



Planning Bus Transit Unit in Sprawling Townships; Khurdha Road Junction, Odisha; India

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Authors' contributions

This work was carried out in collaboration among all authors. Author SPM designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors CK and KCS managed GIS works and analyses of the study. Author MS has done the literature review. All authors read and approved the final manuscript.

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ABSTRACT

The customized buses (CBs) is a novel approach of community transportations at present and have become popular mode of expanded municipal conveyance, modernized, gorgeous and traffic services. The CB is planned by combining long term demand and passenger's comforts and necessities. Based on analysis of the passengers travel data from inland and abroad at a focused point, the development of the CB is to be planned and proposed in a small town like Khurdha Road Junction (Jatni) in Odisha.. Present study points out the glitches linked with the operation and maintenance, expansion of CBs depending upon increase in numbers of travelers and other factors like stop assortment, line plan, schedules, and the impact of the proposed new public bus transit system. Traffic excellence factors, like average speed, delays, traffic jamming, travel time, and cost were considered while planning for the new transit bus terminal. The small towns around the smart city Bhubaneswar is gazing at a grave commuting conundrum. The planning and construction of the bus transit at Khurdha Road junction (Jatni) is developed to cope with the sprawling township and save the roads from severe traffic jam. Economic analysis with environmental Impact assessment of the project is done.

Keywords: *Bus transit; passengers; developing towns; customized buses; Khurdha road junction; educational hubs.*

1. INTRODUCTION

Approaching the 21st century, the transportation system has been rapidly expanding in India. It has not yet coping with the congestion in sprawling towns growing at an alarming number. Census [1] has reported 7935 towns in India with an increase of 2774 numbers more than 2001 census. The urban population of the country is 377millions and the increase in population is due to urban sprawl and population growth like a small town Khurdha road junction (Jatni) in Odisha converted from a small Notified Area Council (NAC) to a Municipality. The connectivity options in the small cities are struggling with beefing up of public transport systems and the growing number of cabs, private cars, Auto rickshaws and two-wheelers. The public transportation is the best choice; there is demand from the public to the government for construction of a bus transit.

This augmented congestion is adversely impacting our life style and are snowballing the

vulnerability of accidents and long delay in travel time. The emerging towns are polluted with Green House gases (GHG) from various subcompact transportation means. To enrich the environment it has become indispensable to opt for Customized buses (CBs) as a mark of urban sprawl, population rise and economic growth. These CBs have been fashioned as a modernized municipal conveyance, and eye catching user-led service.

Availability of space, approaches and quantum of passenger data, the cities, sprawling townships and municipalities are shifting their bus stand regularly as they were unplanned and poor traffic design. To allow for a long term operating bus stop it has become inevitable to consider all the pertinent aspects and design and construct a bus stand in flourishing town ships. The Planning of the bus parking should be such that the passengers must be safe with minimum accidents, easily accessible and passengers should be provided with proper lodging, and riskless landing. The index map is shown in Fig. 1.



Fig. 1. Index map of the study area (Jatni municipality area)

2. REVIEW OF LITERATURE

The shared car practice on cooperative basis was conceptualized in Zurich, Switzerland during 1948; considered as the hoariest economic solution to the problem of traffic congestion which has become popular in Europe later [2]. From 1960 afterwards UK, USA and USSR the car sharing systems, Prototypes in France (1970's), Witkar in Netherland (1970's to mid-1980's), Green cars Great Britain (1977-1984), Bilkoooperativ, Sweden, (1985 – 1990) and many others became popular. In India it is popular as shared taxi's running between towns [3,4,5 and 6].

During design of a bus stop the traffic engineer must consider entry and exit time and length, adequate queue up space and suitable platforms for keeping the coming up traffic load, pull outs etc. [7]. Indian towns are posing severe transport problems like: jamming, parking crisis, rise in numbers of vehicles, traffic injuries and accidents, mortalities and it is due to more private vehicles, abating public conveyance services, outdated and inadequate conveyance infrastructure with unplanned land use producing narrow roads in India [8]. The PTN (public transport network) is the bus route/transit that take care of MAS, the multi-agent system, (Dimitrov et al. [9] and Jing Zhao et al. [10]). There is a huge change in Land use and Land Cover (LU/LC) of Jatni area between 1988 and 2018 as settlement area has been increased from 321.21Ha to 665.47Ha at the cost of scrub, vegetation and agricultural lands Mishra S. P. et al. [11]. With growing urban population, public transit system is considered popular as the institution is easily handy, dependable, expedient and affordable in cities developing from small to medium and check to growth of private vehicles [12].

Owaisa M et al. [13,14 and 15], claimed transit network design is a method that can reduce the number of passengers but enhances service facilities when the road is congested. When overall connectivity is considered in a ring road (radial) in a square city and grid road in old cities, the transit system is better option Sun H., [16], Aziz A., [17], Owaisa M, et al [18]. Since the township considered is a small area; the underground or ring road system and transport transit network, circular bus route proposal (Owaisa M et al. [19]) shall be expensive.

2.1 Aim of the Study

BDA (Bhubaneswar Development Authority) is appointed as the custodian the statutory planning and development of Jatni. It is in the outskirts and within the city urban area. BDA shall frame growth plans by use of land and real estate undertaking construction works of satellite clusters, profit-making organizations and providing public utilities like drainage, sewerage, STP's, water supply, transportation, social facilities and connectivity which is congested and unplanned at present Fig. 2(a) & (b).

