Road Safety of Agglomerating Cities in India – Bhubaneswar

ABSTRACT

Background: The clashing of one vehicle with other vehicle knowingly or unknowingly, directly or indirectly is considered as motor vehicle collision. Road accidents, its mapping and mitigation can be addressed awareness, road engineering interventions; traffic planning, signalling in the Bhubaneswar city, Odisha as increasing at fast pace annually.

Introduction: About 11064 RTCs causing 5333 mortalities during 2019 which has risen by 12% in the year 2021. There also occurred RTCs, smashing of vehicles, in Bhubaneswar; the capital city of Odisha raising from zero to nine black spots in last 3 to 4 decades. Its topography, and located at critical junctions of Kolkata-Chennai national highway (NH-16) and NH roads to pilgrim city, golden sands of Puri (NH 236).

Methodology: Collection of traffic data, traffic study at few places, geographical information studies, remote sensing of geo-referenced satellite data and use of ERDAS software and analytical studies to initiate up-gradation of proposal for existing risky and vulnerable roads, planning for new routes to address the accidents and reduce traffic congestion during peak hours.

Results: Population rise, added with daily floating people and heavy traffic plying through NH-16 and NH-316 have assured traffic congestion, delays and accidents. The dominant black spots found are at road junctions, Rasulgarh, Vanivihar, CRP, fire station, Baramunda and Patia. Environmental malfunctions, rider's faults, mental health of driver and user, and mechanical failures are major causes of RTCs. GIS/RS maps has to be plotted over small scale maps (1:1000m). Probable black spots identified and redressing by up gradation, and new roads have been proposed.

Key words: Bhubaneswar, Road traffic crashes, Road Safety, Mortality, Trauma Care, Road Safety Policy.

Introduction

Severe road accidents have been reported from locations like Ravi Talkies, Kalpana Square, Rasulgarh, and Baramunda as these locations provide entry into the city. Even after having various traffic management measures accidents are still being reported from these locations in a regular manner. As Baramunda bus stand is being developed as ISBT, the area is always overcrowded. In peak traffic, it is very difficult for pedestrians to cross the whole width of NH as there are no proper facilities like a foot over-bridge or dedicated signal time slot. In Odisha state has 91 motor vehicles/000 persons, NIMHANS -2017 (Road Safety in India)

These accidents lead to traffic congestion at the entry point of the city itself. Another small traffic can be mentioned under the umbrella of Rasulgarh i.e. Palasuni traffic. This location connects locations like Balianta,

Pandra, GGP Colony with NH. The series of over-bridges in the city starts from Palasuni to negotiate the speed, travel, service level and delay in time. Even after an important location this traffic is still not developed as per its significance. Death rate due to RTCs in Odisha increased in 2021 against 2020 by 7.24%. According to transport dept., the road traffic deaths (RTD) in Odisha were in 2021 was 5081 people against 4738 in the year 2020. (Kar et al., 2016[1], Kumar et al, 2022[2], Mohapatra 2022[3]).

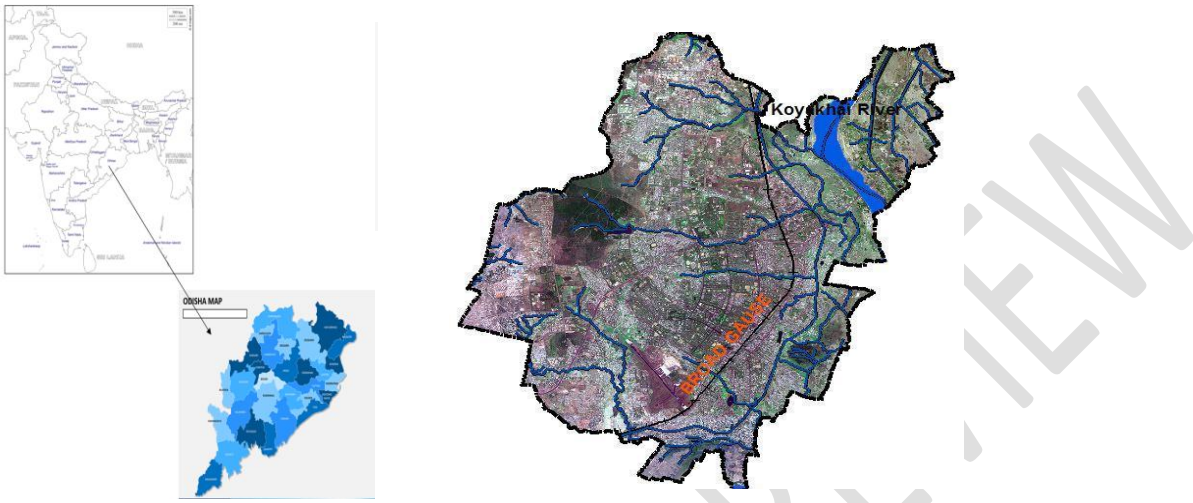

Fig 1: The index map-showing road features of Bhubaneswar, Odisha

As a result, valuable lives fell to death traps and public properties are in risk for a past couple of years. By using GIS and Mapping techniques we are going to find out the traffic hotspots and zones which are very much accidental prone and are not suitable for traffic management. Prioritizing safety on roads is considered as a major public health problem.

