



Sustainable Urban Environment by using Transit Oriented Development: A case study in Bodhgaya, Bihar, India.

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Abstract: Among the attempts made worldwide to foster urban and transport sustainability, transit-oriented development (TOD) certainly is one of the most successful. Since the TOD concept appeared in the late 1980s, it has received increasing attention from researchers and practitioners as a way to merge together transport engineering and planning, land-use planning, and urban design for providing comprehensive solutions to contemporary urban problems. This paper is a response to the need for an evaluation of Indian cities to attempts at producing TOD. It traces the advent of TOD in India and its progress over the years. It evaluates TOD plans, either standalone or as part of the development plan, focusing on the Bodhgaya which is a mid-size city. The framework developed for evaluating these TOD plans is developed after a comprehensive literature review and questionnaire. The first section consists of a comprehensive review of literature on TOD from global experiences with identification of indicators on which the TODs can be evaluated on their TOD ness and the current debates of urban planning on land use and transport integration. We consequently evaluate the Bodhgaya city with respect to the identified indicators to understand the current scenario of TOD ness in India.

Index Terms – Transit-oriented development, sustainability, questionnaire.

1. INTRODUCTION

India has been rapidly urbanizing in recent decades as a result of its growing population and economy. According to Census 2011, urbanization increased from 17.29% in 1951 to 31.61% in 2011. According to a 2010 McKinsey Global Institute report, India's urban population will reach 600 million by 2030. Due to migration from rural areas, it has resulted in unrestrained urban expansion. As a result, the use of private vehicles has increased. Cities are not being developed with transportation infrastructure in mind to accommodate this tremendous expansion. Environmental damage has resulted from increased transportation and automobile use. Adopting a paradigm for absorbing this inflow of population and offering greater connectivity inside cities is the solution to urban sprawl. Cities are currently using Transit Oriented Development (TOD) principles as one of the elements in their urban development strategies to alleviate traffic congestion and improve environmental quality. Transit-Oriented Development (TOD) is recognized as one of the important planning strategies across cities now that the Indian government plans to construct 100 Smart Cities. It is a style of development that occurs around transit stations and features dense construction in high-density areas along transit corridors, with a focus on pedestrian mobility and easy access to transit stations.

National and many state governments are refocusing on enhancing public transportation to offset the social, economic, and health effects of auto traffic congestion in their cities after decades of underinvestment. This is a positive trend, as it indicates a shift away from the urban growth model that many cities adopted in the late twentieth century and that many cities still use today. In which constantly longer and wider highways separate buildings and blocks, allowing for an increasing number of cars. Wherever public transportation infrastructure is being built, cities are attempting to make the most of it by constructing residences, jobs, and other services near to it.

2. WHAT IS TOD?

There are multiple definitions of TOD which lies within the concept of new urbanism. New urbanist theory suggests that compact, mixed-use communities are the answer to the suburban problem. Several academics have adopted their own explanations of this new paradigm. One of the original and most popular definitions of the transit-oriented concept came from Peter Calthorpe, an architect and proclaimed urbanist. According to Calthorpe (Calthorpe 1993), TODs are:

Mixed-use communities within an average 2,000-foot walking distance of a transit stop and a core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot or car.

In addition, the transportation hub should be located in the heart of the neighborhood, within a 400 meter, or 10-minute walk from residents. This central location reflects the importance of transit in the community and in the region as a whole as shown in figure 1.1. TOD comprises a mix of commercial, residential, and institutional developments built to support a transportation hub and to encourage non-motor vehicle mobility options, such as biking and walking, within the community. A TOD area could encompass a radius of as little as 0.5 miles or as much as 1 mile from a transit station (Cervero 2002).

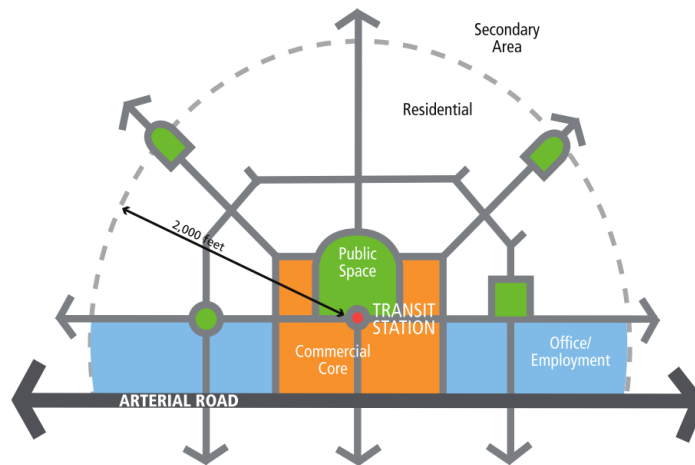


Figure 1: Transit-Oriented Development as explained by Calthorpe

The purpose of a transit-oriented city is to make public transportation more appealing than driving, reducing the demand for the use of automobiles. TOD would make public transportation faster, safer, cheaper, more pleasant, and convenient than automotive transit, causing inhabitants to prefer to take public transportation for the majority of their city excursions.

Table 1: Strategies for sustainable development

Strategy	Examples
Land use and community development	Preservation, rehabilitation, and redevelopment of central cities and high-density inner suburbs <ul style="list-style-type: none"> • Infill in cities and suburbs increased density, mixed use • Reusing brownfields, recycling buildings • Tod's and pods as the paradigm for new developments • Quality of life: attention to crime / schools / services / amenities
Transportation	<ul style="list-style-type: none"> • Recycling / pre-cycling / composting programs Access vs. Mobility — basic concepts • Bike- and pedestrian-friendly cities • Transit, para transit, ridesharing • Telecommuting / teleconferencing
Housing and other building Designs	A range of choices <ul style="list-style-type: none"> • Energy efficient buildings • Edible landscaping • Natural / indigenous plants
Business/job creation	Business leadership <ul style="list-style-type: none"> • Community economic development • Clean / safe technologies

2.1 VARIANTS OF TRANSIT ORIENTED DEVELOPMENT (TOD)

TOD is the efficient integration of land use and transportation. This integration is now carried out in a variety of ways that are variations of TOD. Transit Adjacent Development (TAD), Development Oriented Transit (DOT), and Transit Joint Development are some of the variations (TJD).