2.2 Key Objective

The Bus Transits and stops should be provided with all facilities for Commuters such as to afford expedient and informal but comfortable crusade to the travelers by numerous modes to reconnoiter and generate revenues from vehicular sources by unused land uses as the town is expanding for three decades (Fig. 3). The key challenges for the proposed transit are economic viability, funding agency, bus stops demarcation, crew and bus staffs and public motivation for using the transit to achieve the prospective objective. Present study conveys the design of a simple transit transport network in a small but growing municipality without a bus transit. The Indian urban areas are under severe jamming; worsening air quality; growing GHG emissions from the transport vehicles; more road accidents; due to increased private/government vehicles. The design has considered the quick charging equipment for the new energy vehicles of the future.

2.3 Methodology

The developed small notified area councils in 1980's in Odisha are converted to a municipality. Jatni is a similar town ship which was a prominent railway junction from 1955, leading railway junction along the east coast of India. Since inception; the township grew since then but expansion was meagre though a lot of hilly lands are available encompassing the area and NH16 (posthumous NH-5) is passing by the township at a distance of 5Km from the town. Being at a thickly populated and in advantageous position the township can grow fast if a suitable bus transit is planned.

Present study envisages Landsat satellite imagery data was collected from Geological

Survey website (<http://www.earthexplorer.usgs.gov>). The Satellite images were employed for the study were obtained from Landsat TM (Thematic Mapper), Operation land imager (OLI) onboard Landsat 5 and Landsat 8 considering path row of 140/45 of the Landsat.

Training sites of the images are created to represent the spectral information of the land use and the land cover classes. After the selection of training sites, the classification was run on the image using in ERDAS Imagine. The overall accuracy was determined for each thematic map after measuring the producer's and user's accuracy for each land use and land cover categories. The LU/LC map is used to locate the suitable place in the township to select a site for the proposed bus terminus. Then after the design of the bus stand, it should be processed in the government for implementation and

budgetary provision. The design should be such that it should be easily accessed, accident proof, less transit and better comfort.

2.4 Study Area

Khurdha Road Junction is located 21 KM towards west from the district headquarters; Khurdha, 22 KM from statecapital Bhubaneswar, ofOdisha, towards East Khurdha Roadrailway junction (Jatni: 20.09°N lat.& 85.42° long.). The area is historically prominent, and importance in Odisha transportation map from pre-independence period as a railway junction (Khurdha Road Junction)in East Coast Railways connecting Kolkata to Chennai, and Puriin early 19th century. The Municipal area is 15.82 km² and av. altitude above MSL is 36 m (Fig. 3).

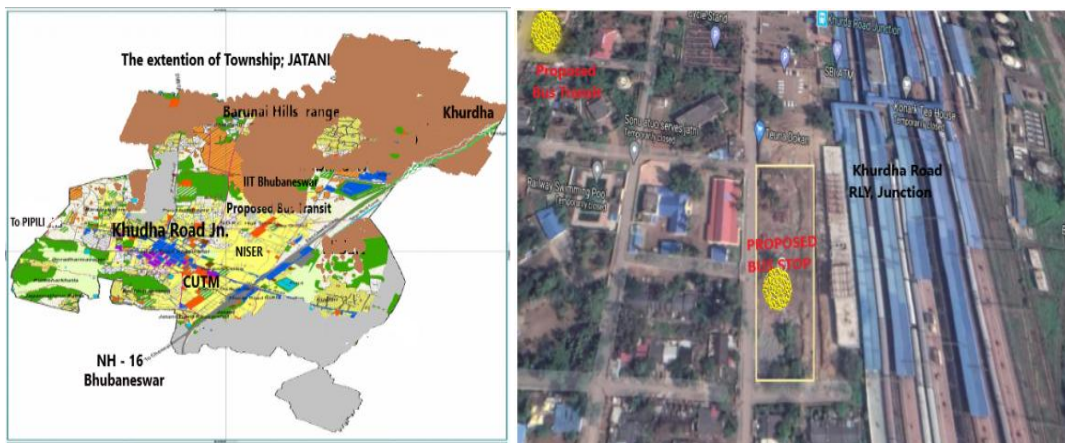


Fig. 2. Extension of Jatni area from 2000 and proposed bus transit and bus stop

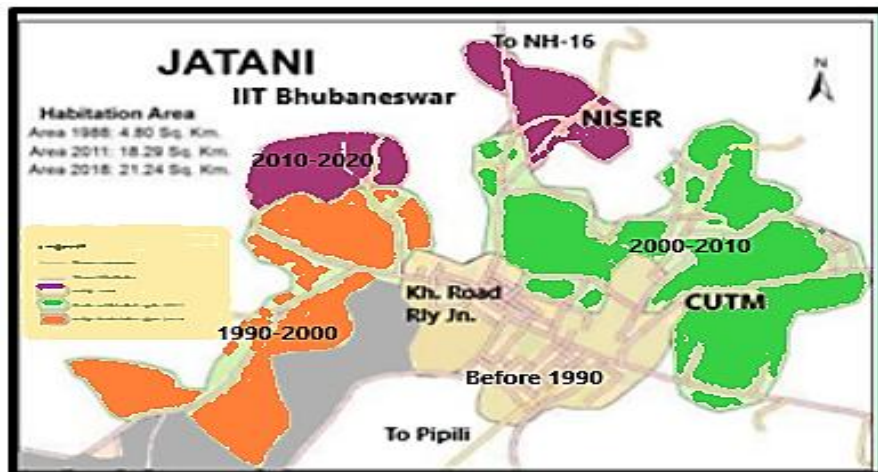


Fig. 3. The extensions of Jatni municipal area from 1988 to 2018

In Indian scenario the public transit is open to all. The young and lower-income group (LIG), in a place like Jatni shall prefer limitation of costly self-regulating mobility to ply to their destinations like scholastic, service bases, leisure and social benefits.