Road traffic crashes (RTCs) India:

Globally about 1.3million die for RTCs and disables 20 to 50billions of people. Globally about 3247 people put to death daily, and the 2nd leading cause of fatalities among RTCs of age group 5−29 years. Rise in population in the country, continuous surge in motor vehicular registration/use, increase in road networks contribute towards the upturn in numbers of RTCs, hike in mortalities and trauma due to injuries and road traffic deaths (RTDs). The country's population have increased at a compound annual growth rate (CAGR) of 3.4%, during the decade 2001 to 2011. During the same period, the number of road accidents in the country increased at a CAGR of 2.1%, RTDs and the number of persons injured in road accidents (RTCs) in the country between 2001 and 2011 increased by 5.8% and 2.4% respectively (Ruikar et al., 2013[4])

Table 1: Statistics of RTCs over Indian roads with fatalities ; crash wise and Population wise

Year	People India	No of RTCs			Person affected in crash			New Vehicle Regd (IND)
		Total	Deaths	% of total	Persons	deaths	%	Number (CEIC data)
2000	1056575549	391449	78911	17.6				4585700
2001	1075000085	405367	80888	20.16	405216	80888	19.96	5499100
2002	1093317189	407497	84674	19.95	408711	84674	20.72	5892400
2003	1111523144	406726	85998	20.78	435122	85998	19.76	6700000
2004	1129623456	429910	92618	21.14	464521	92618	19.94	7270000

2005	1147609927	439255	94968	21.54	465282	94968	20.41	8152000
2006	1165486291	460920	105749	21.62	496481	105749	21.30	8960000
2007	1183209472	479216	114444	22.94	513340	114444	22.29	9670000
2008	1200669765	484704	119860	23.88	523193	119860	22.91	10530000
2009	1217726215	486384	126896	24.73	515458	125660	24.38	11500000
2010	1234281170	499628	133938	26.09	527512	134513	25.50	12770000
2011	1250287943	497686	142485	26.81	511394	142485	27.86	14180000
2012	1265780247	490383	139091	28.63	509667	138258	27.13	15950000
2013	1280842125	486476	137900	28.36	494893	137572	27.80	17600000
2014	1295600772	489400	141523	28.35	493474	139671	28.30	19070000
2015	1310152403	501423	124130	28.92	500279	146133	29.21	21000000
2016	1324517249	480652	150790	24.76	494624	150785	30.48	23000000
2017	1338676785	464910	147913	31.37	470975	147913	31.41	25300000
2018	1352642280	467044	151420	31.82	469418	151417	32.26	27260000
2019	1366417754	449002	151113	32.42	451361	151113	33.48	29580000
2020	1380004385	374397	131714	33.66	348279	131714	37.82	15271519

Source: MoRTH: GOI National statistics of road traffic accidents in Indiareports (2008, 2018, 2019 and 2020)[5]; https://www.macrotrends.net/countries/IND/india/population

There is a constant rise in population, RTCs and people affected in crash and number of vehicles registered in RTO offices of various states of India. India with 1.38billion population have averaged crude death rate and age standardized death rate in the years 1990 and 2017 were 15.8%/18.9 years of age and 15.9%/17.2 years of age respectively. Corresponding Crude death rate/ Age-standardized death rate among low SDI (Socio-demographic Index) calculated by GBD like Odisha from 1990 and 2017, were 11.1%/12.7 years of age at the rise of 28.3% and 17% respectively, which is much lower than the Indian statistics (Lancet Public Health-2020[6])

LITERATURE REVIEW

The roads are kind of the network where the points acts like the interconnecting areas of the roads where the accidents occur, on analysis of the networks, and the point of interaction, the accidents can be minimised Van Aerde et al., 1995[7], Warith et al., 2013[8],. Kurle et al 2016[9], Choudhary et al., 2019[10], Samal et al., 2020[11]., Kumar et al., 2022[12]. In urban transportation network, the space management and the geospatial data needs collection and allocation to carry out the mapping. The digitization made to check the available space in the interconnectivity, Martinez et al.,(2017)[13], Somarzaro et al., 2021[14]. Transportation is the lifeline of urban areas and national economy. To carve a smooth transportation channel, the proper planning of city or town is required. Inappropriate planning will definitely result in subsequent road blockage and traffic deadness of the city Gouj et al., 2022[15].

The proper developmental planning and it's execution must be practised with the help of spatial use of satellite data for focussing on road plans and extensions as per our requirement. Transportation and planning should be performed as an integral part of road development that could further aid in appropriate urban shaping without interferring the growth of each other (Pal et al., 2012[16]). The Vulnerable Road Users (VRU), like pedestrians are cyclists, should not be missed in the planning and design of ameliorative processes like track for cyclists, foot path or Rubberized asphalt mixtures, robots to traffic management etc.

Sec 2O2 of Motor Vehicle Act, 1988 sanctions, a competent police personnel to arrest culprit without warrant who commits an offence punishable u/s 184. 185, or 197 of the Act, along with Suspension of license of the offending drivers may also be effected u/s 20 of MV Ac't. (Odisha police circular order no. R- 382/2019[17]) .

The landscape and street-design of the Bhubaneswar city, the dynamics allied are Eastern Ghats belt undulations, and busy NH-16 heavy traffic plying are mainly accountable for its TRCs and fatalities. The roads needs detaining, DL seized, the consignor, consignee, and driver to be booked for their negligence for the catastrophe. DL, and vehicles permit of Transport Vehicles being suspended including State Transport Undertaking buses. 10. 571 Road Safety Corners created in the show rooms of two wheeler dealers for imparting road safety awareness before handing over the two wheeler to the buyer, Gopal Krishnan 2012[18], Miclăuș, et al., 2020[19],Fisa et al., 2022[20]. All reports about planning, design, and intervention strategies to cut down mortalities, and road crashes, within BMC area to be analysed regularly about death and trauma at the hotspots. Even plan to use robots for guidance and control can be initiated to traffic management Wu et al., 2014[21]. Bhubaneswar though in Hills range and roads have heavy ups and downs, it is not associated with landslides and other hills associated problems like Mizoram Hills (Mishra et al, 2020[22], Nayak et al., 2020[23])

The delineation of old cities have earmarked its road traffic hotspot areas, but the extension scanty towns, satellite cites and newly built up urban towns have unidentified road accident hotspots and traffic congestion areas are the research gap. Present study is exploration of this gap and its rectification of the newly established 70years city Bhubaneswar in Odisha.