1.1.1 Transit Adjacent Development (TAD)

TAD is a development that is close to public transportation but does not take advantage of this proximity to increase transit use and other economic benefits.

1.1.2 Development Oriented Transit (DOT)

The purpose of the DOT is to facilitate development. Transit, rather than leading development, is the case here. DOT transportation is frequently used as a band-aid solution. The National Capital Region (NCR) in Delhi is a good example.

1.1.3 Transit Joint Development (TJD)

TJD's primary premise is that growth occurs concurrently with transportation, rather than before and after transport. In return for the right to build a real estate project above, below, or next to a public transportation infrastructure. TJD's financial viability is helped by increased revenue from real estate development partnerships and improved transit use.

1. RESEARCH METHODOLOGY

The study will conduct in 3 stages:

Stage 1: includes of reviewing various books, case studies, scholarly articles and other relevant publications and identifying the issues.

Stage 2: includes a detailed questionnaire for survey of residents along Metro corridor and authorities.

Stage 3: includes to interpretation and main findings from SPSS Software.

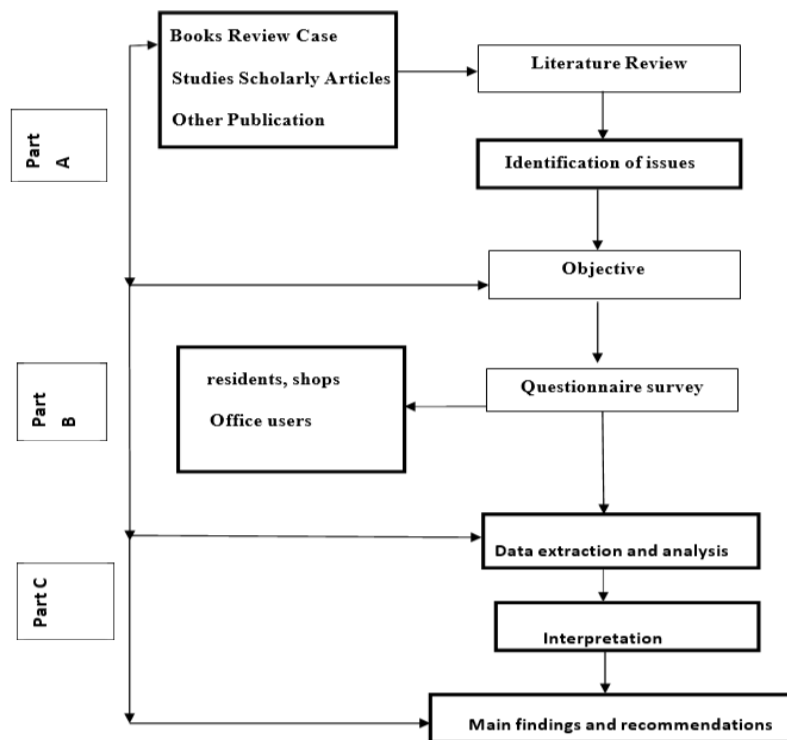


Figure 2: Research Methodology

2. STUDY AREA

2.1 **Bodhgaya:** Bodhgaya is a little town of enormous religious and cultural importance that has gained international attention. More than 2500 years ago, Lord Buddha reached enlightenment in Bodhgaya, which is situated in the Gaya district. The Mahabodhi Temple Complex, which was completed in 2002, is a UNESCO World Heritage Site, and the Bodhi Tree, under which Lord Buddha obtained enlightenment, is regarded as the spiritual heart of Buddhism. Bodhgaya is 13 kilometers from Gaya and is connected to the rest of the area by road. The National Highway 1 connects the town to Delhi, Kolkata, Patna, and Varanasi via NH83 (Gaya-Dobhi Road). Bodhgaya is also just 8 kilometers from an international airport. The fact that Bodhgaya is a UNESCO World Heritage site as well as one of the most prominent Buddhist pilgrimage locations gives it a competitive advantage. Furthermore, the town's proximity to other tourist destinations in the area, such as Gaya and Rajgir, provides additional opportunities for the town to develop as a bustling tourist destination. Bodhgaya is a Nagar Panchayat that covers 19.60 square kilometers. It is divided into 19 wards as well as the home of a UNESCO World Heritage site. Furthermore, the town's proximity to other tourist destinations in the area, such as Gaya and Rajgir, provides additional opportunities for the town to develop as a bustling tourist destination.

Table 2: Brief information of UDHD Bodhgaya Block

S.No.	Name of the ULB	Bodhgaya
1.	Location (Latitude, Longitude)	24.69577, 84.99193
2.	Nearest Highway	NH-83
3.	Nearest Habitat	Mastipur
4.	Number of Wards	19
5.	Number of Towns	1
6.	Number of Villages	132

Source: UDHD (Bihar)