Senior citizens shall use the services more for their utilities like health issues, tapping family life needs. The transit shall be new income source for customer based vendors, hawkers, hotels and restaurants and other end users generating employment and providing public conveyance (Fig. 4).

2.5 Transit Strategic Planning

The players for the transit providers are the land holders, Government and private bus owners and the financiers. The transit shall include transit stop, public connectivity through local auxiliary transport system and developments around the transit. The serviceproviders are transit agency/federal unit, state government and private land owners and private developers. The planning steps are opportunities, vision, transportation plan, capacity building, stake holders input, statutory clearances, comprehensive plan, preparation of detailed project report (DPR), funding sources and drawl of memorandum of understanding (MOU) if public-private, administrative approval, conceptualization, tender floating and Construction (Fig. 4).

2.5.1 Key challenges

A small town like Jatni is less dispersed. It has a low density of land use and less effective fixed routes. It is not community oriented and has a low number of commuters. Passengers prefer small buses and are attracted to large and city like conveyance system. Large vehicles make the transit unclean and unhealthy and their lavatory system is less attended by the passenger and their frequency of cleaning is almost zero. First few years the transit services are maintained and latter neglected due to increase in traffic and increase in numbers of conveyance units. Pedestrian routes become pitiable due to transit stops, shops and services and which becomes worse in rainy seasons. The users of the system are old people, physically disabled persons, people who do not have mobility C stay at home parents accompanying children, ladies, Low income group (LIG), temporary engaged bus staffs, tourists, travelers from Khurdha Rly Junction, and visitors for better travel options.

2.6 Growing Educational Hub

With the construction of campus of Centurion University of Technology and Management (CUTM), Indian Institute of Technology (IIT), Bhubaneswar, National Institute of Science Education and Research (NISER), Xavier University, Konark Institute of Science & Technology (KIST), Orissa Engineering College (OEC) and thirteen numbers of higher secondary schools or high schools grew up as an educational hub along with the old important Khurdha Road Junction of the IR (Indian Railway) (Dist. Hand book, Khurdha) [20].

2.7 Road Connections

The township is connected to SH-13, SH-27, NH-57 and NH-16 (i.e. the 4way-lane between Kolkata and Madras) and by other State Highways. The Jatni area is connected to other important places by (S.H) state highway 33.690 KM, Major District Road (M.D.R) by 37.893km and Other District Road (O.D.R) by 381.79 km. The area of the block is 211.12km² comprising of 13GP's and 113 inhabited villages and the Jatni Municipality (Dist. Stat. hand book Khurdha [20])

2.8 Population Growth

The Jatni Municipality and its sprawl had a population of 50116, 57957 and 63697 in the years 1991, 2001 and 2011 reported in the census of India. The block population was 99644 populations as per 2011 census. But after the growth of the educational institutions, the town and block has grown appreciably and the population shall be beyond 150000 in the year 2020.

2.9 Climate

The block lies in the fringe of coastal (Chilika lagoon) and the typical hilly Savanna climate (Chandaka and Barunei hills range). The area gets average annual rainfall of 1424 mm with major precipitation during southwest monsoon days (Dir. of Eco. and Stat., Odisha). The district is influenced by SW monsoon in tropical areas and under Savanna hot climate. The place is influenced by three distinctive seasons annually such as summer, winter and rainy seasons. The mean daily maximum temp is 38°C (in May), while the coldest is of about 15.7° C (Fig. 5). The RH (relative humidity) varies from 48 to 85 % at Bhubaneswar. The mean monthly PET (potential evapo-transpiration) values of the district range from 57 mm in January to 284 mm in May.

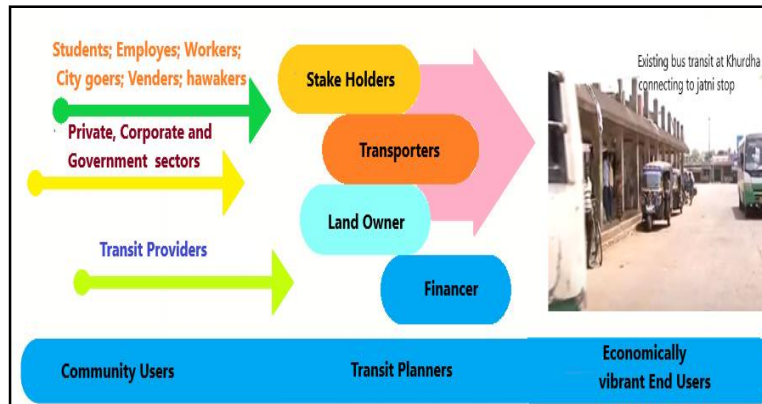


Fig. 4. The decadal extension of Jatni town in last three decades shall

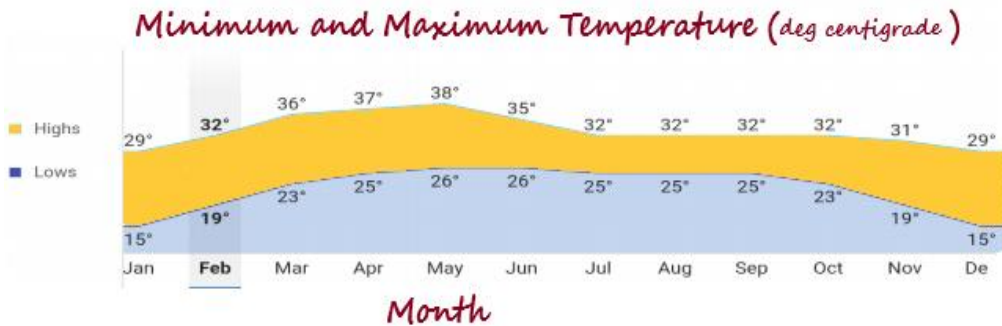


Fig. 5. Minimum and maximum temperature month wise of the Jatni area (Source: IMD)

2.10 Cultural Heritage

The area is within 10-30 Km distance from Dhaulagiri, Khandagiri, Lingaraj Temple, Chilika lagoon, NandanKanan, Atri (Hot Spring) and many notable historical and tourist spots. Though led by Odiya's but the SE-Rly's HQ has made the area multi linguistic like Christians (Anglo Indians), Muslims, Malayali, Telugu, Marwari, Gujarati, Bengali, etc. It is a seasonal business hub due to the Rly Junction and well communicated.