METHODOLOGY

The methodology adopted in road accident mapping and reduction of road traffic crashes in the Bhubaneswar city in the present study comprises of finding the case study area, tracing the accident hotspot zones, observation and data collection from the traffic study. The study also includes collection of accident data from police records, nearby Hospitals and public enquiries. The location of various health care units and trauma centres running in the close vicinity of the hot spot zones are identified. The engineering and the traffic management issues collected. From the present traffic volume, futuristic exploitation of the transport infrastructure guessed. Considering the SDG gloal-11, i.e reduction of RTCs by 50%, a new plan for connectivity and rectifications are considered. Before that the LULC map and the communication maps existing as on date need to constructed with as small scale as possible for better planning. The methodology for flow diagram for LULC map and communications layers and feature extraction are done for preparation of maps.

i. *Methods used for traffic study:*

The traffic statistics should take observations like flow rate (vehicles/unit time), speed (distance/ unit time), travel time/km of road, tardity (inverse of travel time), occupancy, density, time/vehicle, distance per vehicle and concentration of vehicles. The procedures adopted are sectional capacity; measurement over about 10 m., measurement over road length (0.5(km)]; observer to move with the traffic flow, and wide-area samples from many vehicles, part of ITS (Intelligent Transportation Systems). Digital observations are also possible (Van Aerde et al., 1995[7]).

ii. *Making transportation and LU/LC*

Crashes on roads generally happen due to over speed, without using seat belt and helmet, not obeying traffic rules, improper signalling, Damaged roads, drunken drivers, not aware of traffic, and driving while using mobile phone. The department of transport, Government of Odisha (GoO), have acknowledged more 13 new black spots in the BMC witnessing recurrent road mishaps.

Flow diagram for LULC and Communication Map

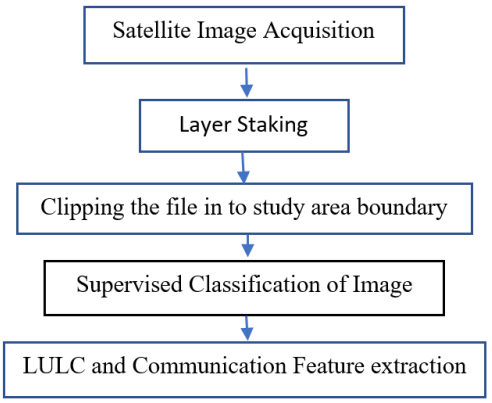

Fig 2: The methodology for preparation of LULC and road map of BMC

ii. *Tracing accident hotspot zones around Bhubaneswar:*

The numbers of road traffic crashes (RTCs) counted during the year 2017 were 625 in Bhubaneswar Municipal Corporation (BMC). About 84% of RTCs occurred within BMC urban areas, ≈46.7%, on the National Highways, ≈18% during rainfall. Vehicle wise, the accidents occurred by the cars (37%) and trucks (≈19.1%). Majority of the sufferers were the Juvenile age group, 18–24 years. Males are the victims and constituting males (≈68%) (Mornecy et al., 2012[24], Mohanty B., 2017[25]). Out of 280000 road traffic incidents (RTIs), Vehicle wise the number of road traffic deaths by road user between the Years 2015-2018 were pedestrians(26%), Bicycles (7%), two wheeler (51), Auto rickshaw (2%), Cars (5%), Buses (3%), truck (5%) and others (2%), results of traffic study made by TRIPP -2020, IIT New Delhi[26].

iii. *Marking present black spots over BMC map.*

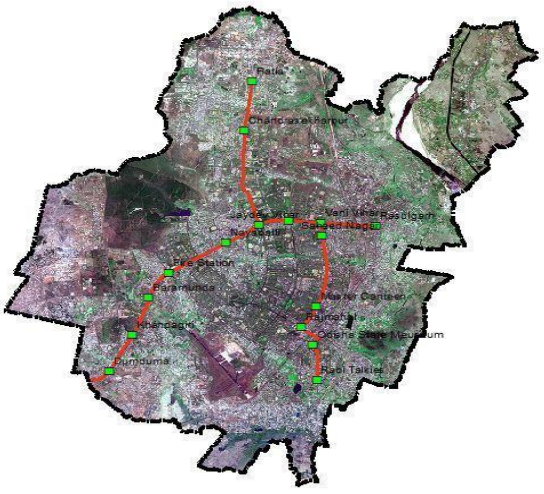

Fig 3: The connecting roads where the accidents are frequent within Bhubaneswar

Out of many black spots, the selected squares in the artery roads considered hotspots are Patia, Jaydev vihar, Vanivihar, Rasulgarh, Fire station, Khandagiri, Master canteen, Rajmahal and Ravitalkies from many on road death traps. Others are major/arterial roads at Satya Nagar, CS Pur, Chandaka, Patia, Khandagiri, Balianta, Raghunathpur, Mancheswar, Saheed Nagar, Biswanathpur, Anantapur, and Kalinga Studio Chhak (**Fig 3**).

iv. Map preparation methodology

For identification of the RTC areas, the data was collected from several sources like hospitals, accident spots, local vendors etc.. The gathered information about health care units in the vicinity of the accident areas were also noted. A plugin named heat map to identify the accident areas in Bhubaneswar city. Sourcing crowd through emerging lanes and updated Google mobile application knowledge needs to be used to amass road accident data. Finally the composed map containing all those layers is in map **Fig 4.**

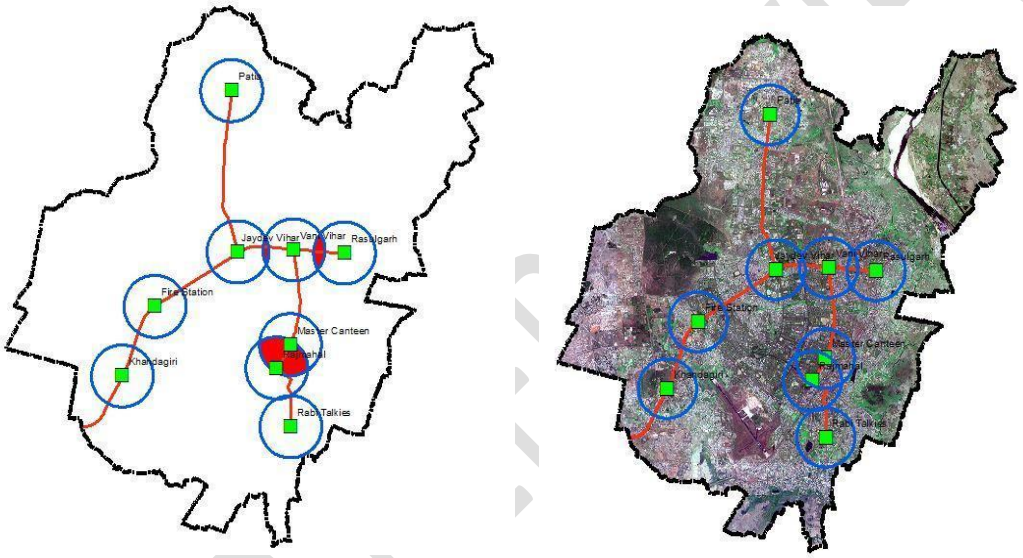

Fig 4: The vulnerable RTC areas at Kalpana to Rajmahal, and Rasulgarh -Vanivihar -Khandagiri

