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# Assessment of the Impact of Transportation on Sustainability: Case of Ayodhya City

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**Abstract**

*Based on changes in the three sustainability pillars of environmental, economic, and social sustainability, the present research suggest a methodology for assessing the impact of various modes of transportation. The procedure comprises calculating the Composite Sustainability Index (CSI) before and after the adoption of a transportation policy using a variety of sustainability pillar indicators.We added metrics for air pollution, resource consumption, health, accessibility, mobility, commuting, and cost. The impact of introducing congestion pricing in the study region during peak hours is investigated in this case study for the city of Ayodhya. The study employs a choice model based on a primary survey and probability. Value of Probability We anticipate a 10% reduction in vehicle PCU and a 5% rise in bus PCU in the After Congestion Price.The choice model estimated a reduction of 10.02% respectively in the total trip distance traveled by car and increment of public transport 5.1% trips after the introduction of congestion charging. The result we got is Congestion pricing also contributed to a 0.66% increase in CSI.*

**Keywords:** Sustainable transport, congestion charging, sustainability pillars, composite sustainable index, spinal area

## INTRODUCTION

For a clean, healthy, and high-quality environment, the concept of sustainable mobility is vital. Due to traffic congestion, accidents, a lack of public transit, and carbon emissions into the atmosphere of space, today's transportation systems in big cities have a bad reputation, contributing to pollution and an imbalance in terms of quality of life in general mobility. The concerns of urbanization and transportation are intimately connected. On the one hand, transportation infrastructure encourages urban development; on the other hand, population increase, and urbanisation Increased travel demand necessitates the construction of more transportation infrastructure [1].

In the absence of suitable policy measures such as parking charges, congestion charges, fare revisions, pedestrianization, and so on, transportation infrastructure and operations bear increasing additional costs, while also causing a slew of environmental, economic, and social issues.

The congestion charge is a method of reducing traffic congestion by levying a tax on motor vehicles entering congested sections of cities (Study area). The purpose of this levy is to reduce the heavy motor vehicle traffic present in city centers while also raising revenue for transportation infrastructure development.System's sustainability may be evaluated using the three sustainability pillars of society, economics, and environment.

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The proposed methodology is used to conduct a case study in Ayodhya to assess the impact of congestion charges with the help [2]. This is done by applying the suggested sustainability model to compute the Composite Sustainability Index (CSI) before and after the introduction of congestion pricing.

## IMPLICATION OF RESEARCH

The studies are limited to assessing the impact of the congestion charge on the modal split, as well as the environmental, economic, and social implications. The new study tackles this shortcoming by combining environmental, social, and economic impacts to create a composite assessment of congestion pricing's long-term impact. As we know the number of vehicles is increasing day by day and it will congest more than before if we don't apply any policy or we don't make any modal. This research paper explained and figure out the importance of three pillars and how the city will become more sustainable when we used the Sustainable composite Index in the respective city of the study area to find out sustainability after input of congestion price in the future.

## METHODOLOGY

This section outlines a technique for assessing how pedestrianisation, tariff revision, congestion pricing, and other variables affect the composite Sustainability Index.The two major components of this framework for research are composite sustainability index determination and mode choice analysis.

The goal here is to determine the variation in the composite sustainability index that occurs as a result of policy decision implementation. A composite sustainability index is built on sustainability pillars, which are defined by sustainability indicators spanning multiple themes.

These identified sustainability indicators are dependent on the mode choice model comprised of policy variables [3-4].

### Composite Sustainability Index Calculation

Based on various literature studies to represent the various aspects of sustainability, many sustainable indicators (Table 1) are chosen. The case study we have done is not used all indicators. These indicator values are determined by the mode of operation under a given policy scenario. These figures, however, are in different units, according to, and so cannot be compared [2].