2.11 Transportation and Road

Due to Khurdha road Junction, the area has excellent railway connectivity with many cities of India due to the major Railway Junction across the East Coast for the Indian Railways. It is well connected to all other cities in the state. The NH-16 (connecting Chennai & Kolkata) runs close to Jatani (around 7 km). The distances from Jatni are Bhubaneswar (22 km), Khurdha (8km), Pipili (13 km) with either inter district or local transport facilities.

3. METHODS

The positioning and operation of customized buses (CBs) should be such that it should accommodate the proper stop selection, flow plan, setting of timings to avoid unnecessary jam, unsafe traffic landing, delay in entry and exit etc to be done by proper design [21,6]. Different choices for landing and takeoff design procedures are one bus in one berth space in a line multiple busses are in different lines at one time and multiple busses in one line at a time with different time of take off with a first come, first leave method/manner. Similarly the passengers should have boarding and landing stops in the passenger line; the vehicle entrance time is prior to the traveler's time of coming; or the passengers will choose vehicle from a number of same destination targeted vehicles. The passengers waiting time either zero or considered as waste time if they reach earlier. As far as practicable the bus terminus should be nearer to be centrally located and within the township and auxiliary vehicles to be available 24 hours.

3.1 Geomorphology of the Area

Jatni area in the Khurdha district lies in the Lateritic upland and Hilly terrain. The area lies in the lateritic upland and in the fringe areas are of old alluvium (Fig. 6). The topography is of undulating terrain is coped with lateritic covers overlain sand stone and rocks of Precambrian origin. The eastern Ghats belt (EGB) hills lying beyond the Chilika lagoon is of hilly terrain covers the southwestern and western part of the area. The topography of the terrain is shallow buried Padi plain, pediments, moderately buried pediment, residual hills and many others. The galloping land use changes in the Jatni area has

been observed after 2000 due to construction of different educational and commercial hubs within Jatni area. There is a rise in settlement and utility areas from 321 ha in 1988 to 665.5 Ha in 2018 without a bus transit or a bus stop. So it is prioritized necessity of the growing town to have a bus stop near Rly Junction and in the ARAGUL areas.

3.1.1 Geographical and geomorphology map

The geological map of Jatni has been drawn which indicate that the southern portion has laterite cover whereas about 35% is alluvial soils of south Mahanadi delta (Fig. 7).

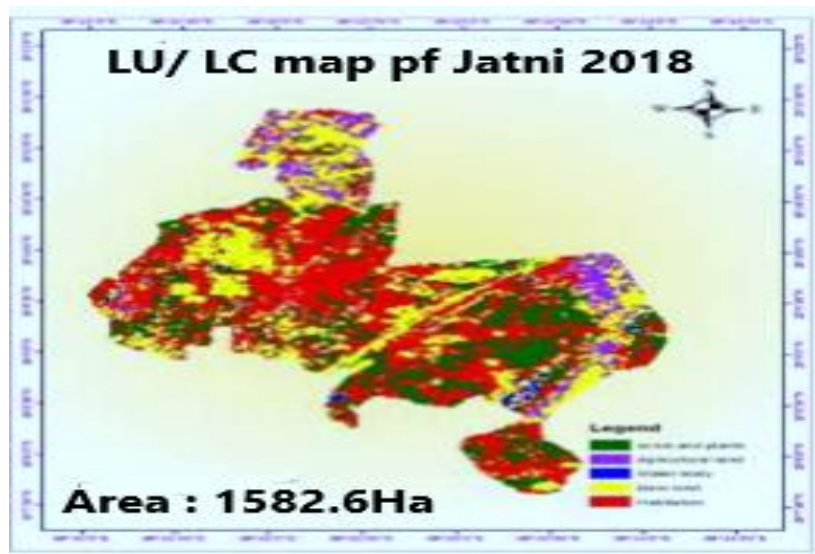


Fig. 6. The LU/LC map of Jatni Area 2018 (Source: Mishra & Barik 2020)