The objective

The objective of the present study is to

i. Locate the risky and vulnerable stretches prone to RTCs.
ii. Accident emerging zones (number of accident cases)
iii. To identify alternate routes to minimize congestion
iv. Renovation of present status of roads with up gradation if necessary
v. To decide the distribution of accident spots in BMC
vi. To suggest recommendations to the traffic police and administration.
vii. To locate the nearest Hospital in case of any emergency.

Rasulgarh is one of the key entry points into the city. It connects Puri & Cuttack with Bhubaneswar. Rasulgarh square traffic is very confusing for all types of road users due to its design and location constraint. Mostly vehicular accidents reported from this traffic. These accidents lead to traffic congestion at the entry point of the city itself. Another small traffic can be mentioned under the umbrella of Rasulgarh i.e. Palasuni traffic. This location connects locations like Balianta, Pandra, GGP Colony with NH. The series of over-bridges in the city starts from Palasuni. Even after crossing an important location this traffic is still not disperse as per its significance. As a result, valuable lives and public properties are being in danger for a past couple of years.

LU/LC and road map extraction:

For Land use and land cover feature extraction from satellite images after geo-referencing. Geo-rectify images done if it not already done (UTM WGS 84). Run an unsupervised classification depending upon number of classes. The output of the unsupervised classification needs consideration if gone out to the field with the GPS unit to define these classes. Finally, all the classes merged if they are the same. The extraction of the LULC layer and road network from the image extracted Fig 5(a); and Fig 5(b).

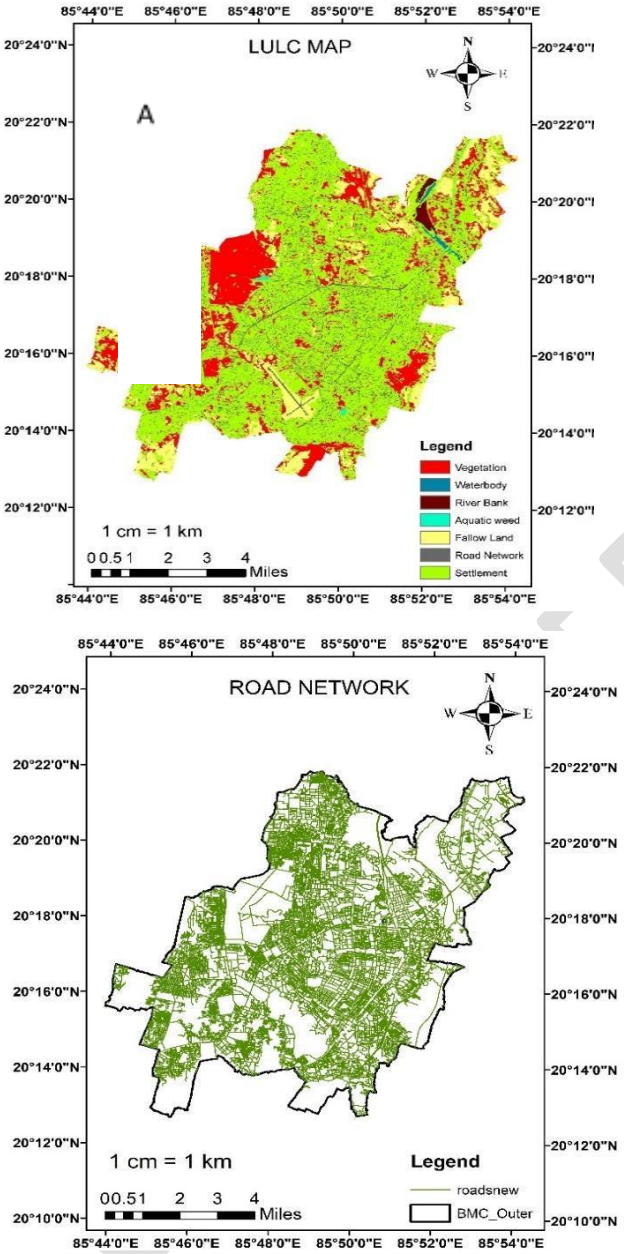

Fig 5 (a): The Land use and Land cover map Fig 5(b). Present road network of Bhubaneswar city

Calculation of road length prone to RTCs

Road accidents in the city occur due to human error, environmental factors and mechanical failures. The major reasons of RTCs are reckless driving, driver's poor physical condition, bad habits e.g. consumption of alcohol while driving, mechanical failures of the vehicles, negligence of other road users, presence of animals on the roads and deficiencies in the construction and maintenance of roads (**Fig 6**)

