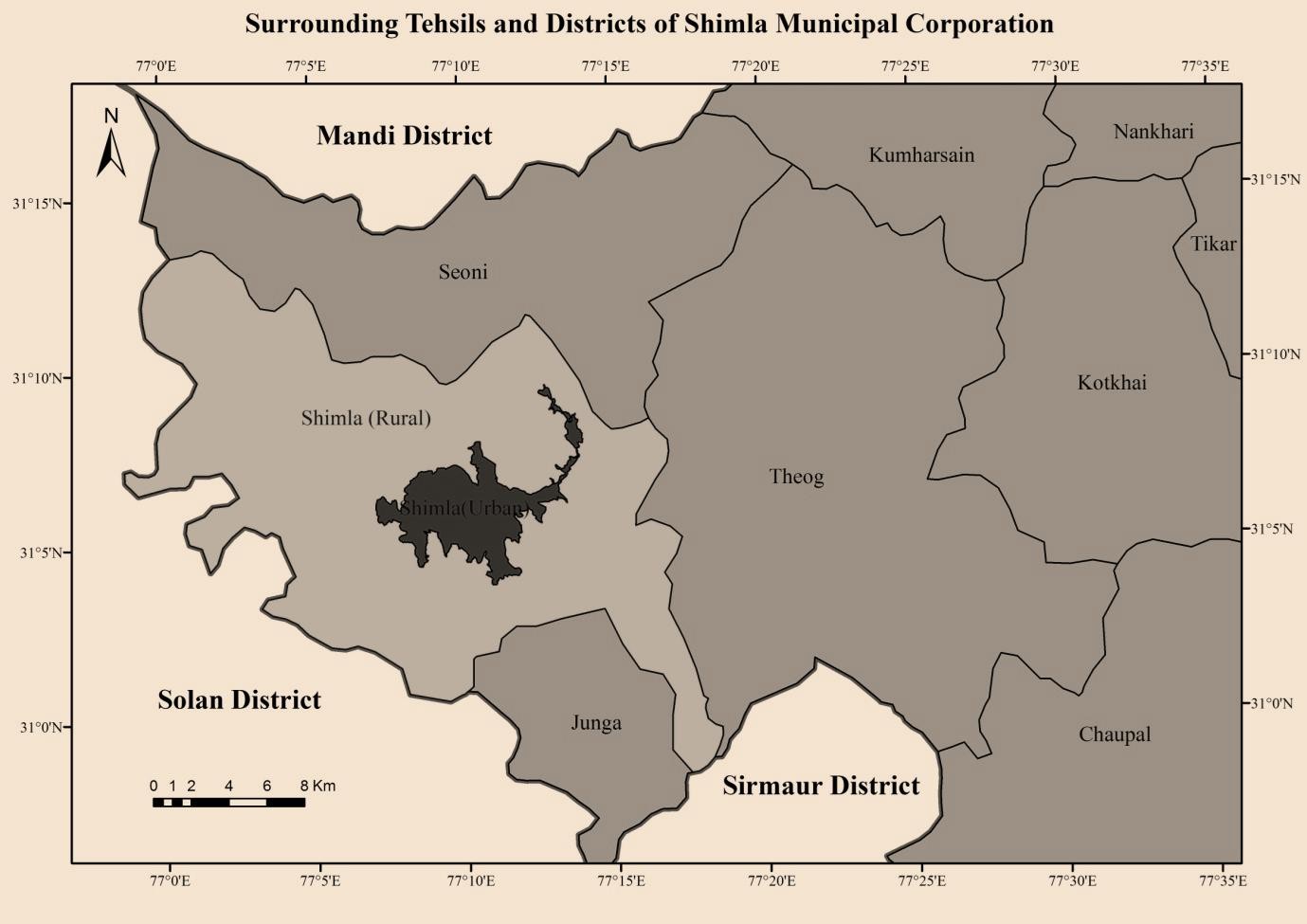
Analysis of travel patterns in Shimla is presented in the context of these three concepts of sustainable transport. The central question is whether the current travel patterns are in line with

3 For details, refer to Thapliyal, R., 2024. Can Shimla be fitted into the compact city model?. *The Scientific Temper*, *15*(02), pp.2362-2374.

the goals of sustainable development, and with changing income in the future, how these patterns are likely to change.

# The Study Area, Data, and Methodology

Shimla, a popular tourist destination, is situated on a ridge constituting seven hills in the central Himalayas south of the Sutlej River. It is the capital of Himachal Pradesh, a northern state of India, located at an altitude of 7116 feet above mean sea level with latitude 31º6' North and longitude 77º13' East (Gazetteer of the Shimla District, 1888-89: 2). Extended over seven hills namely Jakhu, Observatory, Prospect, Elysium, Summer, Potter and Museum Hill the city is inhabited by around two lakh people.



Map 1: Surrounding Tehsils and Districts of Shimla Municipal Corporation

Source: Administrative Atlas-Himachal Pradesh Census of India 2011, Director of Census Operations, Himachal Pradesh.

Shimla Rural tehsil, which borders the entire Shimla urban area, is surrounded by Seoni tehsil on the North, Theog tehsil on the East, Junga tehsil and some area of Sirmaur District on the South and Southeast, and Solan District on the South and Southwest (Map 1). The population increased manyfold over the century from merely 14335 inhabitants to 169758 in 2011 (Gazetteer of the Shimla District, 1888-89; Census of India, 2011 Table T01\_0211). Similarly, population density increased from 2350 persons per square kilometer in 1961 to over 5,000 persons per square kilometer in 2011 (Census of India, 2011). The area of Shimla Municipal Corporation has increased from 19.55 square kilometers in 1991 to 28.53 square kilometers in 2001 and 35.34 square kilometers in 2011 (Census of India, 1991, 2001, and 2011). The area is divided into 25 wards. As per the records of the Forest Department of Shimla, forests cover an area of 843.91 hectares within municipal limits.