**Table 1.** Sustainable indicators for evaluation.

| Pillar | Theme | Label | Indicator | Definition |
|---|---|---|---|---|
| Environment | Air pollution | AP1 | Greenhouse gases | Level of CO[gm]/km of vehicle type |
| | | AP2 | Acidifying gases | Level of NOx[gm]/km of vehicle type |
| | | AP3 | Volatile organic compounds | Level of HC[gm]/km of vehicle type |
| | | AP4 | Fine particles< 2.5 µm | Level of PM 2.5[gm]/km of vehicle type |
| | Natural resources | NR1 | Energy use from fossil fuel | Liters consumed per km |
| Society | Health | HL1 | Exposure to NOx from transport | Number of people exposed to harmful levels of NOx |
| | | HL2 | Exposure to CO from Transport | Number of people exposed to harmful levels of CO |
| | | HL3 | Traffic injuries and deaths | Number of traffic injuries and death per modal share over a year |
| | Accessibility | AM1 | Accessibility to services | Average potential accessibility to services |
| | Commute | AM2 | Vehicle kilometers traveled | Total VKT per mode |
| | | AM3 | Vehicle minutes traveled | Total VMT per mode |
| | Mobility | AM4 | Congestion Index | The average level of congestion in the area under study |
| Economy | Cost(rupees) | EC1 | Transport investment cost | Total rupees spent on upgrading and maintenance of road infrastructure |
| | | EC2 | Transport commuting cost | The overall cost of commuting |
| | | EC3 | Transport external cost | Total rupees due to externalities associated with health |

 

## CASE STUDY AYODHYA

The main Ayodhya Chowk Road is 4.6 kilometres long and has abutting land use that is largely commercial, mixed-use, and religious. It goes from the entry point of Ayodhya from Faizabad to the Naya Ghat Area as shown in Figure 1.

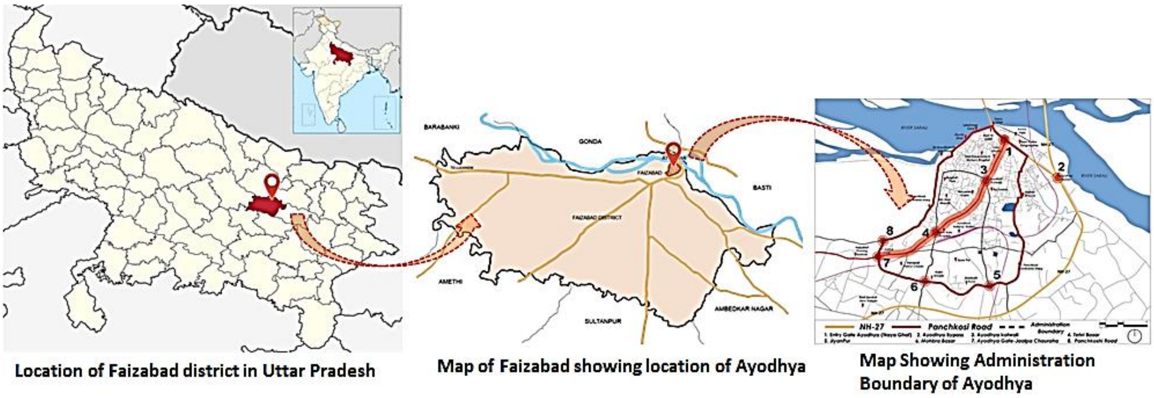


**Figure 1.** Showing case study area in Ayodhya.

The difference between the composite sustainability index before and after the implementation of congestion pricing was used to calculate the effect. For determining the sustainability index, we have done various primary survey & mode shift with private vehicle through spinal stretch of study area and congestion price is determined. The purpose of this study is to evaluate the effects of congestion pricing in the city of Ayodhya using a mode choice model [5].

The model was created with six modes in mind: car, public transportation (bus), two-wheeler (motorbike), auto rickshaw, cycling, and Rickshaw (NMT). The alternatives vehicle and two-wheeler were presumed to be accessible if the person possessed either one. If the travel was shorter than 3 kilometres (km) or 4.5 kilometres (km), walking, cycling, and taking a rickshaw were considered choices.

According to, In-vehicle time, out-of-vehicle time, travel costs, socioeconomic features of family income, the ratio of automobiles to earners in a household, age, gender, and purpose were the variables utilised to create the utility function of the choice model [2].