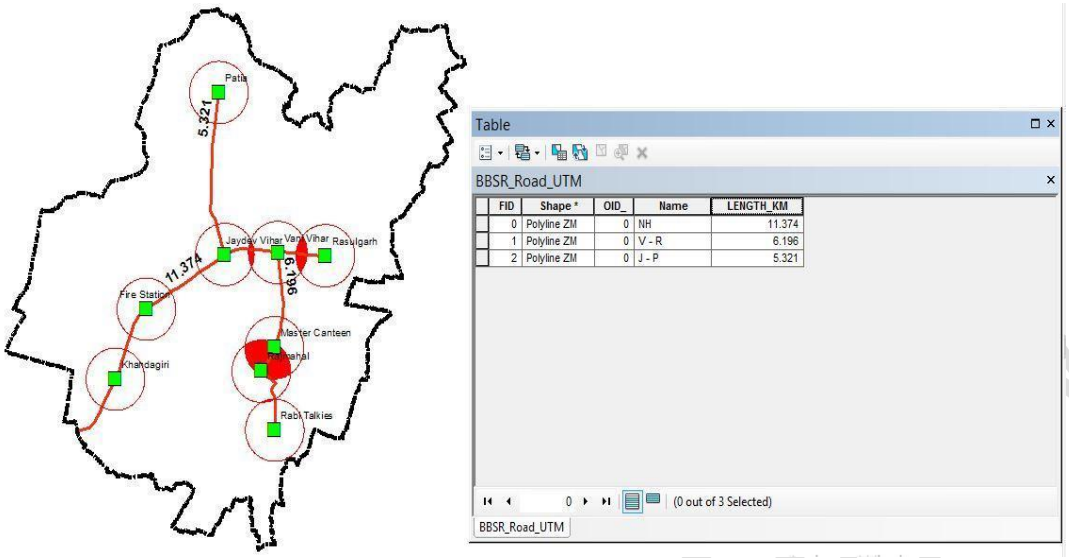

Fig 6: Existing length of roads turning hotspots of black spots in Bhubaneswar Municipal Corporation

The identified hotspot areas, the NH stretch (Rasulgarh to Aiginia near Khandagiri), and the major arterial road from Jaydevvihar to Patia and Rasulgarh to Ravi talkies square. The traffic study conducted from Jaydevvihar (at Kalingavihar, Rail Bhawan, and Acharya Vihar. The results of the hourly volume of traffic during peak hours 9.00AM to 10AM and 6.00PM to 7.00PM analysed. As per IRC-106-1990- Table-1) the corresponding PCU is calculated in combination with Mr. C K Dey. The level of service estimated was in Table 2. The designed service volume as per IRC 106-1990 is 3600. Knowing the PCU/hr the LOC (line of comfort), it is reported that all the squares are congested and need rectification or provision of alternatives, (Dey et al., 2022[12])

Table-2: Traffic survey results at from Jaydev Vihar to Acharya Vihar

Name of Arm	Total Vehicles	Total Vehicles in PCU	Hourly Volume	Hourly Volume in PCU
9.00AM -10.00AM				
Jaydev Vihar-Rail Vihar	595	998		
Jaydev Vihar-Nandankanan	1878	2373		
Jaydev Vihar-Acharya Vihar	1528	2158	4001	5529
6.00PM-7.00PM				
Jaydev Vihar-Rail Vihar	1095	1552		
Jaydev Vihar-Nandankanan	1721	2285		
Jaydev Vihar-Acharya Vihar	1625	2278	4441	6115

Table-3: Traffic survey results at Damana square signal

Name of Arm	Total Vehicles	Total Vehicles in PCU	Hourly Volume	Hourly Volume in PCU
9.00AM -10.00AM				
Jaydev Vihar-Sailashree Vihar/DAV School	590	995		
Jaydev Vihar-Nandankanan	1875	2370		
Jaydev Vihar-Mancheswar	1525	2155	4000	5525
6.00PM-7.00PM				
Jaydev Vihar-Sailashree Vihar/DAV School	1092	1550		

Name of Arm	Total Vehicles	Total Vehicles in PCU	Hourly Volume	Hourly Volume in PCU
Jaydev Vihar-Nandankanan	1720	2280		
Jaydev Vihar-Mancheswar	1623	2275	4441	6110

The various parameters are calculated based on PCU, the level of service (LOS), and the line of comfort (LOC), which was found to be all the stretches are congested from Jayadev Vihar to Nanadankanan, which has higher traffic volume during 21st century. The Kalapana - Rasulgarh and the NH stretch shown in figure -4 possesses much higher traffic and ever congested during urban flood, heavy traffic and peak business, office and educational hours.

Minimising TRC (BMC):

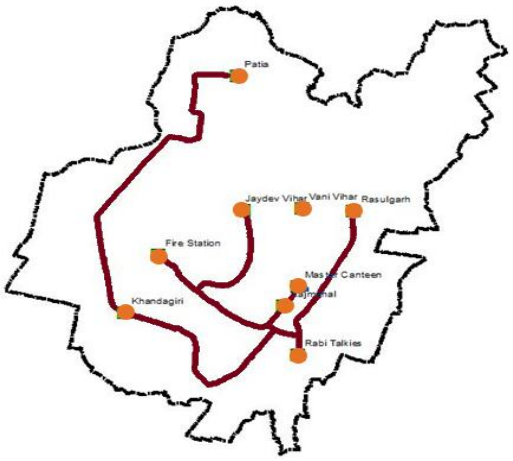

Fig 7: The alternate routes proposed to reduce traffic congestion and RTCs in BBSR

About 5081 fatalities occurred during 2021 whereas the corresponding fatalities were 2014 (3,931) and 2019 (4,738), respectively in the state, Odisha, as per Odisha diary dot com, 24 May 2022. There is 12% upsurge road traffic deaths (RTDs) during 2021 (Jan to Oct) matched to the parallel period during 2020. The rate is higher than the national average.

Gradually the traffic volume is increasing and frequent road congestion is occurring. Continuous use of roads has turned it out creating a huge number potholes and strip of turnouts. To address the RTCs, it has warranted alternate new road network or up gradation of connecting roads so that the traffic jam possibly reduced. People can reach the destination safely, early without mishaps. Fig 7 depicts alternate routes.

Rectifying measures to reduce TRCs:

Respondent to fig 7, various action plans, engineering alternations, regulatory majors and legal penalties in the existing built environment due to high vehicle density apart from condition of roads and pedestrian awareness (Wang et al, 2020[27]). The pillars over which the road safety stands over pedestals like: planning and management using a small scale map, mobile and safe roads, safe vehicles, road users and traumatic care. The safety activities to inculcated are enforce safety, interest, additional funds, public awareness, safety strengthening and management, good safe practices, prompt trauma care structures, and finally monitoring and recording for future planning. As per sustainable development goals targets in clause SDG-3.6 (health/trauma care) and SDG-11.2) relates to safe, accessible, affordable, and a supportable transportation systems to urbans, (UNCTAD series 10, 2011[28])

Various safety measures:

Various safety measures that rectify the hazards of road traffic crashes (TRCs) are improving policies at government level, solicitation of intelligent transport, bolstering of safety laws, improvement of traffic system in BBSR, indorsing cognizance, founding and monitoring road safety database, promising safer road infrastructure. Apart from the government policies, the road management must force a major the Road safety as a primary part of road design during planning stage.