This study is based on a survey of 400 households conducted in December 2010-April 2011 in Shimla. It is in addition to the research (Thapliyal, 2016) on developing indices for various dimensions of a sustainable city. The main study focused on land-use changes and related physical and socio-economic indicators necessary for the sustainability of the city. The household survey questionnaire had three segments. The first segment dealt with household profiles, socio-economic data on sex, age, education, employment, migration patterns, income, occupation, housing, and basic amenities. The second part dealt with issues of locality and peoples’ opinion, problems and requirements of locality, issues related to the safety of people, water availability, consumption and its quality, municipal arrangements for garbage disposal and sanitation, availability of health facilities, the health of people, travel patterns, vehicle congestion, condition of public transport and its weaknesses. The third part dealt with peoples’ participation in development activities, their awareness of government policies, access to various government schemes and services, their experiences and engagements with the city, and their priorities and suggestions for the betterment of the city.

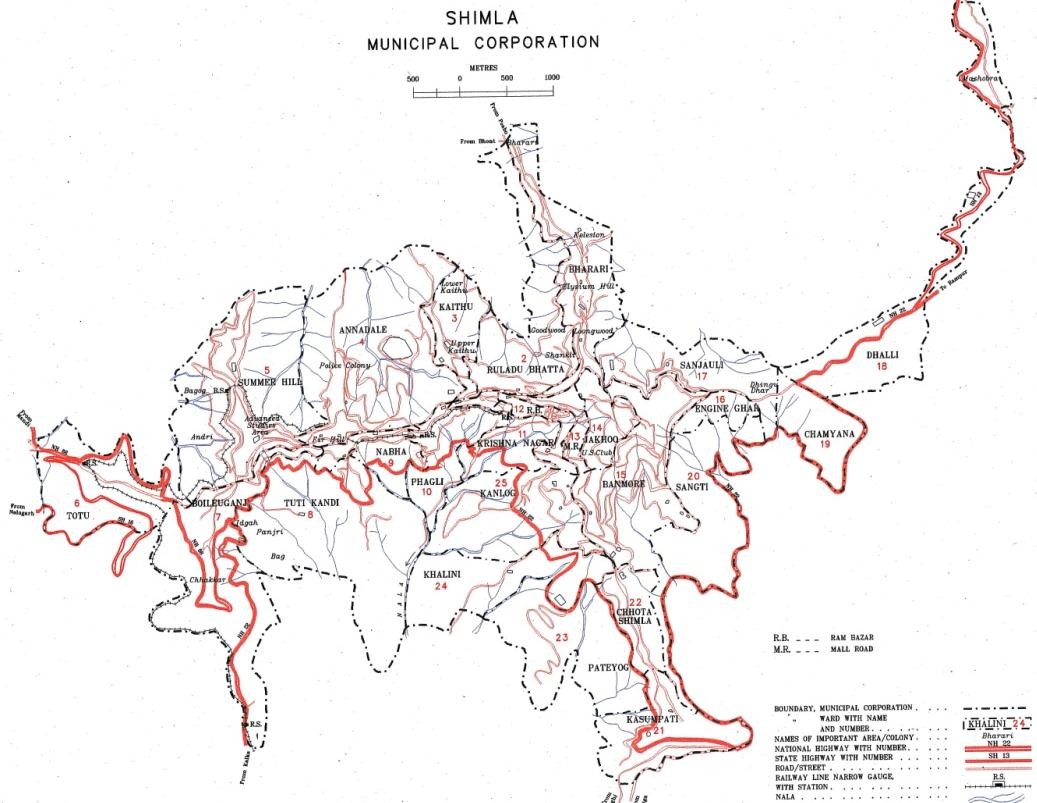
The required number of households was selected from each ward based on the proportion of the population as per the census, 2001. Within the wards, random sampling was used to identify the households for administering the survey questionnaire. For this study, we extracted data on the socio-economic characteristics of the population, availability of transport infrastructure, views on other problems faced by city residents, and a set of questions on perceptions of the transport system and travel preferences.

Table 1 shows the percentage of households belonging to different income groups that responded to the survey questionnaire. The percentage of households in the poor income group is very low, i.e., 7 per cent only, but around one-fourth of households fall in the category of the low-income group. Around 50 per cent population falls into middle and upper-middle-income groups, whereas 22 per cent fall into a higher-income group. Figure 1 shows the map of municipal wards in Shimla, showing the location of wards in the core area and the periphery.

**Table 1.** Percentage of Households in Different Income Groups in the survey sample

|  |  |  |  |
| --- | --- | --- | --- |
| Income Groups | Monthly Income of Household in Rupees | Frequency | Percentage |
| Poor Income Group | < 4000 | 28 | 7.00 |
| Low-Income Group | 4001-10000 | 97 | 24.25 |
| Middle Income Group | 10001-20000 | 90 | 22.50 |
| Upper Middle Group | 20001-40000 | 97 | 24.25 |
| Upper-Income Group | > 40000 | 88 | 22.00 |
|  | Total | 400 | 100 |

Source: Household survey conducted during December 2010 – April 2011



**Figure 1.** Census Ward Map of Shimla Municipal Corporation, Census of India 2001

(The map was collected from the Census Office, Shimla)

This paper presents an analysis of responses to questions regarding travel patterns and perceptions regarding the quality of service provided by the current transport system. Since, in the absence of any major policy interventions, current trends are expected to continue in the future, the current pattern of car use is extrapolated to estimate future car usage. Policy implications of conflicts between residents’ aspirations and sustainable travel patterns are discussed.

# Transport Infrastructure

Presently, Shimla is connected to other places by road, rail, and air transport. The Shimla-Kalka is the only rail line connecting Shimla with other places, while air connectivity is facilitated through Jubbarhati Airport, which is 12 kilometers away from the city. National Highways 22 and 88 and State Highways 12 and 13 are important arteries for connecting Shimla city with other parts of the country, and Bypass roads and internal municipal roads facilitate mobility

within the city. The length of the Bypass Road is 22.8 km. This has facilitated traffic movement, especially of heavy motor vehicles, which are restricted on Cart Road during the daytime through bypassing Shimla City. As per the data available with the Municipal Corporation Shimla, the total length of roads for the movement of vehicles under the Municipal Corporation area is about 75 Kilometers. The Mall Road, which is the most popular among tourists, starts from Scandal Point and extends to Boileauganj in the west and through Secretariat to Sanjauli Chowk in the East. It is the longest stretch of pedestrian road in the world, and several heritage sites and buildings are located along this road.