### Congestion Charge Determination

By dividing the overall congestion costs incurred by each kind of vehicle in Bangalore by the total number of vehicle trips made by that vehicle type, the value of the congestion fee was determined.We have taken both Motorized and non-motorized vehicle for estimation.

**Table 2.** Monetary loss to each vehicle type due to congestion.

| Vehicle Type | Number of passenger trips (1) | Actual trip time (hr.) (2) | Ideal trip time (hr.) (3) | Cumulative actual trip time (trip hours) (4) = (2)×(1) | Cumulative ideal trip time (trip hours) (5) = (3)×(1) | Time lost (hours) (6) = (4)–(5) | Wage rate (Rs/hour) (7) | Cost of time lost (Rs.) (6) × (7) |
|---|---|---|---|---|---|---|---|---|
| Bus | 7200 | 0.6 | 0.25 | 4320 | 1800 | 2520 | 11.99 | 30214.8 |
| Car | 3357 | 0.41 | 0.13 | 1376.37 | 436.41 | 939.96 | 41.98 | 39459.521 |
| Two - Wheeler | 9823 | 0.33 | 0.16 | 3241.59 | 1571.68 | 1669.91 | 25.39 | 42399.015 |
| Auto | 2802 | 0.41 | 0.2 | 1148.82 | 560.4 | 588.42 | 20.52 | 12074.378 |
| Cycle | 2256 | 0.35 | 0.33 | 789.6 | 744.48 | 45.12 | 10.25 | 462.48 |
| Rickshaw | 272 | 0.4 | 0.36 | 108.8 | 97.92 | 10.88 | 15.86 | 172.5568 |
| | | | | | | | Total | 124782.751 |

Table 2 provides an estimate of the financial loss each kind of vehicle experiences as a result of traffic delays. The average travel distance for each mode was multiplied by the estimated real and ideal journey speeds to arrive at the calculation, which used the concepts of ideal and actual vehicle trip durations.

The total monetary loss came as 1.24 Lakh Indian rupees.

The cost of congestion imposed by each kind of vehicle on other vehicles is calculated in Table 3. Table 3 makes the assumption that the bus has a PCU value of 3 and the two-wheeler has a PCU value of 0.5.

**Table 3.** Congestion cost imposed by each vehicle type.

| Vehicle type | Number of passenger trips (1) | Occupancy (2) | Number of vehicle trips (3) = (1) / (2) | Vehicle trips (PCU) (4) | Proportion in total PCU (5) = E/Vehicle type | Congestion cost imposed (Rs.) (6) = ($1.24\times10^5$) ×(5) | Cost of each vehicle (7) = (6)/ (3) |
|---|---|---|---|---|---|---|---|
| Bus | 7200 | 50 | 144 | 432 | 0.062149331 | 7706.51705 | 53.5 |
| Car | 3357 | 2.59 | 1296 | 1296 | 0.186447993 | 23119.5511 | 18 |
| 2-wheelar | 9823 | 1.53 | 6420 | 3210 | 0.461804057 | 57263.7031 | 9 |
| Auto | 2802 | 2.49 | 1125 | 1125 | 0.161847216 | 20069.0548 | 18 |
| Cycle | 2256 | 1.5 | 1504 | 752 | 0.108185873 | 13415.0482 | 9 |
| Rickshaw | 272 | 2 | 136 | 136 | 0.01956553 | 2426.12574 | 18 |
| | | | Total (E) | 6951 | | | |

The change in congestion pricing was explained by the trip cost variable in the model.For all modes, the time variable was assumed to be constant [6]. Value of probability In the After Congestion Price, we assume that car PCU will be reduced by 10% and bus PCU will be increased by 5%, whereas auto and 2-wheeler will have little effect and non-motor vehicle will increase by 5%.

**Calculation of the Composite Sustainability Index**

Based on the total number of vehicle trips travelling through the Spinal area during peak hour and the distance travelled, the indicators were computed for both scenarios, before and after the adoption of congestion charging. Air pollution indicators such as CO, NOx, and HC emissions, as well as fuel usage for the natural resource utilised, were among them; vehicle kilometers and minutes travelled for commuting; and transportation investment cost.