The strict implementation of safety standards, use of personal protective equipment (PPES) for motor cyclists, and for vehicles like Seat Belts, auto anti-lock braking system are players in reduction in RTCs Abdi et al., 2022[29].

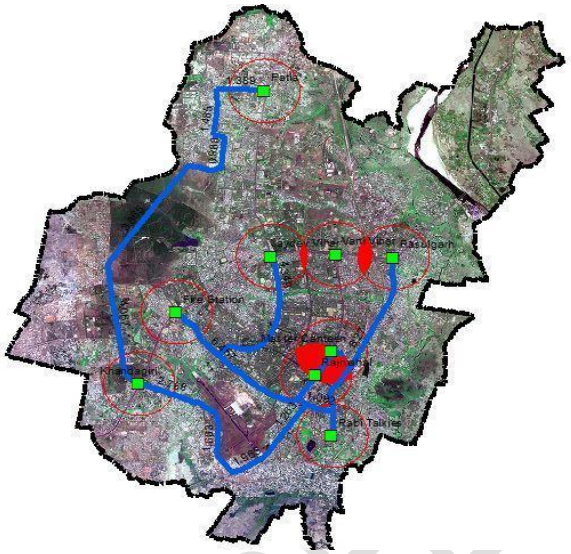

Fig 8: The present survielance zone by CCTV footing in hotspot areas of RTCs

Other actions for minimization of safety on roads are minimizing by the speed controls, construction of pedestrians, foot paths, movement across zebra crossing, closed drains, use of CCTV camera at all crucial points, zero stray animals, rule of left hand drive, and proper signalling, and traffic light with police vigilance and public surveillance on PPP mode during peak hours (Fig 08).

The individual actions and obligations of the stakeholders can reduce accidents. Penalizing the drunken /unruly, reckless young drivers, use of mobile while driving can reduce drastically the frequency of TRCs. Maintaining of slow speed on roads near schools, philanthropic arena, Market areas can address the vulnerability of the TRCs. Making quality pavements, parking areas and proper signage's also reduce the number of road mishaps. Finally, as a social triumph against TRCs, the education, engineering, enforcement & emergency care of road accident victims against (4E's) advocated. However emergency retort and HCU's attendances plays vital role to save breathes for road crash victims (Bhoi et al., 2018[30], Pal et al., 2019[31]).

***New road plan to avoid acc*idents:**

Awareness construction, Engineering rectification, traffic rules adherence, and electronic engineering actions plays vital role to avert this trauma catastrophe, insecurities and financial losses during RTCs.

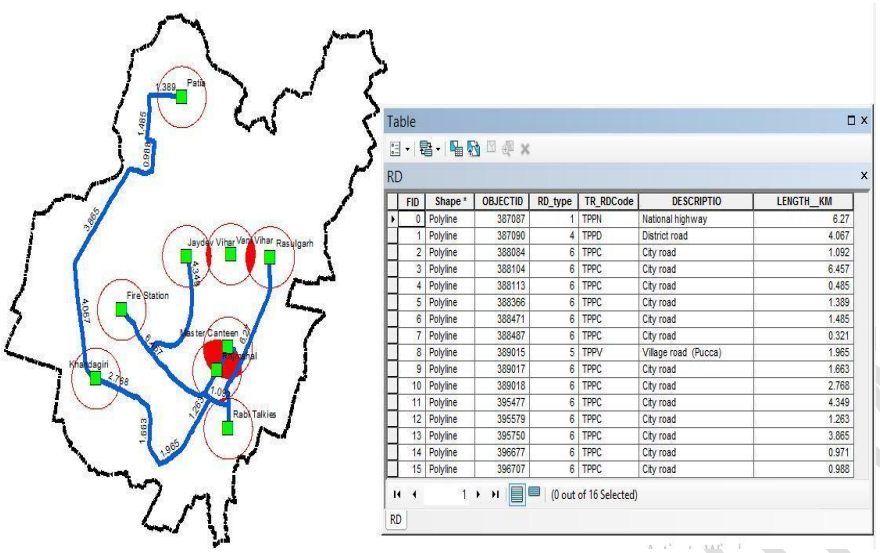

Fig 9: The new connectivity plan with length of the roads to rectify RTC within BMC

RESULTS:

The blue coloured road network is the efficient traffic solving routes. This can have results of reducing traffic jam in peak hours, regulate the circulation more efficiently, proper flow of commentators and reduction of accidents. The red colour lines are the existing road network which has augmented the congestion and deaths in death traps. The action plans to road engineering mediations, pavement action and new road plans are in Fig -10.

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Fig 11 narrates the length of existing road prone to road traffic crashes. The three three stretch of roads are NH-16 from Vanivihar to Khandagiri of length 11.374km, Vanivihar to Rasulgarh of 6.196Km, and Jayadev Vivhar to Patia which is a state High ways and remaining under traffic Jam during the peak hours. Another stretch of road from Samantra Pur to Rasul garh, part of NH 316, is also remaining under traffic Jam. The patch needs to be studied though a number of high level over bridges as connector have already been constructed, the proble has not been completely addressed. Fig 12 narrates the plan to moderate the traffic Jam and to reduce accidents BMC