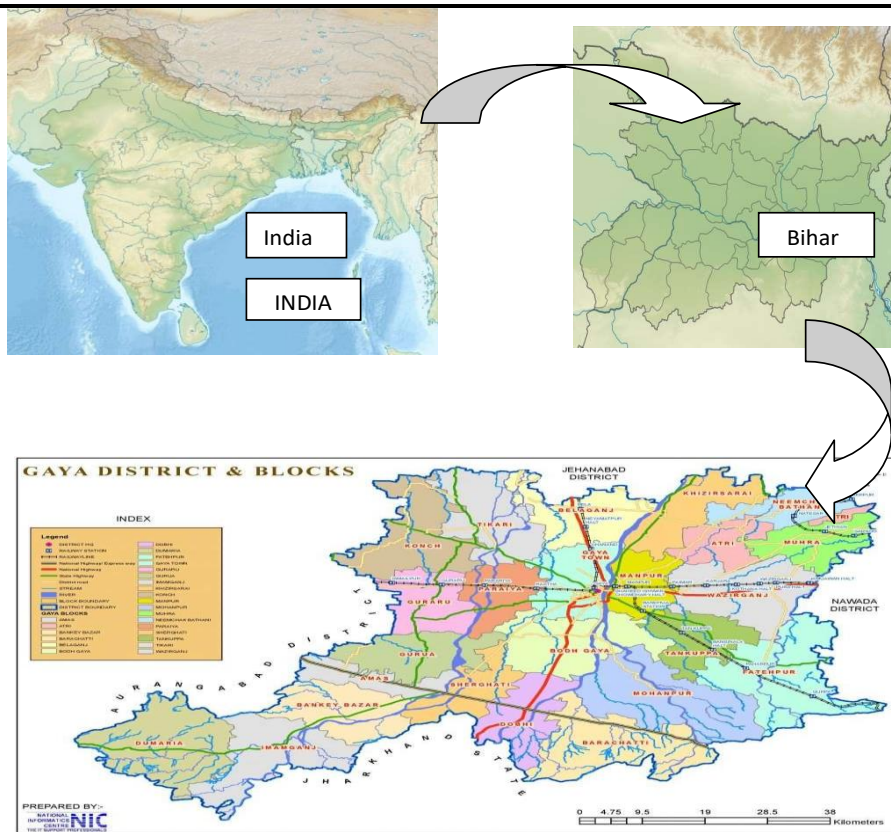


Figure 3: Study area Map of Bodhgaya City

2.2 Location & Linkages

2.2.1 Location

Bodhgaya is part of the Gaya district of Bihar, to the north, the district of Jehanabad, to the west, the district of Aurangabad, to the south, the districts of Hazaribagh and Chatra, and to the east, the districts of Nawada and Koderma (Jharkhand). Its latitude and longitude are $24^{\circ} 41' 45'' N$ and $85^{\circ} 2' 22'' E$, respectively. It is located in a transit zone between the Chotanagpur plateau and the alluvial gangetic plains of south Bihar.

2.2.2 Linkages

The surrounding area is directly connected to Bodhgaya by road and air. The Gaya Dobhi Road, also known as the National Highway (G.T. Road), runs through the district, linking Delhi and Kolkata, as well as other important cities such as Patna and Varanasi are two cities in India. The link to NH1 is especially crucial since it is one of the four main arms of the projected Golden Quadrilateral, a national network of major highways that forms a quadrilateral and is planned to connect all of India's major cities. Bodhgaya is also close to an international airport, which is only eight kilometers away. This airport was recently converted to an international airport and now serves a small number of international flights. The closest rail station to Bodhgaya is Gaya, which is 13 kilometers away. This is an important Indian Railways station on the Howrah-Delhi highway, located on the Grand Chord line. This station is served by many important trains and is linked to a number of important Indian cities.

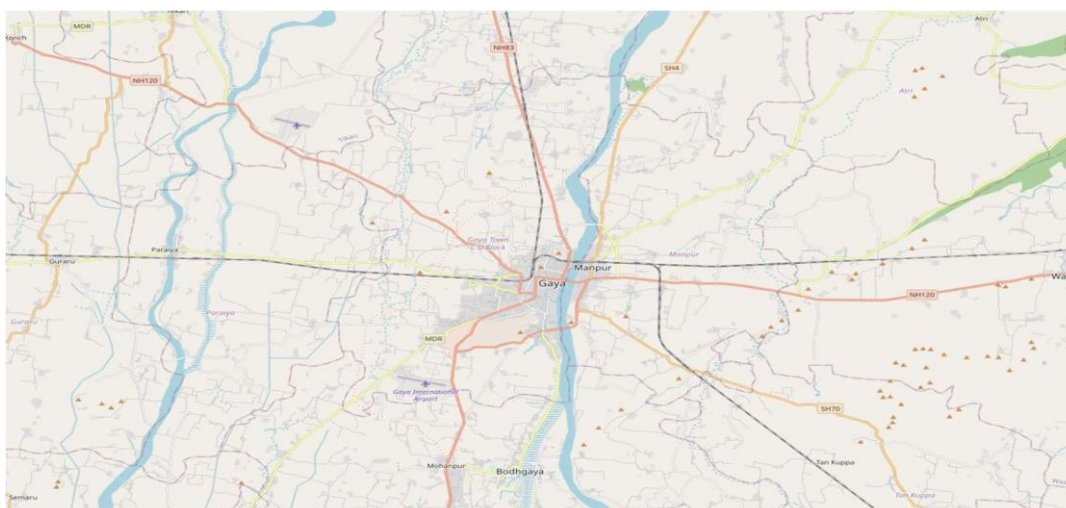


Figure 4: NH Linkage (Source QGIS Software)

2.3 Physical Profile

2.3.1 Physiography and Relief

At an average elevation of 113 meters above sea level, Bodhgaya is situated on the western bank of the Nairanjana River. The lowlands are to the north, and the highlands are to the south. The river runs smoothly from south to north, originating from the plateau floor of the high Hazaribagh. The region is primarily flat ground to the west of the Nairanjana and Mohana rivers.

2.3.2 Climate

The climate in the town is tropical, with hot summers and cold winters. Summers (mid- February to June), monsoons (mid-June to mid-September), and fall (November to mid- February) are the four seasons in the region (mid-September to November). Summer temperatures vary from 27° C to 40° C, while January temperatures range from 8° C to 20° C. Bodhgaya is cooler than Gaya because of its green and open nature. The land must have been much cooler when the area was a green forest and the river was perennial, it was during the time of Lord Buddha.

2.3.3 Rainfall and Humidity

Humidity levels fluctuate throughout the year. The driest season is summer, with humidity levels hovering about 36% during the day. Humidity levels range from 62 to 84 percent during the monsoon season. Humidity levels in the winter range from 27 to 71 percent. The average annual rainfall is 1860 mm, with monsoons accounting for 90% of that.

Table 3: Demographic data of Bodhgaya

	Total	Rural	Urban
Population	236243	197804	38439
Children (0-6 yrs.)	44352	37498	6854
Literacy	60.1%	58.14%	70.04%
Sex Ratio	949	952	931
Scheduled Caste	37.5%	38.3%	33.8%
Schedules Tribe	0.1%	0.1%	0.2%

Source: Census India (UDHD)

2.4 Traffic and Transportation

2.4.1 Existing Traffic and Transportation Scenario

A well-functioning transportation system is essential for the city's growth and development. A good circulation pattern improves the town's connections with other settlements in the area while also improving connectivity within the city. The town's growth axis has been established by old migration patterns and axis to the Mahabodhi in Bodhgaya. As a pilgrimage site, Bodhgaya draws a large number of visitors from India and abroad. During the peak season, the number of visitors exceeds a hundred thousand. This, combined with the local community's desire, necessitates a thorough investigation into the town's current transportation situation. The town is well connected to the rest of the country through via the main railway route and NH 83 (Between Bodhgaya and Bodhgaya is an international airport (Bodhgaya International Airport) that caters to international tourists.