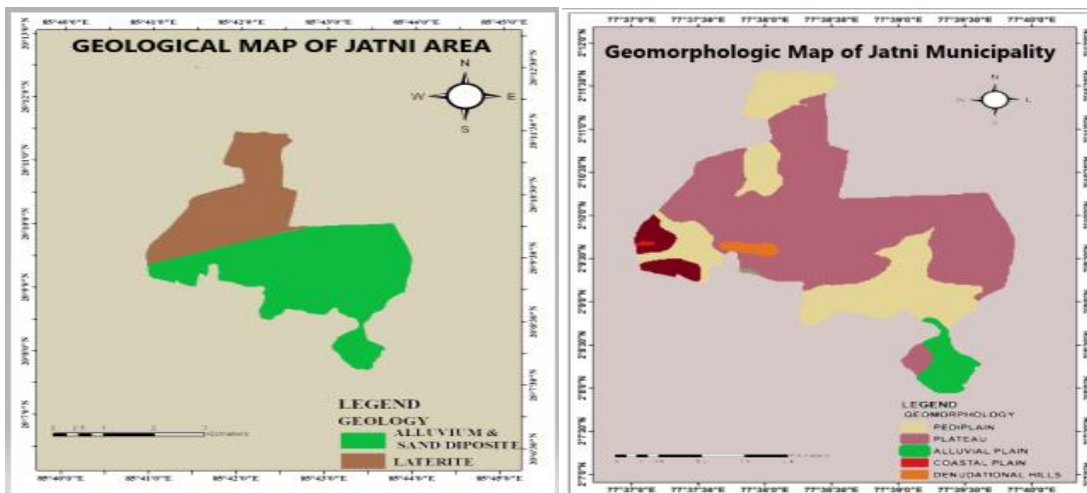


Fig. 7. The geology and geomorphology map of Jatni Municipality area

To save the agricultural land the proposed bus halt project is selected in the northern sector over laterite bed. This will provide firm basement for the structures as well as the bus shelters.

3.2 Overall Criteria of the Project

The considerations should be taken care of during overall design of the terminus which should account for the passenger's continuity in movement from entry to exit and should not be obstructed by any structure at each turning points to avoid accident and confusion. The Bus terminus should be visually tempting; uncongested, expansive, well lighted and should cope with the surrounding and environment. The space and facilities here shall satisfy functional requirements in the peak hour for the target year under all operating conditions. The transport hub should be convenient to all quality of passengers with all amenities for passengers such as secondary connectivity like rickshaw, auto rickshaws, Tempo, taxies, town buses for local passengers with a reassigned unified bus time-table with route escort maps, chartered bus facilities; point wise tariff charts. Similarly the rate charts for point to point prepaid taxis (like Uber and Ola), rickshaws, town busses and auto rickshaw are to be displayed.

The bus transit must have special features like zoning for assignment of regional bus movement allied activities, bus parking of smart city public buses and their movement, parking and plying of connected taxis/auto rickshaws/ private vehicles. The transit must have lane provisions for pedestrian and two wheeler traffic. The inter connectivity between pedestrian and inter-state bus stand, local bus parking and local modes of transportation should be optimized. The space for strategic activities like storing condoned buses, maintenance of unserviceable buses, work shop, all parking areas should be taken care of. The commercial manipulations are to be optimized within the outline of planning and structural frame works within national building standards and transport regulations to enhance the viability of the scheme. The total infrastructure must have adequate provisions like proper electrical energy, drinking water supply, sewage disposal unit, sewerage accumulation and disposition unit or sewage treatment plant (STP), storm water drainage etc.

3.3 Demanding Statutory Clearance Process

As per Environmental Impact assessment (EIA) Notification, 2006 & its amendments, the construction area of the project has covered an area of is 6.27ha and/ or built up area ≥ 150000 m². So the project demands pre EIA clearance from Odisha pollution control board (OPCB), the State Environmental Impact Assessment Authority (SEIAA) Odisha under Sec 8(A) of EIA and the validity grant is up to 7years. The Pre-feasibility report (PFR), the conceptual plan and EIA report along with duly filled in Form 1 and 1(A) is to be applied to Central Pollution control Board (CPCB), Odisha as per norms. After the necessary approval from different regulatory authorities, fixing of funding agency, the work is tendered by the competent authority, in this case the Jatni Federal body.

3.4 Design Consideration (Architectural)

The bus transit project is an opportunity for the growing town, which shall contribute to urban setting and shall improve the familiarity passengers to a better transit system. The separation of traffic flows, avoiding cross-flows and contra flows should be maintained as far as possible. The movement of the travelers must be provided with unidirectional, suitable and well defined space and paths should be direct and at their required points within the congestion of traffic. For passenger movements separate paths is to be provided within the planning concepts. Infrastructure must be technologically advanced, and replicating the modern bus transits with maximum user-friendly and exchanges.

The incorporation of bus transit and improved connectivity to the destinations in the neighboring units is a path to the achievement of the new transit unit. The bus transit should be reachable by foot; man pulled rickshaw, two wheelers, three wheelers and taxis. More open spaces for picking and dropping of passengers must be provided with better knowledge for the passengers within the premises and approaches of the transit and bus stop terminal. To optimize hindrances to the operational basics, care must be provided for safe drive of automobiles, commuters and drive staffs, transport links.

The state of arts should consider smart, contemporary, iconic, open, well lighted with

proper design and civic self-worth. Consideration of comfort and expediency of the passengers with all amenities should be taken care of. The conceptualization of the transit should be user-friendly and shall provide services for the stake holders. Exceptional amenities should be provided for the disabled, diseased, and elderly people. Acceptable direct and obvious spaces by the side of the routes are to be provided. Planning of the transit should incorporate best lines of visibility to avoid accidents, cross-flows and peak hour congestion. Provision of numerous of facilities in a hygienic and pleasant setting is essential for a bus transit. The arrivals and the departures should be well synchronized and ancillary transport vehicles should be provided. The vending zone, utility and service areas are to be up-to-date, effective, and well-coordinated during planning and designing with leading edge tools and innovative soft wares. The service entrée and emergency vehicle approach is to be well coordinated during the planning and design. During exercising on master planframe work of urban bus transit design and transport contacts in the town's terminal environment the sustainability, commercial aspect should be optimized within the scope of the financial limits and design constraints.

3.5 Planning Architecture

The Planning & Building Standards Regulations, India, 2008 (updated in 2017) specifies some improvement control standards which shall be shadowed for transportation LU (land use), FAR (Floor Area Ratio), transport concerned activities like distances from railway station, go-downs, bus stands, bus shelters, transport depot, airport,

special ware housing, cargo terminals. The optimum allowable FAR should be 1.00 (Clause: 34.3). The height as per standards should be 15.17 m as transit is about 1.5-2.0 from the Khurdha road railway junction (cl: 35), parking is to be provided for about 30% of total built up area (assumed as assembly building since the parking criteria table is silent on transportation buildings).