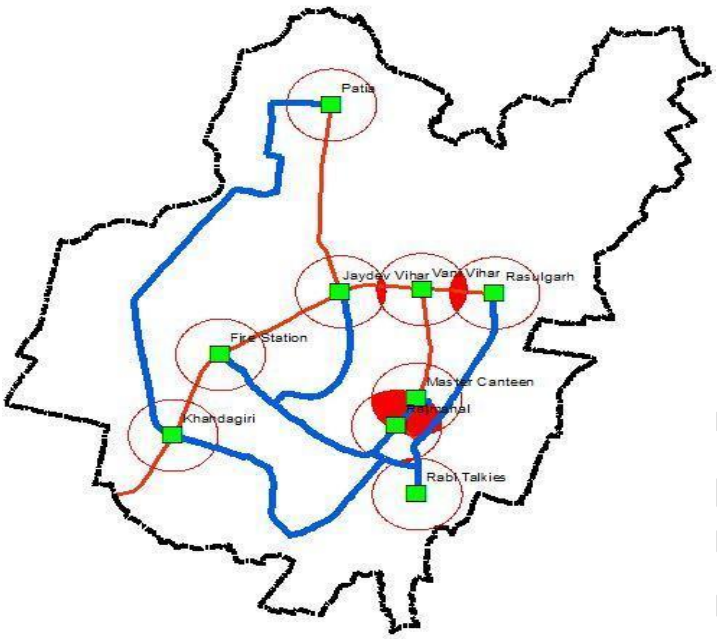
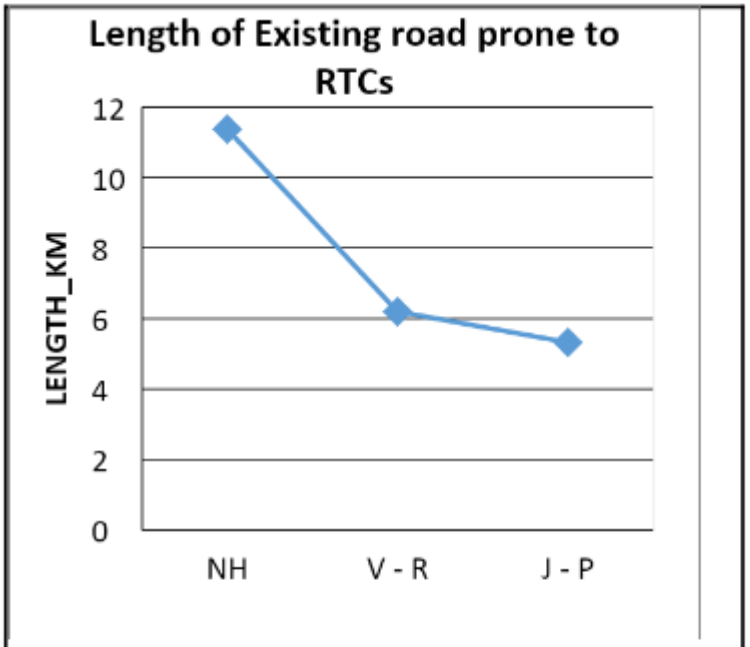


Fig 10: The proposed new and upgrading of roads network in BMC except Ring roads



(a)

Existing hotspots for RTCs (STATS.)

#	Name	LENGTH_KM
1	NH-16	11.374
2	Vanivihar to Rasulgarh	6.196
3	Jaydevvihar to Patia	5.321

(b)

Fig 11 (a) and (b): The length of existing road prone to black spots and their length

Discussion:

Odisha state has exposed a downward trend in RTDs from Jan –June during 2020 matched to the identical period 2019. The STA (State Transport Authority) has reported RTCs in Odisha declined by 30% between Jan-July,

2020. As per STA data, 5125 accidents (2401 deaths in Jan-July), STA data reveals bout 5125 RTCs reported between Jan- July, 2020. In 2019, the State Odisha had 6690 RTCs that resulted in 3426 deaths. The reduction in RTCs was connected to the post the Covid-19, like other states of India, induced by lockdown, shut downs and industrial closure. (Mishra T. K., 2021).

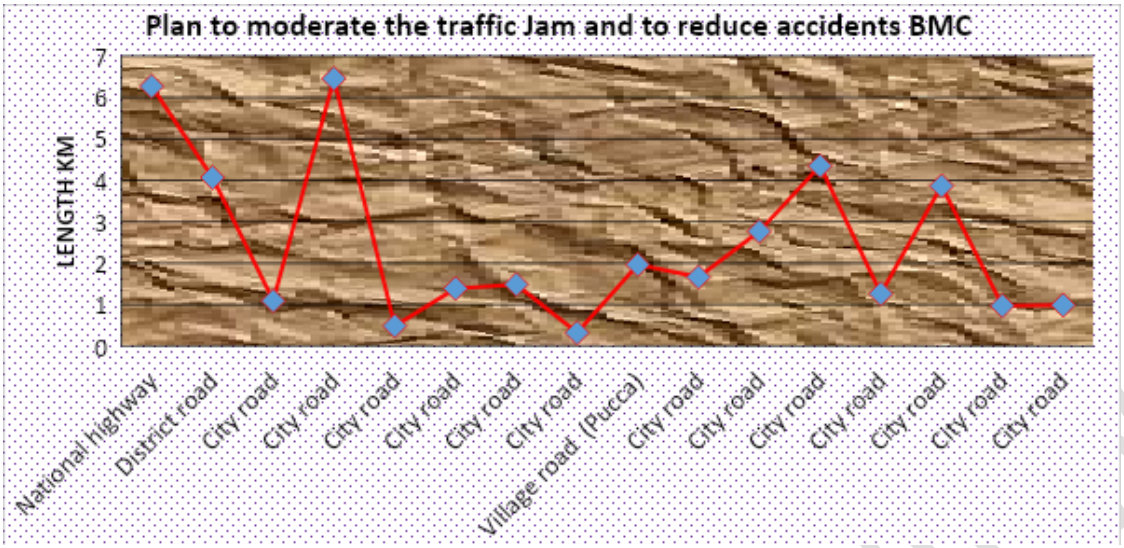


Fig 12: The road network plan to moderate the traffic Jam and to reduce accidents BMC

RTCs deaths projected to hike by 83% in emergent states and lessen by 27% in the developed countries. Stringent actions to be taken against flaws and deficiencies to decline the rule breakers and those causing road traffic accidents. The IPC imposes penalties for the various deviations during plying of vehicles on the roads are Rash driving (Sec – 279), casually causing death (Sec- 304(A)), Threatening life (Sec- 336), hurting by endangering others safety (Sec- 337), and seriously hurting by imperilling life or safety to others (Sec-338). The Motor Vehicle act of 1988 complies towards by drunk, taking drugs and driving (Sec-185), and driving hazardously (Sec-184).