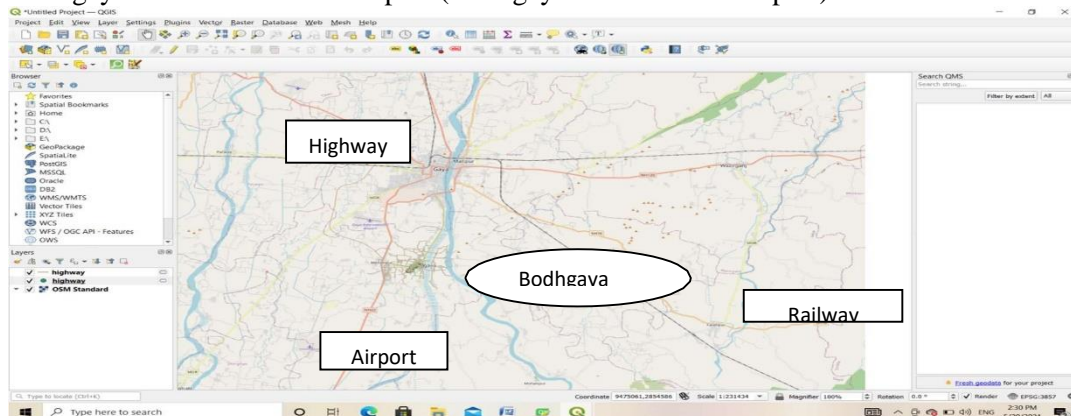


Figure No 3.3. Transportation Network by using QGIS Software

2.4.2 Roads

Three major roads run through the city. The main road, also known as the central spine, the riverfront road, and the peripheral road are the three types of roads (popularly called as by-pass). The riverside road is mainly used by commuters. The road currently has an intermediate lane with a Undivided road with a width of 5.5 meters. The road should be upgraded and extended, with proper surfacing and amenities. Street lighting is almost non-existent, and it is urgently needed. The route has a lot of development potential because it stretches for more than four kilometers alongside the Falgu River. The town's other main road is the central spine (Domuha road). The path is in great shape. Its width varies, although for the most part, the roadway width remains steady. There are three lanes of undivided carriageways on the route. The by-pass is an arc-shaped path that connects the road that runs next to the river and connects to the main road A road with intermediate lanes runs through this by-pass. The by pass road meets the main road at the tourist information Centre, forming a T-junction that must be adequately maintained.

The three main highways that service the residential neighborhoods are connected by a network of narrow pucca or kutchra roads. The kutchra road network makes up 77% of the town's overall road system. This is representative of the town's agricultural, agrarian nature.

2.4.3 Road Condition

The urban layout in Bodhgaya's central area is not built to handle a great number of autos or strong vehicular traffic there are few parking spaces and the roadways are narrow and have limited capacity. Roads and highways are in poor shape and need to be resurfaced. Road maintenance is also necessary; as garbage is strewn across all main thoroughfares a number of junctions will need to be renovated in order for the project to be completed handle increased traffic levels, which are becoming unavoidable as the town grows. In the absence of explicit rules banning encroachment, most roads are encroached upon.

2.4.4 Vehicle Ownership

According to a socioeconomic sample survey, vehicle ownership is currently extremely poor. Per household, there are only 0.27 vehicles. Sixty-six percent of those polled own bicycles, while another twenty percent own two-wheeler. Just 6% of the people in the study owned a vehicle. Public transportation was preferred by 43 percent of the household on a regular basis, and by 41 percent on a weekly basis.

2.4.5 Parking and terminal facilities

The town has a small number of parking spaces expected. This is due to the fact that demand during the peak and lean seasons differs significantly. Parking is available near the temple for all modes of transportation are acceptable, including buses, cars, taxis, and non-motorized vehicles. A bus station and an auto/taxi stand were located near the Mahabodhi Temple during the Kalchakra area.

4.4.6 Public Transport System

Cycle rickshaws and tongas are the only modes of public transportation in Bodhgaya. In the case of Gaya and Bodhgaya, three-wheelers and buses run. In Bodhgaya, there is no organized intra-city public transportation.

2.5 Transport network pattern analysis of the Bodhgaya town

The Road Hierarchy is an urban planning approach for setting up road networks that keep automobiles out of urbanized regions. It is envisioned as a road hierarchy in which the link relevance of each road type is embedded in the network structure. Direct connections between certain types of links, such as residential streets and arterial roads, are restricted or eliminated by street hierarchy, but connections between comparable order streets (e.g. arterial to arterial) or street types separated by one level in the hierarchy are allowed (e.g. arterial to highway and collector to arterial.) Higher order roads (e.g. arterials) are connected via through streets of both lower order levels in many regular, traditional grid systems, as laid out (e.g. local and collector).

2.5.1 Traffic bottlenecks

The riverbank route in front of the Mahabodhi temple there is the town's greatest traffic bottlenecks occur. There are several encroachments here, which has significantly limited the route. The las and gumtis serve the economic activity here, causing traffic congestion on the highways. The roundabout on the major route that designates the second point of congestion enter the plaza of the Mahabodhi complex. The main sources of a lot of uncertainty here are multi-modal traffic and few parking places.

2.5.2 Traffic Congestion

The major highways have the capability of much more vehicles than they do now. This is owing to an increase in the number of two-wheelers and bicycles on the roads. Both the main road and the river side road are expected to experience substantial traffic congestion in ahead due to narrow widths and encroachments on the main route. In the near future, festivals like Kalchakra are likely to push the traffic burden on the roadways beyond their capacity, resulting in horrific congestion.

2.5.3 Poor Road condition:

The majority of the town's interior roadways are kutchra. Almost all of the roads are in poor condition. The area does not have a traffic management system. Poor intersection and road geometrics: Poorly built roads and intersections can cause traffic congestion as well as accidents.

2.6 Social Infrastructure

A survey of Bodhgaya's social infrastructure was conducted. There are 16 primary schools, In the town, there are six high schools and several private schools run by monks. There is one private college and one UGC-accredited university. There is only one primary health care facility in the town, and most patients are referred to nearby District Hospital.