The majority of roads are narrow, ranging between 4-8 meters, except for Cart Road or the Motor Round Road, where the right-of-way ranges between 5-11 meters. The length of Cart Road is 16 kilometers, and it surrounds the core area. The road starts from the barrier and, through the Victory Tunnel, extends up to Sanjauli via Lakkar Bazaar and again meets at the Victory Tunnel via Chotta Shimla. As this is the only option available for traffic movement in the city, it is functioning beyond its capacity as per IRC Specifications (*ibid.:* 15).

HRTC (Himachal Road Transport Corporation) made 33 vehicles available in 1975. Their number kept increasing, which was 50 in 1986-87, 85 in 1996-97, 115 in 2006-07, and 104 in

2008-09.

# Current Travel Patterns and Sustainable Transport Goals

To understand the sustainable transport goals identified in the previous section in the context of Shimla, it is important to understand the travel characteristics of Shimla’s residents. Forty- five per cent of the households had their vehicles, but only 13 per cent of them had private parking, while 54 per cent of households had to park their vehicles on the streets. The municipality has also marked designated spaces along the streets for car parking on various roads like Cart Road, Sanjauli, Tara Hall, Government Office Complex at Kasumpti, New Shimla, Totu, Boileauganj, Shoghi- mostly in the core city. The designated parking space occupies 30-40 per cent road width and has become the reason for aggravating congestion on roads and causing traffic jams. Himachal Pradesh Traffic, Tourist, and Railway Police, with the help of district police, find that 85000 vehicles run in the city daily, and on average, 3000 vehicles enter from the outer regions. This further intensifies in the peak tourist season when more vehicles enter the city daily. Although special parking permission on prohibited roads has also been granted by the government to accommodate the heavy influx of tourists, the availability of parking facilities for vehicles remains a problem. Due to a shortage of parking spaces, tourists pay three times more than the actual parking fee. The number of registered vehicles in the city has increased from 7880 in 1990-2000 to 15235 in 2010[4](#_bookmark3).

The parking problem is expected to increase in the future because 36 per cent of the surveyed households aspire to purchase vehicles in the near future. Out of this, only 12 per cent of households had private parking available to them, and 15 per cent had some common parking space. Therefore, the remaining households will have to park their vehicles on the streets (65 per cent). The travel survey data have been analyzed for travel modes used for different purposes, travel distances for different purposes, and access to different facilities for low- income residents.

4 (Figures calculated from the available data collected from RTO (Regional Transport Office) Shimla and RLA (Registering and Licensing Authority) Shimla).

# Travel Modes of Current Residents

Table 2 presents how people travel by different modes of transport for different trip purposes. Most trips are pedestrian trips regardless of trip purpose. While 50 per cent of work trips are pedestrian trips, for daily shopping, nearly ninety per cent of trips are walking trips.

**Table2.** Purpose-wise percentage of people traveling by different modes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Modes of Work Education Daily need | | | | Major Chemists Hospital Recreation | | | |
| transport |  |  | shops | shopping |  |  |  |
| Car | 18.54 | 07.16 | 01.25 | 26.46 | 05.29 | 35.26 | 37.63 |
| Bus | 30.73 | 37.31 | -- | 36.39 | 04.03 | 35.77 | 31.90 |
| On Foot | 50.41 | 49.02 | 98.75 | 33.84 | 90.43 | 12.85 | 25.09 |
| Taxi | 00.33 | 06.51 |  | 03.31 | 0.25 | 13.10 | 05.38 |
| Ambulance | -- | -- | -- | -- | -- | 03.02 | -- |

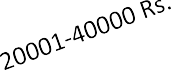
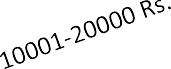
The use of private vehicles/cars is maximum for recreation (37.63 per cent), followed by going to hospitals (35.26 per cent) and major shopping (26.46 per cent). The use of public transport/bus is maximum for going to educational institutions (37.31 per cent), followed by major shopping (36.39 per cent) and going to hospitals (31.9 per cent). Walking trips are maximum for daily shopping and going to chemists, which indicates that these facilities are available in the locality or situated nearby, further suggesting a mixed land-use pattern. Overall, nearly 50 per cent of trips for work and education are walk trips. Nearly 95 per cent of trips for daily shopping and to the chemist are also walk trips. The car is used for about 20 per cent of work trips and 26 per cent of major shopping. The use of taxis is less, and around 7 per cent use them for going to educational institutions, and 5 per cent of people use them for going to recreational places. Very few people (3 per cent) avail themselves of ambulance facilities in an emergency. Overall, walk trips are the most dominant trips, followed by bus trips.

The survey data shows that out of 615 people going to work, 18 per cent go by car, 30 per cent go by bus, and 50 per cent go on foot. Also, an analysis shows that 95 per cent of the 18 per cent who go by car own their private vehicles. Though the number of students going by car is a mere 7 per cent of the total school-going children, out of the total students going for education, 91 per cent of households own private vehicles. This trend confirms earlier research findings that higher car use is strongly associated with car ownership (Kenworthy and Laube, 1996: 290; Gilbert, 2000; Bannister, 2005).

Figure 2 shows the percentage of different income groups for work trips by different modes of transport. The proportion of car trips increases with the increase in income. However, about 40 per cent of trips remain walk trips in the highest income group.

**%**

**Figure 2.** Percentage of different Income Groups going to Work by different Modes of Transport



**Percentage of different income groups going to work by different modes of transport**

100

80

60

40

20

0

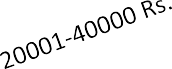
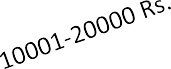
Car

Bus

On Foot

Taxi

Figure 3 shows education trips of different income groups by different modes of transport. The dominant mode is walk-trips in lower and middle-income groups, followed by public transport. The use of private vehicles, although very small in the overall travel mode share, is found to be the maximum in the highest income group.