**Table 4.** Total trip travelled (VKT-Vehicle Kilometers Traveled) on links Chowk Road before and after introduction of congestion pricing.

| Mode | Before congestion pricing | | After congestion pricing | |
|---|---|---|---|---|
| | *Normal flow distance (Km)* | *Maximum flow distance (Km)* | *Normal flow distance (Km)* | *Maximum flow distance (Km)* |
| Bus | 1296 | 3110.4 | 1361 | 3266.4 |
| Car | 11664 | 36786.4615 | 11080 | 34944.6154 |
| 2-wheelar | 57780 | 119171.25 | 57203 | 117981.188 |
| Auto | 10125 | 20756.25 | 10075 | 20653.75 |
| Cycle | 13536 | 14356.3636 | 15296 | 16509.3636 |
| Rickshaw | 1224 | 1360 | 1407 | 1564 |

In order to equalise the sustainability indicators, the research also required figures for maximum and lowest vehicle flow across the study region before and after the adoption of congestion charging. It was believed that the variation in this likelihood value would change depending on how far commuters travelled. In both normal and maximum traffic circumstances, Table 4 shows the total journey distance taken on the study area's links before and after congestion pricing was applied. Because the minimal flow was expected to be zero vehicles per hour, the minimum flow trip distance was calculated to be zero kilometers.

***Value of Different Indicators (Pillars) before Introduction of Congestion Pricing***

Value difference of 3 indicatores (Pillares) before introduction of congestion price are–Module for the Environment, Module for the Social & Module for the Economics [7].

*Module for the Environment*

*Air Pollution*

Air pollution indicator's value is found from [3] which consist CO, NOx and HC. The emission function $e_p^m$ ($v_a$) typically, has a polynomial form with average link speed $v_a$ as the dependent variables.

$$e_p^m(v_a) = C_1 * v_a^2 + C_2 * v_a + C_3.$$

The speed of each mode was represented by $v_a$ in kilometers per hour (Km/hr.) and the coefficients $C_1$, $C_2$, and $C_3$. represents the emission factors for mode 'm' and pollutant 'p' in grammes per kilometer (g/Km).

Table 5 shows the coefficient values for each emission factor and the calculated emission for each mode.

**Table 5.** Pollutant coefficient.

| Vehicle Type | Pollu tant | C1 | C2 | C3 | Actual Trip | | Maximum Trip | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Speed (Km/hr)* | *e (g/Km)* | *Speed (Km/hr)* | *e (g/Km)* |
| Car | NOx | 0.0003232 | –0.01358 | 0.1726 | 22 | 0.0303 | 17 | 0.0351 |
| | CO | 0.0020380 | –0.22270 | 8.8100 | 22 | 4.89 | 17 | 5.6130 |
| | HC | 0.0003123 | –0.02808 | 0.7374 | 22 | 0.271 | 17 | 0.3502 |
| Bus | NOx | 0.0068150 | –0.84510 | 27.550 | 22 | 12.26 | 17 | 15.152 |
| | CO | 0.0002483 | –0.04090 | 1.698 | 22 | 0.918 | 17 | 1.0744 |
| | HC | 0.0001958 | –0.02934 | 1.139 | 22 | 0.588 | 17 | 0.6968 |
| Auto–rickshaw | NOx | 0.0003 | –0.0210 | 0.4639 | 22 | 0.147 | 17 | 0.1936 |
| | CO | 0.0061 | –0.7781 | 27.4060 | 22 | 13.24 | 17 | 15.941 |
| | HC | 0.0198 | –1.6526 | 36.8350 | 22 | 10.061 | 17 | 14.463 |
| Two–wheeler | NOx | 0.00002 | –0.0038 | –0.1815 | 22 | –0.255 | 17 | –0.240 |
| | CO | 0.00430 | –0.4952 | 18.1330 | 22 | 9.319 | 17 | 10.957 |
| | HC | 0.00080 | –0.0991 | 3.4116 | 22 | 1.618 | 17 | 1.9581 |

For each mode, an average speed of 22 km/hr was taken for normal flow and 17 km/hr for maximum flow [3].