2.6.1 Local Economy

Bodhgaya's economy is based on tourism and agriculture. There are various tourist-related dwelling units in the town, as well as a few flour mills. The town has the ability to establish tourism-related manufacturing units such as artefact and handicraft production. There are several boarding and lodging facilities, which grow in number during peak tourist seasons and are mainly unregulated.

2.6.2 Heritage and Tourism

Bodhgaya is an ancient village with a history dating back over 2500 years, but it appears to be a modern bustling town, similar to any other in India. Bodhgaya is the most important of the four principal pilgrimage sites associated with Gautama Buddha's life, the others being Kushinagar, Lumbini, and Sarnath. The Mahabodhi Temple, which is located in the city of Mahabodhi, was built in 2002 in Bodh Gaya.

2.7 Land Management (Including Land Availability)

Although the exact figure of land availability/land bank is not available with BGNP. The town's present total developed area is approximately 550 hectares. This reflects the town's welcoming atmosphere. The remaining 1148 hectares of land are undeveloped, with potential for future development. The low density of the town also shows that there is room for more redensification.

Table 4: Land Use Distribution Data

S. No	Land use	Existing Land use area Developed area Percentage
1	Residential	38.67
2	Commercial	2.50
3	Industrial	1.35
4	Public and semi public	30.58
5	Religious Uses/Monasteries	5.68
6	Recreational Uses	11.57
7	Transportation	9.65
	Total	100.0

Source: UDHD (Bihar)

Table 5: Water Condition of Bodhgaya

S. No	Items	Bodhgaya Nagar Panchayat
1.	Quality	Good
2.	Quality Problems	Iron
3.	Level	100-200 ft
4.	Drought/flood prone	Drought Prone
5.	Major source	Piped water Supply (35%) & Hand pumps (65%)
6.	River	Niranjana and Mohana

Source: PHED, Bihar

3. DATA COLLECTION

In order to collect the needed data for this research, there are two types of data sources are used:

- **Preliminary resources:** it is not available in the secondary resources and it is collected through questionnaire and interviews which is analysis by SPSS data software.
- **Secondary resources:** Such as; research papers, thesis, books, journals, reports, and web pages and analysis of QGIS Software.

5.1.1 Questionnaire Design

Questionnaire design and distribution is a preliminary data source that is used to poll the study population about the requirements that are needed to create a sustainable and smart pattern based on the term Transit Oriented Development.

5.1.2 Population and sample size

The Population of the study area is the people of Bodhgaya City. Sample is determined by choosing 18 block of Bodhgaya city. Survey is conducted more than 500 families. Research Sample were distributed by creating google form and 100% of them are received.

5.1.3 Questionnaire Content

The questionnaire which explaining the purpose of the study, the way of responding, the aim of the research and the security of the information in order to encourage a high response. The questionnaire includes multiple-choice question, which used widely in the questionnaire. The variety in these questions aims first to meet the research objectives, and to collect all the necessary data that can support the criteria, decisions, results in the research. Some questions are linear scale and multiple choice.

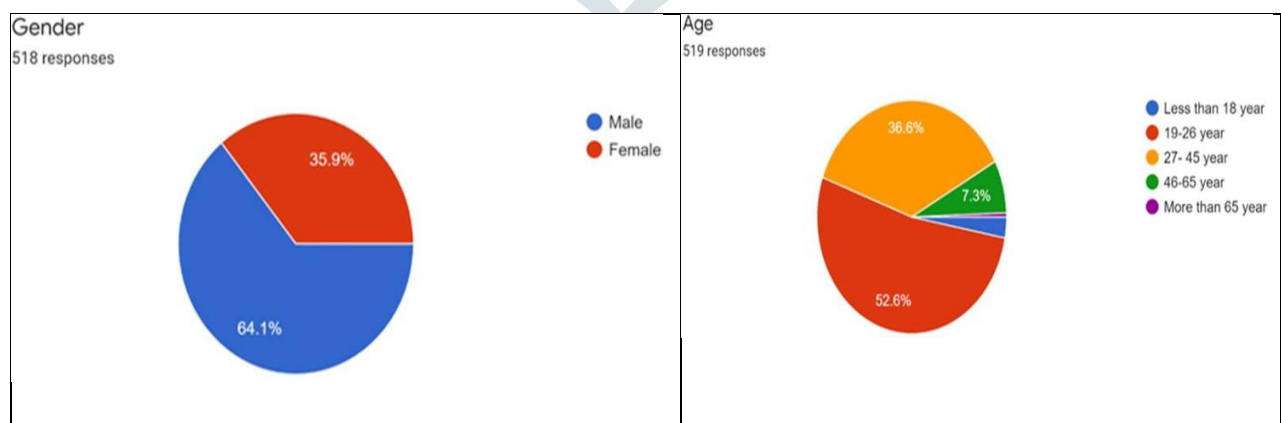
The sections in the questionnaire verify the objectives in this research related to building a sustainable and smart pattern, which based on the term Transit Oriented Development (TOD) as the following:

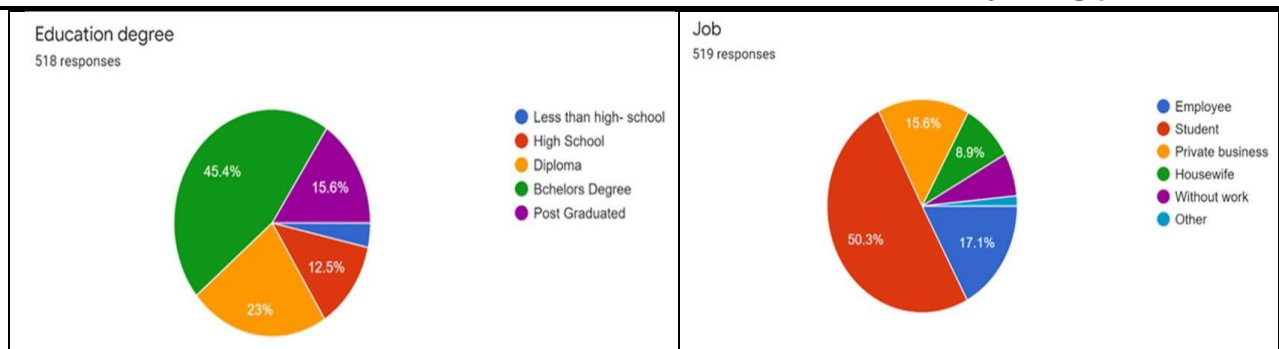
- General Information questions.
- The Trips and Transportation questions.
- Walk and Using the Public Transport questions.
- Transportation Network, Services and Land Use questions.