**Percentage of different income groups going for education by different modes of transport**

80

70

60

50

40

30

20

10

0

Car

Bus

On Foot

Taxi

**%**

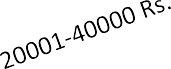
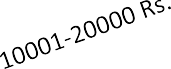
**Figure 3.** Percentage of different Income Groups going for Education by different Modes of Transport

As expected, walk trips decline sharply with an increase in income, and car trips increase with the increase in income. Bus trips increase with income increase; however, for incomes more than 20,000 Rs. per month, the bus trips decline and car trips increase at a higher rate.

Figure 4 gives a percentage of different income groups going to daily needs shops by different modes of transport. For daily needs shopping, almost all the trips are walking trips, which suggests a mixed land-use.

**%**

**Figure 4.** Percentage of different income groups going to daily needs shops by different modes of transport



**Percentage of different income groups going to daily need shop by different modes of transport**

120

100

80

60

40

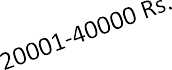
20

0

Car

On Foot

For major shopping, as shown in the graph, a large percentage of people move by private vehicles, although the other two modes, i.e., the use of public transport and walking, are also dominant. It suggests that most people go to Mall Road for shopping, which is the central ward of Shimla. The people residing near Mall Road Walk, whereas those residing in the peripheral wards use cars or buses. The maximum percentage of car users is found in the highest income group. Figure 5 shows that the percentage of bus users declines in the higher income group, which is in coherence with the use of cars.



**Percentage of different income groups going for major shopping by different modes of transport**

70

60

50

40

30

20

10

0

Car

Bus

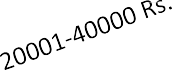
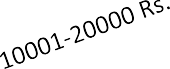
On Foot

Taxi

**%**

**Figure 5.** Percentage of different income groups going for major shopping by different modes of transport

Figure 6 presents the percentage of different income groups going to chemists by different modes of transport. For going to chemists, the dominant mode is walking, which means that in most of the wards, chemist shops are available in the locality, which is again an indication of mixed land-use. The maximum percentage of car users is found in the highest income category.



**Percentage of different income groups going to chemists by different modes of transport**

100

80

60

40

20

0

Car

Bus

On Foot

Taxi

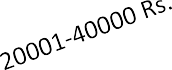
**%**

**Figure 6.** Percentage of different income groups going to chemists by different modes of transport

Figure 7 presents the percentage of different income groups going to hospitals and the use of private vehicles. Maximum use of private vehicles and taxis for hospital trips may be due to the non-availability and poor services of emergency vehicles, as the use of an ambulance is very less. This is clear from the survey, as the residents reported that they do not get this service in an emergency. The use of private and public vehicles is almost equal, and a significant amount of taxi use is also found for this purpose. The use of cars increases with higher income, corresponding to a decrease in bus users in the same category. Also, the use of taxis increases in the lower and middle-income groups but decreases in the highest-income group, suggesting that in the case of an emergency, even the poorest people are forced to use taxis, maybe because of the non-availability of Ambulance service.

**%**

**Figure 7.** Percentage of different income groups going to hospitals and use of private vehicles



**Percentage of different income groups going to hospital by different modes of transport**

80

70

60

50

40

30

20

10

0

Car

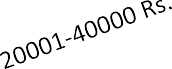
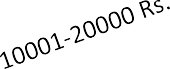
Bus

On Foot

Ambulance

Taxi

Figure 8 shows the percentage of different income groups going for outings by different modes of transport. Most people go for the outing by car, and the higher-income group is the most dominant user of cars. Table 3 presents a comparison of the percentage of different income groups going for different purposes by different modes of transport.



**Percentage of different income groups going for outing by different modes of transport**

70

60

50

40

30

20

10

0

Car

Bus

On Foot

Taxi

**%**

**Figure 8.** Percentage of different income groups going for an outing by different modes of transport

**Table 3.** Comparison of percentage of different income groups going for different purposes by different modes of transport

Mode of Transport

< 4000

Rs.

4001-10000

Rs.

10001-20000

Rs.

20001-40000

Rs.

> 40000

Rs.

Total

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | Work |  | | |
| Car | 0.0 | 5.4 | 10.0 | 27.0 | 33.5 | 18.5 |
| Bus | 13.5 | 26.2 | 42.5 | 31.8 | 29.2 | 30.7 |
| On Foot | 86.5 | 68.5 | 46.7 | 41.2 | 36.6 | 50.4 |
| Taxi | 0.0 | 0.0 | 0.8 | 0.0 | 0.6 | 0.3 |
| Education | | | | | | |
| Car | 0.0 | 1.7 | 3.3 | 8.9 | 16.7 | 7.2 |
| Bus | 25.0 | 20.0 | 48.4 | 57.4 | 32.5 | 37.3 |
| On Foot | 75.0 | 74.8 | 48.4 | 26.7 | 34.2 | 49.0 |
| Taxi | 0.0 | 3.5 | 0.0 | 6.9 | 16.7 | 6.5 |
|  |  |  | Daily Need shop |  |  |  |
| Car | 0.0 | 1.0 | 1.1 | 2.1 | 1.1 | 1.3 |
| On Foot | 100.0 | 99.0 | 98.9 | 97.9 | 98.9 | 98.8 |
|  |  |  | Major shopping |  |  |  |
| Car | 0.0 | 9.4 | 18.0 | 29.2 | 58.0 | 26.5 |
| Bus | 37.5 | 38.5 | 51.7 | 33.3 | 21.6 | 36.4 |
| On Foot | 62.5 | 51.0 | 28.1 | 30.2 | 17.0 | 33.8 |
| Taxi | 0.0 | 1.0 | 2.2 | 7.3 | 3.4 | 3.3 |
|  |  |  | Chemists |  |  |  |
| Car | 0.0 | 2.1 | 3.4 | 7.2 | 10.2 | 5.3 |
| Bus | 10.7 | 6.3 | 2.3 | 2.1 | 3.4 | 4.0 |
| On Foot | 89.3 | 91.7 | 94.3 | 89.7 | 86.4 | 90.4 |
| Taxi | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.3 |
|  |  |  | Hospital |  |  |  |
| Car | 0.0 | 14.4 | 24.7 | 44.3 | 69.3 | 35.3 |
| Bus | 69.2 | 55.7 | 34.8 | 24.7 | 17.0 | 35.8 |
| On Foot | 26.9 | 12.4 | 16.9 | 11.3 | 6.8 | 12.8 |
| Ambulance | 3.8 | 5.2 | 3.4 | 1.0 | 2.3 | 3.0 |
| Taxi | 0.0 | 12.4 | 20.2 | 18.6 | 4.5 | 13.1 |
|  |  |  | Outing |  |  |  |
| Car | 0.0 | 9.1 | 35.8 | 37.2 | 60.8 | 37.6 |
| Bus | 54.5 | 47.7 | 38.8 | 30.8 | 15.2 | 31.9 |
| On Foot | 45.5 | 38.6 | 20.9 | 23.1 | 20.3 | 25.1 |
| Taxi | 0.0 | 4.5 | 4.5 | 9.0 | 3.8 | 5.4 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