Present search envisages how to reduce the accidents frequency in Bhubaneswar. Identifying and displaying in sign boards trauma care units nearby black spots to avoid first four hours called the golden hours. The mobile PCR vans should be alert and keep bird's eye view on probable RTCs.

The registration (like e-Parivahan) should be done by each motor vehicle so that all registration details of the vehicles are displayed to regulate drivers authenticity. The Government of Odisha (GoO) has made mandatory for HSRP (high-security registration plates) for all vehicle that is attached to ADHAR link to avoid theft, penelities, violation of traffic rules, rush and illegal driving from with third registration mark on old vehicles registered prior to 01.04.2019. Presently the transport Department has introduced smart card Driving Liscene, which has been embedded with a microprocessor chip.All vehicles registered before April 1, 2019, it has become mandatory, the vehicle owners shall get HSRP fixed on their vehicles by different dates beforw December 2022.

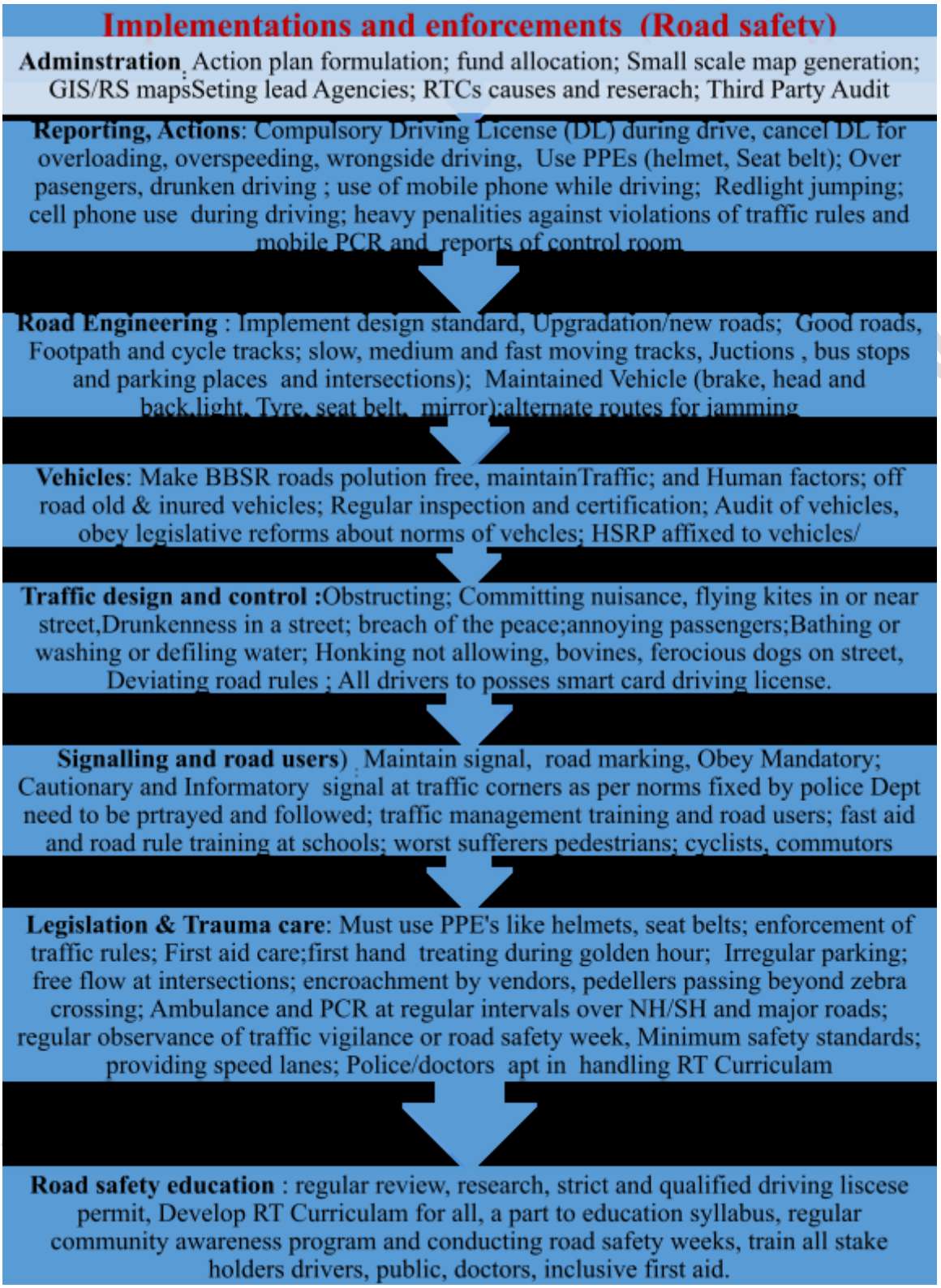


Fig 12: Points to reduce traffic jam and road traffic crashes in the Bhubaneswar city

CONCLUSION

The road network should minimize the increasing traffic clashes on the roads of the Bhubaneswar. About 50% or more RTDs deaths are in the midst of vulnerable road users such as pedestrians, cyclists, and motorcyclists and of teen and young mass. Motor cyclists are most susceptible to RTCs. Road traffic traumas are the foremost causes for mortalities for children and young adults aged 5-29 years.

Various measures to be built to avoid or minimize traffic congestion are building more use of existing ring roads of the Bhubaneswar city from Hanspal to Khordha on right fringe and Hanspal to Daya bridge. Widening and upgrading of roads, more use of public transport than personal cars and motor cycles, use of CCTV at black spots and death traps are solutions. Heavy legal/ financial penalties for rule violators, the police should be honest and loyal to maintain the traffic flow, speed limit display, Installing CCTV cameras for monitoring and management. Exclusive lanes, and flying of drones for vigilant over rule breakers, should be provided for different vehicles. Building speed breakers to decrease the vehicle speed, creating alternative routes, parking zones, roundabouts, and for immediate response Trauma care centers need to be ready in all the health care units in and around Bhubaneswar. All vehicles with smart card Driving License and affixing HSRP as mandatory

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