5.2 Questionnaire Result

The collected raw data was first sorted, edited, and then entered. Appropriate graphical representations and tables were obtained to understand and analyze the questions. Also, the ordinal scale is used in the analysis process for the rating questions. The ordinal scale is a ranking or rating data and Multiple-choice question.

Basic General social information of the participants like their name, gender, age and occupation was collected. And very basic question was asked to local people which is we find how much they have knowledge about TOD and from this survey we can analyse that in Bodhgaya city need implement of TOD.





1. The question was asked to people how familiar to Transit Oriented Development (TOD) and it clearly seen most of people were aware that term TOD. In urban planning a transit-oriented development is a type of urban development transit can make a city to be more corridors oriented and making easier to provide infrastructure and planned city is very stable and easy to work.
2. During Covid-19 outbreak, the entire world is dealing with new challenges. The effect can be seen in the usage of public transportation and also Indian-railways have suffered a loss. Due to lockdown in many countries, the demand of passenger transport has been adversely hit. And clearly seen by a pie chart which is created from the people responses. Here, in pie chart 49.7% people are Strongly Agree that Transportation hit and they faced problems. TOD shortens travel times, decreases traffic, and cuts emissions, increasing access to diverse parts of the city and boosting economic activity.
3. From the question it can clearly see that people are much aware of transportation system in Bodhgaya. The social role of transport has caused people to live in permanent settlement and give chances to sustainable development. Transportation is responsible of development of city. As Bodhgaya Mahabodhi temple side area has restricted the use of auto rickshaws, cars and buses to make pilgrimage site more peaceful, only Taxi available is an electric rickshaw that is mostly noiseless.
4. Bodhgaya is a religious site and place of pilgrims associated with Mahabodhi complex. Due to rushand crowded by visitor which created congestion problem so that in survey more than 50% people strongly agree and more than 30 % people agree with road widening is necessary because it gives more space to explore properly and enhance the beauty of Bodhgaya. After widening it will be no more congested.
5. From question asked for follow of traffic rules with responsibility by people from graph many portions of people is seriously concerned of traffic rules and responsibility. It is necessary for everyone to be aware of traffic signs and road rules and aware of traffic rules can lower chances of accidents. It is very necessary to implementation of Transit Oriented Development (TOD)
6. More than 80% of people are agreeing with pedestrian's corridors. The idea of implementing pedestrianism and bicycling corridors is agreed and can enhance the approach. There are many benefits of pedestrian's corridors like low atmospheric emissions, low road accidents and better built environmental conditions which create sustainable development.
7. More than 40 % trips that the people do during per month generally people use public transport due to traffic congestion. Major work places have to treated, and the peak hours that relate to workers have to be treated.
8. More than 70% are agreeing with the good transportation network increase the quality of environment of the Bodhgaya. Generally, it benefits reduces air pollution, reduced traffic congestion, also benefits communities financially and reducing the harmful carbon dioxide green gas emissions.
9. The time which is spent to reach workplaces is between 21-30 minutes (34%). The pattern must take in consideration that the trips have be longer that this period. This factor effect on selecting velocity average and choosing the road.
10. The time which is spent to reach airport is between 20-30 minutes (38%). The pattern must take in consideration that the trips have be longer that this period. Due to traffic congestion, it is difficult to reach airport within 10 minutes as Bodhgaya airport is nearby Mahabodhi temple.

11. (60.9%) of people are agreeing with the idea of existing all educational, commercial, administrative, health and recreational services in their area. Such services have to be allocated in residential areas within acceptable walking distances. To create sustainable development, it is necessary to existing all services
12. (53.3%) of people prefer simplest path with least angular changes. Choosing pedestrians' corridors have to be according to the most simplicity and least angular changes
13. More than 50 % of people agreed the harassment cases increase day by day and thefts increasing. So, it is necessary to implement of TOD to make female can move freely without any fear.
14. Due to rapidly growth of vehicle in Bodhgaya side area due to traffic and noise pollution is main problem due to this. But now a days auto, bus is restricted that area so people agreed that Bodhgaya is quiet and free from traffic and other noise pollution.
15. From the responses that graph is created and seen that people are concerned about environment pollution. As we know that poor quality air has harmful effects on human health, particularly the respiratory. So, we can control this problem by reduce the number of trips you take in your car etc.
16. As we can see that in graph people are concerned about sustainable development in transportation sector. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is developments that meets the needs of present without compromising the ability of future generations to meet their own needs.
17. (77.9%) are agreeing with the idea of depending on the public transportation means after develop it and reduce costs. Public transportation must to be the focal point of planning and designing the model and they must integrate with pedestrianism. Administrative and economic support has to be implemented on this
18. Most people disagreed that Bodhgaya is a low crime area compared to other. To Implement of TOD, we need to focus on these issues so that make a crime free city.
19. The idea of afforesting, lighting and furnishing streets encourages (76.9%) of people to walk to reach your destinations. Designing streetscape must include these elements.
20. More than 70 % people agreed with Transit Oriented development can change the city face. TOD density results in well populated streets, ensuring that station areas are lively, active, vibrant and safe places where people want to live.
21. (83.1%) of people think that direct connection between of areas with other and with city centre by efficient transportation system, may increase the degree of satisfaction of residents. Improved transportation system enhances community satisfaction and make each residential area an attractive place to live in.
22. As per the data collected by the public, they are able to do day to day shopping in the neighbourhood centre. So, we can say this is boon for the people of Bodh-Gaya so in less time they are able to do shopping and others thing as well. But some people is not able to do shopping due to unavailability of showrooms and mall.
23. Neighbourhood is not clean and well maintained as compared to smart city because of lack of work or incompetent officers and less aware public they did not follow the rules of dumping waste and result is in data. This data shows that public wants clean and well-maintained society. If TOD will implement in Bodh-Gaya then it not only beneficial for state but it also raises the standard of living and help to build high class society.
24. As per the data to reach nearest railway station it takes more than 30 minutes but it can be improved and can be reachable in less than 30 minutes. The roads are not wide enough for vehicles in speed mode. TOD implementation can decrease the time consumption and it will attract more tourists.
25. As per data, 45.7% people strongly agree that shortage of electricity effect the transportation in both ways. In smart city to reduce pollution government will encourage people to use electric vehicles either electric bike, cars, scooter and bus these all will affect because of shortage of electricity. And 24.2% is agree with that so agree and strongly agree people are in same category so we can say that total number is 69.9% more than half of people whose opinion are same. So, we can say that better electricity will not only increase efficiency of small-scale industry as well as transportations and transportation control rooms and automatically traffic system will manage also.