# Test of significance using one-way ANOVA for daily trips for Work by different modes of transport

To find out whether there is a significant difference between modes used for daily trips such as going to work and education, a statistical analysis is done by using ANOVA.

Descriptive statistics table for mode of transport used for workplace

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Workplace** | **N** | **Mean** | **Std.**  **Deviation** | **Std. Error** | **95% Confidence Interval for Mean** | |
|  |  |  | **Lower Bound** | **Upper Bound** |
| Personal Vehicle | 21 | 21.38 | 10.562 | 2.305 | 16.57 | 26.18 |
| Public Transport | 24 | 30.84 | 15.586 | 3.181 | 24.25 | 37.42 |
| On Foot | 25 | 52.44 | 21.583 | 4.317 | 43.53 | 61.35 |
| Total | 70 | 35.72 | 21.156 | 2.529 | 30.67 | 40.76 |

To find out if there is any significant difference between the means of different modes of transport used by the residents to go to their workplaces, one-way ANOVA was carried out. But Levene’s Statistics (4.719, p < .05) shows that there is homogeneity of variances among different groups, one of the essential assumptions for ANOVA, is violated. In other words, heterogeneity of variances exists among groups. Therefore, to test if there is a significant difference between the three groups of modes of transport, another useful statistical test, i.e., Welch ANOVA and Brown-Forsythe test (another robust alternative to ANOVA when variances are unequal), was carried out. The result of Welch's Anova F (2, 43.357) = 20.076, p

< 0.05 confirms that at least the mean of one group is different from the mean of the other groups. A similar result is shown by the Brown Forsythe test (F (2, 56.038) = 22.125, p < 0.05.

Since both the tests, i.e., Welch ANOVA and Brown-Forsyth, indicate significant differences, and therefore to find out that the mean of which group differs from the mean of the other group, a post-hoc test (Games-Howell) was carried out, and the results are shown in the table given below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Post-hoc Test** (Games-Howell) for different modes of transport used for workplace | | | | | | |
| **(I) Mode of Transport used for**  **Workplace** | **(J) Mode of Transport used for**  **Workplace** | **Mean Difference (I-J)** | **Std. Error** | **Sig.** | **95% Confidence**  **Interval** | |
| **Lower**  **Bound** | **Upper**  **Bound** |
| Personal Vehicle | Public Transport | -9.460 | 3.929 | .053 | -19.02 | .10 |
| On Foot | -31.067\* | 4.893 | .000 | -43.03 | -19.11 |
| Public Transport | Personal Vehicle | 9.460 | 3.929 | .053 | -.100 | 19.02 |
| On Foot | -21.608\* | 5.362 | .001 | -34.62 | -8.60 |
| On Foot | Personal Vehicle | 31.067\* | 4.893 | .000 | 19.11 | 43.03 |
| Public Transport | 21.608\* | 5.362 | .001 | 8.60 | 34.62 |
| \*. The mean difference is significant at the 0.05 level. | | |  |  |  |  |

The above table shows that there is no significant difference between personal vehicle and public transport, used for going to work, although the level is only 0.053. But there is a significant difference between the mean of the group going on foot and the group using a personal vehicle, and also between on foot and public transport users.

# Test of significance using one-way ANOVA for daily trips (Education) by different modes of transport

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Education** | **N** | **Mean** | **Std.**  **Deviation** | **Std. Error** | **95% Confidence Interval for Mean** | |
|  |  |  | **Lower Bound** | **Upper Bound** |
| Personal Vehicle | 19 | 18.13 | 9.603 | 2.203 | 13.50 | 22.76 |
| Public Transport | 23 | 40.54 | 25.522 | 5.322 | 29.50 | 51.58 |
| On Foot | 23 | 53.18 | 25.639 | 5.346 | 42.09 | 64.26 |
| Total | 65 | 38.46 | 26.037 | 3.229 | 32.01 | 44.91 |

To find out if there is any significant difference between the means of different modes of transport used for education, one-way ANOVA was carried out. But Levene’s Statistics (7.560, p < .05) shows that there is homogeneity of variances among different groups, one of the assumptions for ANOVA, is violated. In other words, heterogeneity of variances exists among groups. Hence, to test if there is any significant difference between the three groups of mode of transport, another useful statistical test, i.e., Welch ANOVA and Brown-Forsythe test (another robust alternative to ANOVA when variances are unequal) was carried out. The result of Welch's Anova F (2, 36.606) = 22.580, p < 0.001 confirms that at least the mean of one group is different from the means of the other groups. A similar result is shown by the Brown- Forsythe test (F (2, 50.230) = 14.200, p < 0.001.