3.6 Water Supply Requirement

The total daily water requirement will be approx. 1288 KLD, out of which total domestic water fresh water requirement will be approx. 772 KLD. The flushing use water requirement will be 515 KLD and water required for horticulture would be 20 KLD calculated in Table 1.

3.7 Sewage Treatment Plant (STP)

Waste water quality generated from the project during operation phase shall be of domestic sewage characteristics and of quantity 979 KL/day. Hence Sewage Treatment Plant of 1000 KLD is proposed for the project with the treatment up to tertiary level with the provision of reuse of the treated water to its full capacity, thus attaining zero discharge. The uniqueness of STP system that works on the biodegradation principle followed by sedimentation within a compact compartment, and has multi fold performances on volumetric efficiency. Smaller STP systems may be placed outdoor in planned transit at Jatni. Treated water from STP shall be transferred and stored to overhead tank from where it will be used for toilet flushing, horticulture and HVAC make up water.

Table 1. Water requirement for the proposed bus transit at Khurdha road junction in KLD

Description	Area	Popul ⁿ	Allotment Basis	Water necessity	Water required. Domestic	Flushing	Code Provision
Unit	m ²	numbers	lit/capita	K-liters	K-Lits (60%)	K-lits (40%)	
Terminal traveler parking/fire fight	-	78000	15	1170	7020	4080	NBC cl.4.1.2 & 1.3
Terminal (offices and staff	5400	600	45	26.55	15.93	10.62	≈ 1per/10m2
ISBT commercial retail & offices	10575	1077	25	26.94	16.16	10.78	≈ 1per/10m2
Restaurants & other uses	4381	926	70	64.84	38.90	26.94	≈ 1per/03m2
TOTAL				1288.32		772.99	515.33

3.8 Rain Water Harvesting System

Two numbers of rain water harvesting storage tanks is proposed in the campus of the bus terminal. It should be desirable for the collected runoff to pass through a de-silting-cum-filter chamber and should be allowed to be stored for reuse for gardening and plantations purposes. Overflow from the storage tanks recharges the aquifer by using percolation boreholes. Oil and grease separators are provided before desilting-cum-filtering processes which retain and segregate the balance oil present in the runoff.

3.9 MSW Disposal

Municipal Solid Waste (MSW) estimated to be generated during operation phase of the transit is about 9000 kg/day. Two different types of bins (biodegradable & non-biodegradable) at various points on every floor will be provided from where it will be collected and segregated into biodegradable & recyclable material. Biodegradable waste will mostly be constituted of Restaurant canteens and hotel kitchen waste. Organic waste convertor will be installed in campus to convert the food waste into manure which will be used as compost in the greenness of the area. The inorganic wastes comprising recyclable materials such as paper, plastic, glass, packaging material etc., will be sold to recyclers.

Paper recycling unit is also proposed for the waste paper. It is estimated that about 10 Kg/day of STP sludge will be generated which will be used for horticulture in the area. Hazardous waste like Diesel Generator waste, oil and its barrels will be sold to CPCB approved hazardous waste recycler. Before selling them to the authorized recycler they will be kept in isolated and separately marked area. E-waste like IT/telecom sources, insulation, wires, cables, fluorescent lamps, batteries, external electric cables and CFL bulbs will be generated from the commercial activity shall be collected at common point and be given to authorized e-waste recyclers. *Municipal liquid waste* needs to be collected in small pond area and aerated for increase in biological oxygen demand (BOD) and Chemical oxygen demand (COD) and then to be disposed to municipal drains with storm water disposal system.

3.10 Fire Fighting

Fire-Fighting System in the bus transit type of building includes assemblies, commercial and

business. Wet riser & hydrants belonging to the firefighting system need to be designed as stipulated under National Building Code (NBC-2005) of India. The other pertinent I.S codes and recommendation are to be adopted in practice by the resident Fire Brigade. The structures consist of two underground storage tanks known as fire and terrace tank whose capacity is designed as per clauses NBC-2005 reliant on the block height and the wet-riser system with hydrant valves and cabinet of the fire hose (NBC Pt- IV). A Fire Hose Cabinet comprises of one Fire Hydrant/Landing Valve and two specified 63 mm dia. and 15 m long rubberized fabric lined hosepipe, 5-mm bore SS- couplings, branch pipes with nozzle, minimum 35m long 20mmφ first aid fire thermoplastic hose reels with fire-men's axe with all accessories of sprinkler, fire pumps and fire extinguishers.

3.11 Alternate Power Supply

In addition to the state electricity supply; threediesel generator (DG) sets of 750 KVA should be provided as a source of power back up. Stacks are to be provided for dissipating emissions from the Diesel Generator (DG) set. The height (H) of DG set should be at as $H = 0.2 \times \sqrt{kVA} = 0.2 \times \sqrt{750} = 5.47 \text{ m.}$, where, H= height of stack requisite (m). Hence DG set of 750 KVA has a height of 6 mtr above acoustic enclosure.

3.12 Construction Materials and Machineries

The quarries for the building materials required for the construction like coarse aggregate (HG black HG Chips from crushers within 10-15 km), river sand (nearby Daya or Kuakhai river bed at 5-25 km distance), laterite blocks (within 5 km), filling boulders and Murom are plenty and easily available. As Jatni area is age old and near the railway junction, the chances of availability of building materials like bricks (kilns bricks), cement, steel, iron scaffolds, PH materials, sinks, overhead water tanks and all other construction materials are available within maximum 25kms reach. The construction machineries like bulldozer for dismantling and excavating old structures and leveling laterite undulations, JCB for digging and earth work, dumper to be used for mud and material handling, concrete mixer with hopper for RCC work, cranes for lifting and moving of materials and scraper, road roller for pavement and track preparation are available in the nearby construction agencies.