26. Yeah, strongly agree and data is also saying it clearly. In India there are several cultures with many rituals and for foreigner they faced language issues because every state has its own language and literacy rate of Bihar is so least in India and because of this tourist face communication problem and cultural shock.

6. DATA ANALYSIS AND RESULTS

6.1 Analysis of Data by SPSS Statistical software

The questionnaire which is analysis by SPSS software, generally it is used by various kinds of researchers for complex statistical data analysis, such as collect data with an online survey platform.

In SPSS software there is a sheet where we can define the variable of the data. The variable include name, type width, decimal, label, value, missing align, measure. And there is data view in SPSS where we can include row and columns, the data can be entered view sheet either manually or the data can be imported from data file. From analyze the questionnaire first extracts data from Google form in excel sheet after that in excel form replaced by code according options like (1,2,3,4) and go to SPSS software and paste the data and after go to analyze.

The “Variable View” tab at the bottom of the screen can be used to establish these meanings behind the numbers. The “Value Labels” dialogue box should open after you click the little button in the “Values” column for the variable you want to add or change labels for. This is where you can enter each unique value as well as the text label that corresponds to it.

	No.	Std.			
		Min	Max	Mean	Deviation
Q1. Gender	518	1	2	1.43	.496
Q2. Age	519	1	5	2.52	.726
Q3. Education degree	518	1	5	3.54	1.096
Q4. Job	519	1	5	2.38	1.135
Q5. Workplace	518	1	6	2.76	1.901
Q6. How familiar are you with the concept of Transit Oriented Development?	521	1	5	2.45	.995
Q7. Do you agree corona virus impacted transportation system very badly in Bodhgaya?	518	1	4	1.62	.698
Q8. How much aware are you about the transportation system in Bodhgaya city?	519	1	5	4.13	.849
Q9. Do you Agree, Road widening is necessary because of tourist rush in Bodhgaya city?	516	1	4	1.68	.818
Q10. How much portion of people follow the traffic rules with responsibility?	519	0	10	7.63	2.314
Q11. Do you agree with pedestrian corridors?	519	1	4	1.69	.787
Q12. How often do your public transport such as bus or a train?	516	1	4	2.65	.942
Q13. Do you think that a good transportation network may increase the quality of the living environment of the Bodhgaya?	516	1	4	1.80	.812

Q14. Approximately how long it takes you to reach the Airport by Vehicle?	515	1	4	2.68	.962
Q15. Do you agree the idea of existing all, educational, commercial, administrative, health and recreational services in Bodhgaya city?	514	1	4	1.83	.850
Q16. How much time do you spend arriving workplace by vehicle?	514	1	4	2.64	1.017
Q17. How long can you walk on feet to the work, home or any other trip per day?	515	1	4	3.12	.957
Q18. Which path is preferable for you to walk in?	505	1	2	1.47	.499
Q19. How much congestion increase in the Bodhgaya city due to tourist place?	511	1	3	1.75	.664
Q20. Do you agree, security for female passengers is lagging in Bodhgaya city?	517	1	4	2.62	.749
Q21. In Bodhgaya city the Hotels facility is Good for staying tourists?	507	1	2	1.11	.316
Q22. Do you think Bodhgaya area is quiet and free from traffic and other noise pollution?	515	1	4	1.84	.885
Q23. Approximately how long it takes you to reach the nearest railway station by vehicle?	516	1	4	2.69	1.149
Q24. What is your evaluation for the performance and efficiency of the current transpiration network and the public transport?	511	1	3	1.79	.680
Q25. What are the most trips that you do during a week?	516	1	3	1.77	.599
Q26. How concerned are you about environment pollution in Bodhgaya?	517	1	10	8.12	1.679
Q27. How Concern are you about the Sustainable Development in Transportation sector?	512	1	10	8.05	1.716
Q28. What type of building do you currently live in?	506	1	4	2.44	1.042
Q29. Do you think that the direct connection of your area with other areas and the city center by efficient transportation system may increase the degree of satisfaction of residents?	512	1	3	1.24	.572
Q30. Do you think that depending on public transport can contribute in solving the fuel problem that effect on Bodhgaya?	508	1	3	1.32	.640

Q31. Is the idea of afforesting, lighting and furnishing streets encourage you to walk to reach your destination?	512	1	3	1.32	.635
Q32. Can Transit Oriented development change Bodhgaya city face?	511	1	3	1.38	.692
Q33. Do you agree the neighborhood is well provided with community facilities?	503	1	4	1.94	.991
Q34. Do you agree the neighborhood is a low crime area, compared to other parts?	510	1	5	3.53	1.332
Q35. Are you able to do day to day shopping in the neighbourhood centre?	495	1	4	1.16	.491
Q36. Do you agree the neighbourhood is clean and well maintained?	510	1	5	3.66	1.167
Q37. How is the condition of footpath in Bodhgaya?	500	1	3	1.42	.716
Q38. Do you agree the shortage of electricity is effecting the transportation in one way or the Other?	514	1	5	1.89	1.032
Q39. Do you agree the tourist come from out of India have to face communication problem or cultural shock in Bodhgaya?	510	1	3	1.27	.626
Valid N (listwise)	380				

6.2 Descriptive Analysis by using SPSS Statistical tool

In which Descriptive statistics there is many more methods of descriptive analysis but the analysis is done by these two data first is frequencies and another is descriptive. Descriptive analysis, like many other types of data analysis, can be extremely open-ended. To put it another way, you decide what you want to search for in your analysis. Having said that, the process of descriptive analysis usually follows a similar pattern.