Since both the tests, i.e., Welch ANOVA and Brown-Forsyth, indicate significant differences, hence, to understand the mean of which group differs from the mean of the other group, a post-hoc test (Games-Howell) was carried out, and the results are shown in the table given below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Post-hoc Test** (Games-Howell) for different modes of transport used for workplace | | | | | | |
| **(I) Mode of Transport used for Workplace** | **(J) Mode of Transport used for**  **Workplace** | **Mean Difference (I-J)** | **Std. Error** | **Sig.** | **95% Confidence**  **Interval** | |
| **Lower**  **Bound** | **Upper**  **Bound** |
| Personal Vehicle | Public Transport | -22.412\* | 5.760 | .002 | -36.63 | -8.19 |
| On Foot | -35.048\* | 5.782 | .000 | -49.33 | -20.77 |
| Public Transport | Personal Vehicle | 22.412\* | 5.760 | .002 | 8.19 | 36.63 |
| On Foot | -12.635 | 7.543 | .226 | -30.93 | 5.66 |
| On Foot | Personal Vehicle | 35.048\* | 5.782 | .000 | 20.77 | 49.33 |
| Public Transport | 12.635 | 7.543 | .226 | -5.66 | 30.93 |
| \*. The mean difference is significant at the 0.05 level. | | |  |  |  |  |

The above table shows that there is a significant difference between personal vehicles used for educational purposes and public transport. Similarly, there is a significant difference between personal vehicle used for education and going on foot. But there is no significant difference between the means of the groups, i.e., on foot and by public transport.

# Travel Distances

Figure 9 shows distances traveled for different purposes in Shimla. Forty per cent of the work trips are shorter than 2 kilometers. Around 73 per cent of work trips are shorter than 5 kilometers. The closer the wards are to the core area, the shorter the distance of work trips. Almost 100 per cent of the work trips are shorter than 2 kilometers in the Rambazar ward. In

Jakhoo ward, 76 per cent of and in Banmore, 67 per cent of work trips are shorter than 2 kilometers. In the distant wards (away from the core city) like Totu, Boileauganj, Tutikandi, Dhalli, Kasumpti, Pteyog, and Chamyana, more than 30 per cent of people travel 6-10 kilometers. This shows that in the central region, there is a mixed land-use where workplaces and educational institutions are situated near the residential areas. However, in the outer wards intensity of mixed land-use may be less; therefore, people are traveling long distances. This may be one of the reasons for the more use of private vehicles.

For education, 41 per cent of students cover a distance of 1-2 kilometers, 32 per cent cover 3-5 kilometers, 20 per cent of students travel 6-10 kilometers, and 5 per cent travel more than 10 kilometers. In Bharari, Ruladu Bhatta, Totu, Krishnanagar, Ram Bazar, and Sanjauli wards, above 61 per cent move to a distance of 1-2 kilometers. In Kaithu, Annandale, Boileauganj, Phagli, Banmore, Chotta Shimla, Pateyog, and Kanlog more than 50 per cent of students cover a distance of 3-5 kilometers. In Tutikandi, 70 per cent of students go 6-10 kilometers, whereas in Ksumpti the percentage is 48. In Tutikandi, Chamyana, Sangati, and Kasumpti wards more than 12 per cent of students cover a distance of 11-20 kilometres.

**Distance travelled by the people of Shimla for various purposes**

120

100

80

60

40

20

0

< 1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 >15

**Distance (in Km)**

Work Education

Daily need shop Major Shopping

Chemist Hospital

Mostly visited outing place

**Cumulative %age**

**Figure 9.** Distances traveled for different purposes in Shimla

# Access to Different Facilities for Low-income Residents

Often, low-income households do not benefit from transport infrastructure, which is primarily focused on motorized trips; indeed, transportation investments disproportionately degrade those environments (Almanza and Alvarez, 1997). Low-income households should be given employment near their residences and should not be forced to travel long distances, which consumes a substantial proportion of their income on travel. Gardenshire (1999) recorded in- depth ethnographic profiles of 74 residents with incomes below the poverty line in low-density Marin County, California. She found that those residents with cars felt compelled to choose between vehicle-related expenses and other important household needs. Residents without cars, however, had severe barriers to mobility. Clifton (2002) used interviews and ethnography to study the changes in the opportunity that resulted from a small auto ownership programme for

welfare recipients (Crane et al., 2003). We discuss access to work and other facilities for low- income households in Shimla.

# Travel Pattern of Low-income Households in Shimla

Out of the 400 households surveyed in Shimla, 125 households belong to very low and low- income groups with an income of less than Rs. 10000 (150USD) per month. 56 per cent of people travel up to 2 Km, 30 per cent travel 3-5 Km, and the remaining 14 per cent travel more than 5 Km for work. Out of the 125 households in the low-income group, 74 households have zero expenditure on travel for non-discretionary trips- going to work and education. These are walking trips. Almost 25 per cent spend 10 per cent of their monthly income on travel for work and education trips. 10 per cent of the households spend up to 25 per cent of their monthly income on travel. The remaining 7 per cent spend more than 25 per cent of their monthly income on travel.

The second most important factor contributing to social equity is the availability of public or emergency transport. Out of 400 households surveyed, 11 per cent of households are not able to get conveyance in case of emergency, and out of these households, the maximum belongs to the low-income group. In other words, the income of the household significantly affects the availability of conveyance in an emergency. Table 4 shows that the higher-income group has maximum accessibility to transport because of owning personal vehicles.

**Table 4.** Access to public and emergency transport vs. household Income

Income

< 4000INR (60USD)

4001-10000

(61-150USD)

10001-20000

(151-300USD)

20001-40000

(301-600USD)

> 40000

>600USD

Total

available

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (in INR)  No | % | No. | % | No | % | No. | % | No | % | No. | % |
| Transport not 13 | 46 | 17 | 18 | 9 | 10 | 3 | 3 | 2 | 2 | 44 | 11 |
| Taxi 9 | 32 | 48 | 49 | 39 | 44 | 46 | 48 | 22 | 25 | 164 | 41 |
| Ambulance 6 | 22 | 23 | 24 | 21 | 23 | 15 | 15 | 15 | 17 | 80 | 20 |
| Personal 0 | 0 | 9 | 9 | 21 | 23 | 33 | 34 | 49 | 56 | 112 | 28 |
| Total 28 | 100 | 97 | 100 | 90 | 100 | 97 | 100 | 88 | 100 | 400 | 100 |

Vehicle

From the above analysis, it is clear that Shimla at present largely fulfills the conditions of sustainability concerning the following criteria:

* + 1. It fulfills the criteria of compact development and mixed land-use, as the majority (70 per cent) of the compulsory trips (work and education) are short trips. Trips for daily shopping and chemist are also short trips. This shows the presence of work opportunities, education, and shops for daily needs in the residential localities.
    2. The most dominant mode of travel is on foot. The share of walking trips reduces as household income increases. The share of non-discretionary trips by walking is very high -nearly 90 per cent, regardless of household income.