3.13 Concrete and Steel

The cement concrete (CC) to be used are M 25/30 grade for footing/ column/slabs and beams. The steel reinforcement shall be of grade Fe 500 for HYSD bars. The Cement Concrete is to be carried from the nearby installed batching plants to site by transit mixers with proper cube tests as per quality control norms.

3.14 Pollution Control/ PPE during Construction

Construction activities under loose material environment may generate dust. This dust shall impact the air quality of the adjoining area within the project premises. The continuous movement of vehicle / machineries during construction activities and transportation construction goods create dusts. To minimize such impact the mitigation measures shall be: All the loose and dusty materials shall be regularly sprinkled with water and covered with cloths and sheets. Vehicles used should have Pollution Control certificates and materials carried will be covered and the build activities should have time limit from 0600 AM-0500 PM. The first aid box with health assistants should be present at work site with fencing of work site. The working personnel must be clad with respective PPE (personal protective equipment).

3.15 The Ground Water Quality

The under-ground water for construction and portability for the stake holders (bus transit in operation), should not have toxic non-metals, metals and heavy metals. So X-ray spectroscopy tests are conducted and the results are shown in Table 2.

The heavy metals like lead (Pb), chromium (Cr), cadmium (Cd), mercury (Hg), copper (Cu) and aluminum (Al) in excess are toxic for health. The ground water of Jatni contain the only heavy metal contaminant is iron. High concentration of Fe in supply water provides iron taste making it undesirable in colour, odour and turbidity as drinking water. High dose of Iron present in supply water may cause Hemochromatosis i.e. accumulation of Iron in lungs, kidneys, liver etc. resulting in stone formation and malfunctioning of these organs.

3.16 Avoidance of Accidents

Medium towns like Jatni, have greater share of the low income group and poor with larger share from slum dwellers than the densely populated cities [8]. Indian towns have major conveyance problems due to unplanned parking, congestion, parking shortage, untrained drivers, increase in private vehicle, waning public transport services, outdated bus stops and transits, improper transport planning that multifold accidents. There were 501423 numbers of road accidents out of which mortalities were in 2015. More than 50% of deaths in accidents on road are young of age group of 15-34 years. The transit should be planned to have minimum accidents To minimize accidents at bus stops / transits at the exits and entry should be separated [24,25]). Less private owned busses should be allowed inside. Regulation on speed limits is to be imposed and better site distance is to be provided. Jaspal Singh UITP (intelligent transport, <https://www.intelligenttransport.com/transport-articles/21458>).

3.17 Design and Drawings

The latest revised versions of the IS codes are used for of structural design. They IS Codes are IS 456 – 2000 (Concrete structure design), IS 13920 - 1993 (ductile detailing of RCC structures), IS 875 - 1987 – Part II(Imposed loading (other than earthquake) and Part III - for Wind loading, IS 1893 – 2002, IS 800 – 2007 (Steel structure design). For earthquake resistant structures and Sp -16 - 1980 – for column design are to be used.. Structural analysis is to be done using software STAAD-Pro-V8i and drawings are drawn by the software Auto CAD. Design of all the components of the structures need to be confirmed with the pertinent IS codes. Mat/ grill foundation needs to be designed to withstand the worst grouping of loads. The foundation depth in soil strata should be kept at a minimum of 1.5m below the ground level.

3.17.1 The drawing of a transit

After considering all the architectural, environmental and civil structural aspects a drawing has been prepared by the AUTO CAD and the floor plan of the bus transit is given in Fig. 8. Necessary auxiliary utility spaces of the bus terminals like taxi stand, cycle stand and 2, 3 and 4 wheeler stands are provided to help the passengers to move to their destination (Fig. 9).

Table 2. The chemical composition of the ground water of Jatni area which determine the drinking water quality

Sl No	Oxides of metals	Unit in % or ppm	Quantity present	Effect on cement concrete/portability
1	Aluminum Oxide Al ₂ O ₃	%	26.41%	no effect on both
2	Silicon dioxide (SiO ₂)	%	50.55%	no effect on both
3	Ferric Oxide (Fe ₂ O ₃)	%	17.16%	on portability
4	Phosphorous pentoxide (P ₂ O ₅)	%	0.57%	on CC phosphate attack
5	Sulphite (SO ₃ ⁻²)	ppm	692	on CC as sulphate attack
6	Chlorine (Cl ⁻)	ppm	698.5	on CC chloride attack
7	Pottasium Oxide (K ₂ O)	%	2.47%	no effect on both
8	Calcium Oxide (CaO)	%	0.87%	effect on portability
9	Rubidium Oxide (Rb ₂ O)	ppm	211	no effect on both
10	Strontium Oxide (SrO)	ppm	114	no effect on both
11	Barium Oxide (BaO)	ppm	405	Affect health in excess
12	Chromium Oxide (Cr ₂ O ₃)	ppm	611	Affect health in excess
13	Manganese Oxide	ppm	852	no effect on both
14	Lead oxide (PbO)	ppm	168	Affect health in excess

Sources: Secco et al. [22]; Das et al. [23]