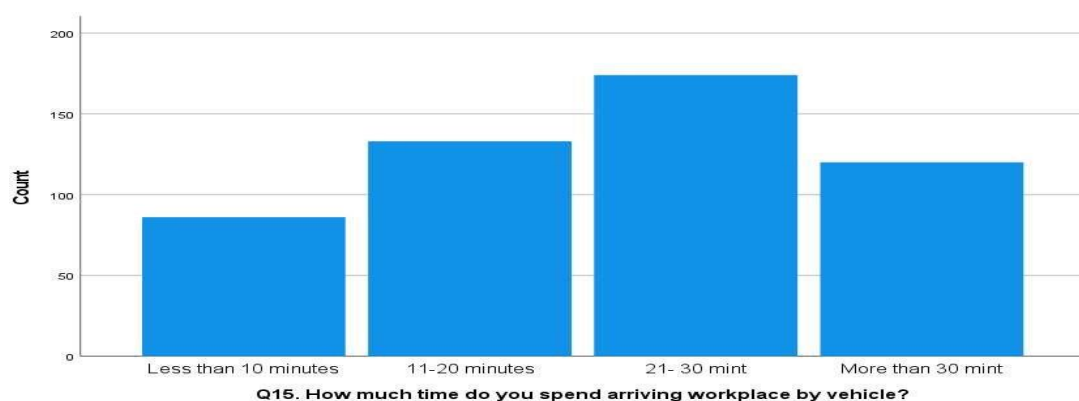
The collection of data is the first stage in any form of data analysis. This can be accomplished in a variety of methods, but surveys and old-fashioned measures are frequently employed.

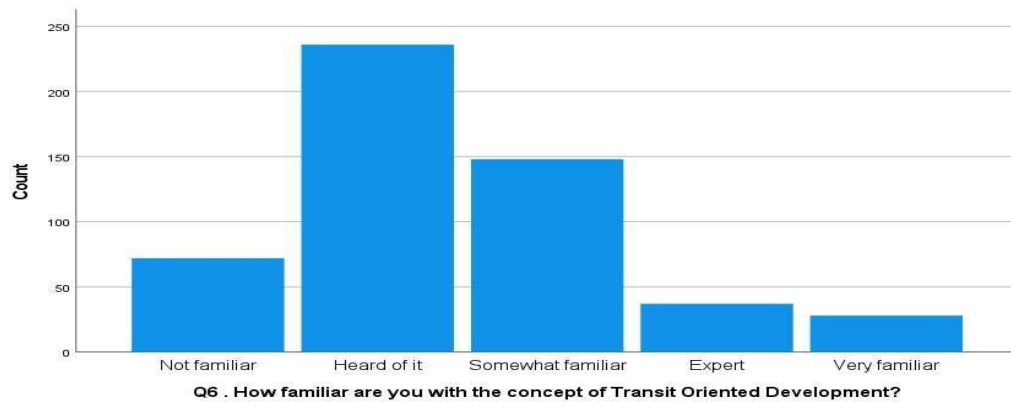
This information must be analyzed in order to obtain valuable insights and influential trends that will allow the next batch of content to be created in accordance with agree or disagree.

In surveys, which are one of the main types of Descriptive Analysis, the researcher gathers data points from a large number of samples, as opposed to experimental studies, which require smaller samples. When doing one of the main forms of Descriptive Analysis, the researcher often collects data points from a large number of people into small sample. It is generally advised by researcher to use of descriptive analysis.

6.3 Outputs in the form of Bar Chart

Here from survey analysis taken some outputs from SPSS in the form of bar chart and line





By the analysis by SPSS Statistical software, it is clearly seen that people given answer and comes output in the form of frequency, percentage and valid percentage. SPSS use because it gives output very fast. Generally, researchers use this software. This software is explained with simplest form and analyze the survey which can easily understand.

7. CONCLUSIONS

The resulted conclusions can be classified and demonstrated as the following:

1. Controlling the urban progress needs efficient tools

Communities are seeking for ways to make the most of new development and get the most out of social, economic, and environmental activities. Communities expect new neighborhoods to be more attractive, convenient, safe, and healthy, as well as sustain old ones. As a result, guidelines and instruments must be established.

- **Sustainable Development**

Sustainable development is a significant trend since it focuses on system analysis rather than danger analysis. It's about how environmental, economic, and social systems interact at various space-based scales of operation to their mutual benefit or disadvantage, community image, cultural diversity, accessibility, housing quality, transport system, public transport, town centers and collaborative leadership.

- **Smart Growth**

Smart Growth never refers to growth; rather, it aims to renew the built environment to the extent that it is essential, and to promote efficient development in the region's peripheries through the creation of more livable communities. The ten principles of Smart Growth give a framework for how development and growth might be carried out in a way that is superior to the status quo. These principles include developing existing communities, transit options, making development decisions that are fair, consistent, and predictable, and community and stakeholder participation.

Transit Oriented Development as a significant planning paradigm

In metropolitan regions, the detrimental consequences of urban design and transportation systems have become particularly evident. This necessitates an effective planning

tendency capable of directing the solution of such difficulties. TOD has since grown in popularity as a method for accomplishing Smart Growth and Sustainable Development objectives. Also, most people make the mistake of thinking that TOD can be created through the design and development of one project, but in actuality, it usually takes multiple projects working together to create an urban fabric that seamlessly blends the ideals of trend.

1 Bodhgaya City: difficulties and constrains

Bodhgaya City was chosen as a study place, although it has a unique urban structure that has been subjected to difficult geopolitical conditions, and all of these factors have resulted in a distinctive physical planning scenario, as seen in:

- **Institutional and administrative situation**

Bodhgaya City's urban planning is marked by inconsistencies and disorganization. Different and outdated rules and regulations, the lack of planning, and the lack of clear limits for local government entities are all contributing to this problem.

- **Urban structure**

Population increase, a scarcity of available land for future expansion, a lack of services, infrastructure inadequacies, environmental pollution, particularly in water (aquifer contamination), traffic congestion, especially in downtown, and a lack of recreational places characterize the urban form of Bodhgaya City.

- **Social responds with Transit Oriented Development**

The study improves community participation in the planning process. The community's comments on TOD's practical concepts are then gathered through a questionnaire. A significant social support has been established and recognized; people prefer to use the approach's key methods.

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