Hence, the current travel patterns are sustainable. However, we estimate whether this trend is going to continue or not. In the following section, I have presented responses of Shimla residents regarding their satisfaction level with the current transport system and future expectations.

# Aspirations of People

People’s preferences and their future travel behaviour have been analyzed based on the responses to specific questions regarding perceptions of the quality of service provided by the existing transport system and reasons for preferring private vehicles over public transport systems. People’s perceptions are equally important for influencing travel behaviour. Our survey also shows that there is a small difference between the actual conditions of the public transport system in Shimla and peoples’ perceptions about the same. Table 5 and Table 6 present peoples’ preferences for private vehicles and the weaknesses of public transport as stated by the respondents. People prefer private transport due to its comfort and time-saving. People do not prefer public transport as they find it overcrowded, risky, and not safe for vulnerable groups such as the disabled, women, the elderly, and children. At present use of private vehicles is low; however, private vehicles were preferred over public transport by the people surveyed for this study. 62 per cent of the responders listed comfort and 29 per cent listed time-saving the quality of private transport as compared to public transport, as the most important reasons for preferring the use of private vehicles. Poor quality of public transport (5 per cent) and its nonavailability (4 per cent) are some other reasons for giving higher preference to private vehicles.

**Table 5.** People’s Preference for Private Vehicles

|  |  |  |
| --- | --- | --- |
| Preference for a private vehicle | Frequency | Percent |
| Saving time | 47 | 29 |
| Non-availability of public transport | 6 | 4 |
| Poor quality of public transport | 8 | 5 |
| More comfort | 100 | 62 |
| Total | 161 | 100 |

**Table 6.** Weaknesses of Public Transport Considered by Respondents

|  |  |  |  |
| --- | --- | --- | --- |
| Weaknesses of Public Transport, as stated by respondents  (in percentage) | | | |
|  | **No** | **Yes** | **Not Sure** |
| Connectivity | 43 | 49 | 8 |
| Less Frequency | 36 | 47 | 17 |
| Expensive | 54 | 45 | 1 |
| Overcrowded | 5 | 95 | - |
| Risk of accident | 27 | 59 | 14 |

|  |  |  |  |
| --- | --- | --- | --- |
| Safe for Women | 80 | 15 | 5 |
| Safe for senior citizen | 87 | 10 | 3 |
| Safe for Children | 84 | 13 | 3 |
| Safe for Disabled | 92 | 6 | 2 |
| Time Taking | 14 | 80 | 6 |
| Comfortable | 67 | 28 | 5 |

Table 7 shows logistic regression results for satisfaction with the current transport system as a dependent variable, and the age of the respondents, gender, income category, educational status, vehicle ownership, mode of transport, and probability of purchasing vehicles in the future are predictor variables. The result of logistic regression shows that age, gender, vehicle ownership, and mode of transport significantly predict peoples’ satisfaction with the current transport system. The odds ratio explains that older people are 70 per cent less likely to be satisfied with the current transport system than younger people. Similarly, females are 59 per cent less likely to be satisfied with the current transport system than males. People using cars have a 60 per cent lower probability of being satisfied with the current transport system than those who use the bus for regular travel.

**Table 7.** Logistic Regression Result for People’s Satisfaction with Current Transport Dependent variable: People’s Satisfaction with Current Transport

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Reference Category | Sig. | Exp(B) |
| *Age (Years)* | Below 30 | 0.129 |  |
| 30-60 |  | 0.699 | 0.894 |
| > 60  *Gender* | Male | 0.046 | 0.305\* |
| Female |  | 0.002 | 0.416\*\* |
| *Income Category (Rs)* | Below 10000 | 0.557 |  |
| 10000-30000 |  | 0.313 | 0.705 |
| Above 30000 |  | 0.347 | 0.677 |
| *Education Status* | Illiterate | 0.051 |  |
| Till 10+2 |  | 0.947 | 0.968 |
| Graduation and above  *Vehicle Ownership* | No | 0.151 | 0.476 |
| Yes |  | 0.036 | 0.514\* |
| *Mode of Transport* | Bus | 0.016 |  |
| On foot |  | 0.236 | 1.393 |
| Car |  | 0.043 | 0.4\* |
| *Purchase of Vehicles in the future*  Yes | No | 0.356 | 0.778 |
| Constant |  | 0.018 | 3.654 |

\*Significant at 5 % Level of Significance.

\*\* Significant at 1 % Level of Significance.

Table 8 shows logistic regression results in which peoples’ preference for private vehicles is considered as a dependent variable, and the age of the respondents, gender, income category, educational status, vehicle ownership, mode of transport, and future probability of purchasing a vehicle as independent or predictor variables. When all predictor variables are considered together, they significantly predict whether people prefer private vehicles. Income category, vehicle ownership, and mode of transport were found to be significant. The results show an odds ratio that represents that the medium and higher-income categories are 3 and 2.86 times more likely to prefer private transport than the low-income category. Similarly, people owning vehicles are 24.06 times more likely to prefer private transport than people not owning vehicles. The respondents who use the car to go to the workplace as a mode of transport are 4.8 times more likely to prefer private vehicles than people going to the workplace by bus.

**Table 8.** Logistic Regression Result for Respondents Preferring Private Over Public Transport

Dependent variable: Preference for Private over Public Transport

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Reference Category | Sig. | Exp(B) |
| *Age (Years)* | Below 30 | 0.748 |  |
| 30-60 |  | 0.576 | 1.251 |
| > 60 |  | 0.475 | 1.668 |
| *Gender* | Male |  |  |
| Female |  | 0.237 | 1.513 |
| *Income Category (Rs)* | Below10000 | 0.046 |  |
| 10000-30000 |  | 0.016 | 3.065\* |
| Above 30000 |  | 0.041 | 2.864\* |
| *Education Status* | Illiterate | 0.848 |  |
| Till 10+2 |  | 0.568 | 1.562 |
| Graduation and above |  | 0.634 | 1.451 |
| *Vehicle Ownership* | No |  |  |
| Yes |  | 0.00 | 24.068\*\* |
| *Mode of Transport* | Bus | 0.009 |  |
| On foot |  | 0.822 | 1.083 |
| Car  *Purchase of Vehicles in Future*  Yes | No | 0.004  0.9 | 4.842\*\*  0.957 |
| Constant |  | 0.00 | 0.02 |

-2 Log likelihood = 260.455 Cox & Snell R Square = 0.484

\*Significant at 5 % Level of Significance.