Table 6 displays the total value of each emission factor for all modes under normal flow conditions.

**Table 6.** Emission factors across modes for normal flow.

| Vehicle type | eNOx (g/Km) (1) | eCO (g/Km) (2) | eHC (g/Km) (3) | Vehicle distance (Km) (4) | Emission (g) | | |
|---|---|---|---|---|---|---|---|
| | | | | | *eNOx (1) × (4)* | *eCO (2) × (4)* | *eHC (3) × (4)* |
| Bus | 0.030269 | 4.896992 | 0.270793 | 1361 | 41.20 | 6664.81 | 368.55 |
| Car | 12.25626 | 0.918377 | 0.588287 | 11080 | 135799.36 | 10175.62 | 6518.22 |
| 2-wheelar | 0.1471 | 13.2402 | 10.061 | 57203 | 8414.56 | 757379.16 | 575519.38 |
| Auto | 0.25542 | 9.3198 | 1.6186 | 10075 | 2573.36 | 93896.99 | 16307.40 |
| | | | | Total | 146828.47 | 868116.57 | 598713.55 |

Table 7 displays the total value of each emission factor for each mode for maximum flow.

 

**Table 7.** Emission factors across modes for maximum flow.

| Vehicle type | eNOx (g/Km) (1) | eCO (g/Km) (2) | eHC (g/Km) (3) | Vehicle distance (Km) (4) | Emission (g) | | |
|---|---|---|---|---|---|---|---|
| | | | | | *eNOx (1) × (4)* | *eCO (2) × (4)* | *eHC (3) × (4)* |
| Bus | 0.030269 | 4.896992 | 0.270793 | 3110.4 | 94.14 | 15231.60 | 842.27 |
| Car | 12.25626 | 0.918377 | 0.588287 | 36786.4615 | 450864.43 | 33783.84 | 21640.99 |
| 2-wheelar | 0.1471 | 13.2402 | 10.061 | 119171.25 | 17530.09 | 1577851.18 | 1198981.95 |
| Auto | 0.25542 | 9.3198 | 1.6186 | 20756.25 | 5301.56 | 193444.09 | 33596.06 |
| | | | | Total | 473790.23 | 1820310.73 | 1255061.28 |

Table 6 & 7 is a Combination of Table 4 & 5 respectively.

*Natural Resource Consumption*

The number of natural resources (gasoline and diesel) utilised by each mode was reflected by this indication. It's determined by multiplying a mode's total vehicle distance by its mileage. as with conversation with Prof. T.M. Rahul & [2] the mileage obtained for each mode is shown in Table 8. We used a mileage of 16.8 Km/L (Kilometer/Liter) (13.6+20)/2 for cars, 3.27 Km/L for public transportation, 24.9 Km/L for autos, and 46.1 Km/L for two-wheelers ((38.4+53.3)/2).

**Table 8.** Mileage of various modes.

| Vehicle type | Fuel (Km/liter) |
|---|---|
| Gasoline Motor Scooter (2-stroke) | 38.4 |
| Gasoline Motor Scooter (4-stroke) | 53.8 |
| Electric Motor Scooter | N/A |
| Gasoline Minicar | 24.9 |
| Gasoline Car | 13.6 |
| Diesel Car | 20.0 |
| CNG Car | N/A |
| Electric Car | N/A |
| Diesel Bus | 3.27 |
| CNG Bus | N/A |

Using mileage and distance travelled during Normal flow total fuel consumption came as 2721 L. & Total fuel consumption calculated using miles and distance travelled during Maximum Flow was 6468 L, as indicated in Table 9.