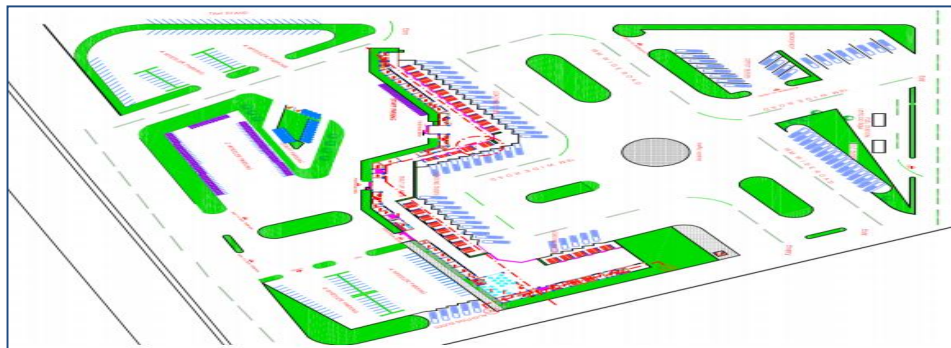


Fig. 8. Proposed floor plan of the bus transit at Jatni

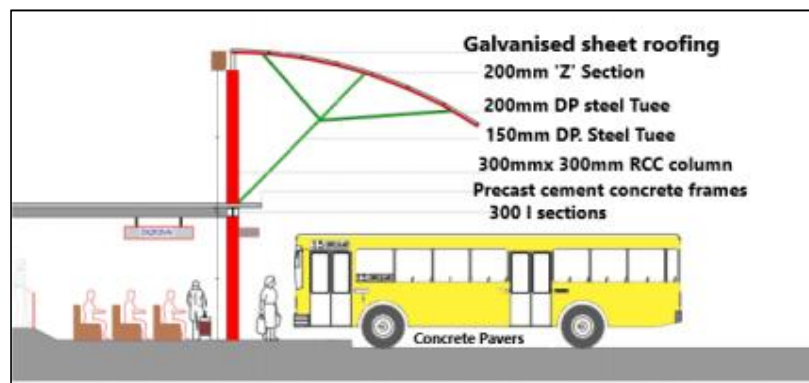


Fig. 9. Typical vertical section of single bus corridor with sitting arrangement and landing

4. CONSTRUCTION PHASE

During the construction in operation, the runoff from the site must not be permitted to debouch into the roadside drains. Suitable actions are to

be taken to gather the run off. All attempts will be made to reuse it. To minimize the use of water for construction purpose, Ready Mix Concrete (RMC) should be used. Potable movable toilets, separately for men and women shall be provided

to maintain the hygienic sanitation conditions. Sewage from these toilets should be channelized to the external sewage network. Stagnation of water shall not be allowed in or around the project side to prevent the breeding of mosquitoes. Modern in-house maintenance, as well as regular weekly/ annual maintenance/ overhauling of equipment and prompt replacement unserviceable pumps and pipeline valves are to be carried out to optimize emissions. The Excavated earth, debris etc. should not be dumped and disposed of on road side and to be used for levelling undulations or landscaping. Cement bags, waste paper and cardboard packing materials should be recycled or reused.

5. RESULTS AND DISCUSSION

The Indian urban areas are under severe jamming; worsening air quality; growing GHG emissions from the transport vehicles; more road accidents; due to increased private/government vehicles. Odisha had 5219 thousand numbers of registered vehicles in 2015 which had increased to 5833 thousand numbers in 2016 (<https://www.ceicdata.com/en/india/number-of-registered-motor-vehicles/>). Coping with large scale rural to urban migration to growing small medium towns near the large cities it is observed that six areas demand reforms in the public transport system, policy-level initiatives, in situ ground pilot schemes, modern technical applications, labeling initiatives for public transport, searching funding agencies and initiating Bus Rapid Transit Systems (BRTS) and metro rails for fast, relaxed, and cost effective urban transport [25]. The state transport undertakings (STU'S) in India should be joint venture of state and public vehicles which link three towns (Jatni, Bhubaneswar and Khurdha) started from 1960's and are state managed [24].

After conceptualization of the bus transit lane segregation keeps importance both for the main bus systems and the ancillary interim conveyances. The management of traffic during negligent hours should be such to reduce fatalities. The auxiliary conveyance systems like two wheelers, three wheelers and taxis, electric vehicles are to be engaged to achieve last mile connectivity. The public and private bus terminus should be separated and scheduled properly to improve traffic system. For cost effective ness the CNG vehicles are to be introduced for local connectivity. The auxiliary stands for 2, 3 and 4

wheelers should be well separated from the major vehicles, and higher tariff rate to lean the traffic density. Integrated LU, travel optimization, smart transport should be the goal with stressing upon less accidents, smooth running, well communicated, improved accessibility and easy expansion [26 and 27].

The Indian urban areas are under severe jamming; worsening air quality; growing GHG emissions from the transport vehicles; more road accidents; due to increased private/government vehicles. The design has included quick charging equipment for the new energy vehicles like solar operated e-vehicle of the future along with the intelligent traffic command system for the future development of smart cities like the present customized bus transit system in the present project at Khurdha road Junction area.

6. CONCLUSION

The public transit systems such as bus rapid transit system (BRTS), sharing conveyances, transport pulls, private institutional buses, town buses, Metro rails have their own traffic and passengers depending upon the size, standard and democratic growth. Hence while planning a bus transit system, the considerations are it should be well-judged and should cope with the traffic growth and add to the existing infrastructure and travel demand. Of the various initiatives, the scheduled and planned transit at Jatni is a replica of similar bus stations of successfully operating in nearby towns constructed under Jawaharlal Nehru National Urban Renewal Mission (JNNRUM) guidance. The conceptual bus transit should be clean, convenient and congestion less (3C's) to achieve the principal objective of the nation i.e. connect India, travel footprint optimization, practicing public conveyances, adopting fast journey, comfort travel, green model, smart concept and modern means to all class of people of India.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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