\*\* Significant at 1 % Level of Significance

As the analysis above shows, households owning a private vehicle mainly use them for work and education trips- compulsory trips, and hence, if the number of vehicles in the future increases, it is likely that more people will use them. Secondly, there is a strong linkage between the increase in income and purchasing vehicles, as has been found in Shimla also.

The understanding of the concept of captive and choice users is also important for understanding future trends. Whether people are using public transport by choice or whether

the lack of other choices is responsible for the high usage of public transport? With increasing income, the captive users may become choice users for cars. For Shimla, it can be inferred that the higher the income, the more the use of private vehicles. The survey data shows that the households owning vehicles mostly use private vehicles (80.6 per cent) for compulsory trips. Table 9 shows the expected increase in the use of private vehicles in the future when car ownership increases, as stated in the survey. In the near future, out of total vehicle owners, i.e.,

67.8 per cent (31395) of households, will move by private vehicles. Car usage will increase by 18 per cent.

**Table 9.** Current and Future Scenario of Shimla’s Private Vehicle Users

Current Scenario Future Scenario Increase

Owner- ship

Private Vehicle for Compulsory Trip

Owner- ship

Private Vehicle for Compulsory Trip

Private Vehicle for Compulsory Trip

1 2 3 4 5 (4-2)

Surveyed Data

400 HH

180

(45)

145

(80.6)

271

(67.8)

217

(80.07)

72

(18)

Total HH as per 2011 Census

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 20838 | 16795 | 31395 | 25138 | 8343 |
| (45) | (80.6) | (67.8) | (80.07) | (18) |

46306 HH

Note: Figures in parentheses are in percentage.

This indicates that the future travel pattern may be moving away from sustainability. This sustainable city structure will likely be lost in the future if appropriate steps are not taken at present. The needs of different income groups are not only different but also conflicting. There is a high-income group that uses the car even for short distances. Shimla, at present, is compact and sustainable, but people are not satisfied with the current transport conditions.

If we try to meet peoples’ aspirations – preference for private vehicles, the city will move away from sustainable travel patterns. The outer wards have no mixed land use, resulting in long travel distances and are dependent on bus travel.

# Findings and Policy Implications

The current travel pattern of Shimla residents is dependent on walking and public transport, and most trips are short. This satisfies the two most important conditions required for sustainable travel. However, people are not satisfied with the current transport infrastructure- pedestrian paths, bus system, etc. It is important to pay attention to these concerns as the captive bus users may get converted to ‘choice’ car users with increasing income in the future. Current land-use is conducive for short travel due to resource constraints. The mixed land-use patterns will have to be retained in the future. Areas away from the core city will need investment to create mixed land-use patterns (For details please refer to Thapliyal (2024) on mixed landuse and compact city).

Also, the increase in vehicles may lead to severe parking problems. All major streets have permitted parking, causing severe road congestion. Due to land constraints, expansion of the road system is not possible. Shimla is a major tourist destination both in the summer and winter seasons. This leads to a large parking demand because of tourist vehicles. Parking restrictions

-spatial, temporal, and fiscal will need to be implemented to address future parking problems. The state of pedestrian infrastructure is dismal. People have expressed a preference for private vehicles because of perceived comfort (Refer to Table 5). At the same time, people are very dissatisfied with the current operation of buses (Refer to Table 6). If this condition continues in the future, with the increase in income and vehicle ownership, more people will choose private vehicles to commute. Developing safe and comfortable pedestrian infrastructure will retain walking trips, and improvements in public transport would reduce car use in the future. This will be challenging because public transport will have to compete with private vehicles in terms of comfort. Butler et al. (2020) has suggested technological changes and innovations for smart urban mobility such as “transport modeling, understanding consumer preferences, policy barriers, and the implementation and analysis of pilot programs and trials”. City authorities must have detailed guidelines, regulatory mechanisms, and financial incentives to promote mixed land-use patterns in new developments and prioritize pedestrian and public transport- friendly infrastructure to retain sustainable mobility patterns in the future.

# Conclusion

Shimla, the capital of Himachal Pradesh, a northern state of India, is a growing hill city and a hub of all administrative, commercial, educational, and health facilities. People come from all over the state to avail such facilities. It is also a busy tourist destination for almost all seasons and attracts a large number of people globally, including the floating population, more than its resident population. During the last 7-8 years, the government has made many pedestrian- friendly changes under the Jawaharlal Nehru Urban Renewal Mission and constructed many public parking lots, but problems of traffic congestion still exist. Roads are choked, especially during tourist season.

While many existing travel patterns are in line with the goals of a sustainable transport system, as discussed, the aspirations of city residents conflict with the sustainable transport goals. The majority of trips are short distances, walking, and using public modes of transport. But people are not satisfied with the condition of public transport. Future mobility patterns are unlikely to meet the goals of sustainable transport unless major policy interventions are implemented.

# Author Contribution Statement

This paper has been written under the guidance of my doctoral research co-supervisor, Dr. Geetam Tiwari, Head of the Department of Civil Engineering and Design, Indian Institute of

Technology Delhi, India. Under her guidance, the concept was designed, and various interpretations and analyses were done.

**Data Availability Statement:** Data are available within this article or its supplementary materials. The Ward map of Shimla was procured from the office of the Census of India, Himachal Pradesh, Shimla, for the year 2001. The figures for the population of Shimla Municipal Corporation were downloaded from the official website of the Census of India [https://censusindia.gov.in/census.website/.](https://censusindia.gov.in/census.website/) Mapwork and analysis are based on primary household survey data of city residents collected by the researcher (Thapliyal, 2016).

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