**Table 9.** Mileage and distance travelled during normal & maximum flow total fuel consumption.

| Mode | Before congestion pricing | | Fuel (Km/liter) | Liter consumed by vehicle | |
|---|---|---|---|---|---|
| | *Normal flow distance (Km)* | *Maximum flow distance (Km)* | | *Normal flow distance (Km)* | *Maximum flow distance (Km)* |
| Bus | 1361 | 3266.4 | 3.27 | 416.208 | 998.8991 |
| Car | 11080 | 34944.6 | 16.8 | 659.524 | 2080.037 |
| 2-wheelar | 57203 | 117981 | 46.1 | 1240.846 | 2559.245 |
| Auto | 10075 | 20653.8 | 24.9 | 404.618 | 829.4679 |
| Cycle | 15296 | 16509.3636 | 0 | 0 | 0 |
| Rickshaw | 1407 | 1564 | 0 | 0 | 0 |
| | | | Total in L | 2721.196 | 6467.648 |

 

*Module for the Social*

As shown in Table 10. The amount of commuting was measured by total vehicle kilometres (VKT) and total vehicle minutes (VMT) (VMT).The general idea is that higher VKT and VMT values will be associated with greater levels of commuting distance and time [8].

To find Normalize value: {100(actual value – minimum value)} / (maximum value – minimum value)

**Table 10.** Values of Social module indicator after introduction of congestion pricing.

| | | Normal Flow (A1) | Minimum Flow (A2) | Maximum Flow (A3) | Normalized Value |
|---|---|---|---|---|---|
| COMMUTING | Vehicle Minutes Travelled (VMT) | 4294 hours | 0 | 11328 hours | 37.9 |
| | Vehicle Km Travelled (VKT) | 94479 Km | 0 | 192563 km | 49 |

Here in Table 10, the total VKT for current trips was 94479. VKT came in at 192563 km for maximum flow. Total VMT was computed by subtracting total VKT from a speed that was expected to be 17 km/hr at maximum flow and 22 km/hr at normal flow. The normal flow time was 4294 hours, and the maximum flow time was 11328 hours [9].

*Module for the Economic*

The cost indicator elicited in the study was transportation investment cost.

**Table 11.** Transportation investment cost.

| Transport Investment Cost | Normal Flow (A1) | Minimum Flow (A2) | Maximum Flow (A3) | Normalized Value |
|---|---|---|---|---|
| | Rs.11.95 × $10^6$ | 0 | Rs.24.3 × $10^6$ | 49.17 |

So, all respective pillar of sustainable index Table 12 show below are:

**Table 12.** Value of indicators before introduction of congestion pricing.

| Pillar of Sustainability | Indicator | Indicator value for Actual number of Vehicle Trips | Indicator value for Minimum vehicle Trips | Indicator value for Maximum vehicle trips | Normalized Value | Impact on sustain ability |
|---|---|---|---|---|---|---|
| **1. ENVIRONMENT** | | | | | | |
| Air pollution | Level of CO[gm]/km of vehicle type | 876440.18 | 0 | 1820310.73 | 48.14 | –1 |
| | Level of NOx[gm]/km of vehicle type | 154081.81 | 0 | 473790.23 | 32.5 | –1 |
| | Level of HC [gm]/km of vehicle type | 604925.63 | 0 | 1255061.28 | 48.19 | –1 |
| Natural Resources | Energy consumption l/km. | 2750.605 | | 6559.507 | 41.9 | –1 |
| **2. SOCIAL** | | | | | | |
| Commuting | Vehicle Km Travelled (VKT) | 4346.59 hours | 0 | 11502.35 hours | 38 | –1 |

 

| | | | | | | |
|---|---|---|---|---|---|---|
| | Vehicle Minutes Travelled (VMT) | 95625 Km | 0 | 195540 km | 49 | –1 |
| **3. ECONOMY** | | | | | | |
| | Transport Investment Cost | Rs.11.95×$10^6$ | 0 | Rs.24.3×$10^6$ | 49.17 | – |

It was calculated by multiplying the total VKT by an expected transport investment cost of 125 Rupees per vehicle kilometre.

So, = 95625×125 = Rs.11.95 × $10^6$ Normal
& 195540×125= Rs.24.3×$10^6$ Maximum as shown in Table.11

***Value of Indicators After Introduction of Congestion Pricing***

Similarly, all selected pillars sustainable index value taken out and presented in Table 13.

**Table 13.** Value of indicators after introduction of congestion pricing.

| Pillar of sustainability | Indicator | Indicator value for actual number of vehicle trips | Indicator value for minimum vehicle trips | Indicator value for maximum vehicle trips | Normalized value | Impact on sustain ability |
|---|---|---|---|---|---|---|
| | **ENVIRONMENT** | | | | | |
| Air pollution | Level of CO [gm]/km of vehicle type | 868116.57 | 0 | 1802671.21 | 48 | -1 |
| | Level of NOx[gm]/km of vehicle type | 146828.47 | 0 | 451019.58 | 32.5 | -1 |
| | Level of HC [gm]/km of vehicle type | 598713.55 | 0 | 1241880.87 | 48.0 | –1 |
| Natural Resources | Energy consumption l/km. | 2721.196 | 0 | 6467.648 | 42.0 | –1 |
| | **SOCIAL** | | | | | |
| Commuting | Vehicle Km Travelled (VKT) | 4294 hours | 0 | 11328 hours | 37.9 | –1 |
| | Vehicle Minutes Travelled (VMT) | 94479 Km | 0 | 192563 km | 49 | –1 |
| | **2. ECONOMY** | | | | | |
| | Transport Investment Cost | Rs.11.80 ×$10^6$ | 0 | Rs.24.1 × $10^6$ | 48.90 | – |

***The Composite Sustainability Index (CSI)***

Prior to the adoption of congestion charge, the following are the sustainability indicators and the composite sustainability index [10].

CSI = SI Environmental + SI Social + SI Economic, whereas SI stands for Sustainable Index.

**Note:** Here
**α** = (Impact on sustainability)is a binary variable with a value of +1 if the indicator has positive effect on CSI and -1 if it has negative effect on CSI;

λ = Normalize value, W = local weight attached;

& Here AP = Air pollution, NR= Natural resources (Fuel used in model split in km/liter) & EC = Economy & The global indicator value for indicators was determined based on [2] research as it responses from many transportation experts as well as industry experts.

Now,

1. SI Environmental = $(\alpha_{AP1} \times W_{AP1} \times \lambda_{AP1}) + (\alpha_{AP2} \times W_{AP2} \times \lambda_{AP2}) + (\alpha_{AP3} \times W_{AP3} \times \lambda_{AP3}) + (\alpha_{NR1} \times W_{NR1} \times \lambda_{NR1})$

Whereas Global weight of environmental indicators as shown in Table 14 are:-

**Table 14.** Global weight of environmental indicators.

| AP1 | AP2 | AP3 | AP4 | AP5 | NR1 |
|---|---|---|---|---|---|
| 0.106 | 0.045 | 0.029 | 0.059 | 0.051 | 0.040 |

So, we get SI Environmental value = – 9.63 [2].

2. SI Social =
$(\alpha_{AM2} \times W_{AM2} \times \lambda_{AM2}) + (\alpha_{AM3} \times W_{AM3} \times \lambda_{AM3})$

Whereas Global weight of social indicators as shown in Table 15 are:

**Table 15.** Global weight of social indicators.

| HL1 | HL2 | AM1 | AM2 | AM3 | AM4 |
|---|---|---|---|---|---|
| 0.064 | 0.054 | 0.070 | 0.056 | 0.046 | 0.039 |

So, we get, SI Social value = – 4.38 [2].

3. SI Economic =
$(\alpha_{EC1} \times W_{EC1} \times \lambda_{EC1})$

Whereas Global weight of economic indicators as shown in Table 16 are:

**Table 16.** Global weight of economic indicators.

| EC1 | EC2 | EC1 |
|---|---|---|
| 0.143 | 0.130 | 0.057 |

So, we get, SI Economic value = - 7.03 [2]
Now, Hence, CSI before is = (CSI = SI Environmental + SI Social + SI Economic)

$$CSI_{Before} = (-9.63) + (-4.38) + (-7.03) = -21.04$$

Similarly,

$$CSI_{After} = (-9.62) + (-4.37) + (-6.99) = -20.98$$

Hence, The CSI after the introduction of congestion charging is increased approximately 0.7%. It indicates an improvement in sustainability [11].

## CONCLUSION

The traffic and transportation problems in Ayodhya (Chowk Road) are more serious due to numerous causative factors. The proliferation and use of motorised automobiles must be reduced as other forms of mobility emerge.

This study was incomplete because mode selection was used as a parameter to create a Composite Sustainability Index (CSI), which only considers three pillars of sustainability: environmental, social, and economic.

The pillars were conveyed through the use of a variety of metrics, including those for air pollution, resource consumption, health, accessibility, mobility, and commuting.

The most undervalued road users in the city are pedestrians.It is necessary to plan and create appropriate pedestrian amenities. To reduce the high rate of road fatalities among pedestrians, the city's traffic police may start a vigorous "pedestrian education program."

Wherever pedestrians and slow vehicles must cross fast motor traffic, traffic calming measures are required.

Need to make Transportation Model which will help not to Increase Congestion Price & will Increase Composite Sustainable Index.

## REFERENCES

1. Aljoufie M, Zuidgeest M, Brussel M, M.F.A.M. Van Maarseveen. Urban growth and transport: Understanding the spatial temporal relationship. ResearchGate. Published June 6, 2011. Accessed June 18, 2022. https://www.researchgate.net/publication/261947351_Urban_growth_and_transport_Understanding_the_spatial_temporal_relationship
2. Verma A, M RT, Dixit M. Sustainability impact assessment of transportation policies – A case study for Bangalore city. ResearchGate. Published June 2014. Accessed June 18, 2022. https://www.researchgate.net/publication/262921766_Sustainability_impact_assessment_of_transportation_policies_-_A_case_study_for_Bangalore_city
3. India Map. Maps of India. Published 2019. Accessed June 18, 2022. https://www.mapsofindia.com/
4. Sharma S, Mathew T. Multiobjective Network Design for Emission and Travel-Time Trade-off for a Sustainable Large Urban... ResearchGate. Published May 2011. Accessed June 18, 2022. https://www.researchgate.net/publication/227472740_Multiobjective_Network_Design_for_Emission_and_Travel-Time_Trade-off_for_a_Sustainable_Large_Urban_Transportation_Network
5. mathews. A Review of Urban Transport Scenario in Bengaluru. International Journal of Management and Social Science. Published 2015. Accessed June 18, 2022. https://www.academia.edu/43239992/A_Review_of_Urban_Transport_Scenario_in_Bengaluru
6. Muhamad, Ismail R, Riza ATIQ Rahmat. The Use of Non-Motorized For Sustainable Transportation in Malaysia. ResearchGate. Published December 31, 2011. Accessed June 18, 2022. https://www.researchgate.net/publication/271891346_The_Use_of_Non-Motorized_For_Sustainable_Transportation_in_Malaysia
7. Programme Consultation with Experts on Methodologies for Assessing Transport System Efficiency and Benefits for Development.; 2009. Accessed June 18, 2022. https://www.un.org/esa/dsd/susdevtopics/sdt_pdfs/meetings/ecm0609/Programme.pdf
8. Litman T. Developing Indicators for Comprehensive and Sustainable Transport Planning. Transportation Research Record: Journal of the Transportation Research Board. 2007;2017(1):10–15. doi:10.3141/2017–02

 

9. Jiang X, Zhang L, Xiong C, Wang R. Transportation and Regional Economic Development: Analysis of Spatial Spillovers in China Provincial Regions. ResearchGate. Published July 11, 2015. Accessed June 18, 2022. https://www.researchgate.net/publication/280098882_Transportation_and_Regional_Economic_Development_Analysis_of_Spatial_Spillovers_in_China_Provincial_Regions
10. Carbon Emissions of Infrastructure Development. ACS Publications. Published 2013. Accessed June 18, 2022. https://pubs.acs.org/doi/10.1021/es402618m
11. Tsay MY, Lin YJ. Scientometric analysis of transport phenomenon literature, 1900–2007. ResearchGate. Published \. Accessed June 18, 2022.