*IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*
*e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 18, Issue 6 Ser. III (Nov. – Dec. 2021), PP 47-59*
*www.iosrjournals.org*

# Integrated Multi-Modal Transportation System: A Sustainable Approach for Urban Transport in Kathmandu

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***Abstract***
*Being the administrative and economic hub of Nepal, Kathmandu valley experienced rapid urbanization in the last decades. The rapid population growth resulted in the huge travel demand and numerous transportation problems as well. The lack of a reliable public transport system augmented private vehicle ownership is increasing rapidly. In order to improve the urban transport scenario, several initiatives have been attempted in the past. However, desired results could not be achieved. In this context, alternative as well as innovative methods shall be worked out on the basis of integrated approach among various modes and services.*
*Over the last decades, numerous mass rapid transit system like metro rails, bus rapid transits etc. have come up in various cities. Nepal has also plans to develop mass rapid transit as metro rail, electric bus rapid transit and others. There are other mega infrastructure projects like Kathmandu-Terai Fast Track Project under construction and Outer Ring Road under study for transport improvement of the valley. However, to have a sustainable transport system, integration of different transport modes, public as well as private, is now the important issue from user point of view. At the same time there is an opportunity from planners' point of view to develop transportation system that provides seamless connectivity, safe, comfortable reliable transport and warrants for overall sustainability of public transportation. This paper is an attempt to understand the integrated multi-modal transport system (IMMTS) for its effective implementation in Nepal and particularly in Kathmandu valley. With the study of existing transportation system of the valley and future plans for improvement of transportation system, efforts are made to identify the advantages and challenges of IMMTS and recommend strategies and plans for implementation of IMMTS.*

***Key Words:*** *Multi-Modal transport, Sustainability, Integrated Transport, Transport Modes, Modal Share*

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Date of Submission: 14-12-2021 Date of Acceptance: 28-12-2021

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## I. Introduction

Rapid urbanization along with economic growth have intensely increased vehicle ownership and usage in Nepal, particularly in the Kathmandu valley. Present transport infrastructure and transportation system along with the current pattern of motorization are not only causing congestion, air and noise pollution but also increasing accidents leading to injuries and deaths. Generally, urban areas are characterized by higher population densities; mixed-use land-use, fewer physical and social infrastructure; especially transport infrastructure where there is a lack of proper roads and parking facilities, poor public transport, and/or literally no public transport, lack of road-user discipline, etc. The urban transport system in Kathmandu valley is under heavy strain and has negatively affected the quality of life of people in the valley. Facilities of mass transit in the valley are utterly insufficient for providing fast, comfortable and convenient travel. This has resulted in a heavy shift of commuter patronage from mass transit to private or personal transportation and as a consequence, there is a huge increase in personal vehicle ownership. The resultant effects are, increased traffic congestion and transport-borne pollution, heavy fuel consumption, poor level of service to the commuters, etc. Still, the travel demand that is being generated is not fully met by private (motorcycles and cars) and public modes of transportation. As a consequence, the mass rapid transit system becomes mandatory for Kathmandu valley, to provide better, advanced, efficient, and quality transit services. However, very few studies and research works regarding the development of a proper urban transportation system have been conducted. Sustainable development and sustainable transport have been the major issue of debate over the years but very few steps have been taken to improve the condition. Solutions for transport improvement have been proposed and executed in a piecemeal approach rather than a holistic approach. However, it has been advocated that sustainable transport can be achieved by reducing fuel used for transportation, for example, reducing car use and

switching to public transport use, decreasing the excessive public transport to efficient and effective public transport, switching unimodal to the multimodal public transport system. In view of this, some steps are being taken by the Government of Nepal (GON) to promote sustainable transport.

Nevertheless, the efficiency and effectiveness of mass transits rely on the accessibility of various modes in the city, design, and availability of routes, the incoming flow of pedestrians at the station, frequency of service, etc. Transportation infrastructure development, traffic management, intelligent transportation systems, use of green and renewable fuels, higher traffic speed, fewer operation costs, maximum utilization of public transport, less congestion and accidents on road, easy & safe movement of pedestrians, etc. are the key parameters for the sustainability of public transportation facilities. In levy to suffice the never-ending needs of urban commuters, transport authorities of many countries try to combine two or more public transportation modes, to achieve easy and uninterrupted travel in the cities. The resultant process, which has evolved out of this, is the Integrated Multi-Modal Transport System (IMMTS) that involves the coordinated use of different modes and its integration to fight against road congestion, longer journey time, and air pollution. In view of this, it is now necessary for the GON to take a policy to promote integrated multimodal transport system (IMMTS) for Nepal and for Kathmandu valley in particular.

## II. Existing Transport System in Kathmandu Valley

**Urbanization and Population Growth:** Nepal is one of the ten least urbanized countries in the world. However, it is also one of the top ten fastest urbanizing countries. In 2014, the level of **urbanization** was 18.2 percent, with an urban population of 5,130,000, and a rate of urbanization of 3 percent (UN DESA, 2014). For the period 2014- 2050, Nepal will remain amongst the top ten fastest urbanizing countries in the world with a projected annual urbanization rate of 1.9 percent (ibid). Urbanization in Nepal is dominated by a few large and medium cities with an excessive population concentration in the Kathmandu Valley.

The Kathmandu Valley is the most populated urban region and one of the fastest-growing urban agglomerations in South Asia (Muzzini & Apericio, 2013; MoUD, 2015). Kathmandu Valley accounts for 24 per cent of the total urban population, with Kathmandu Metropolitan City alone accounting for 9.7 per cent (MoUD, 2015). According to the census 2011, the total population of Kathmandu Valley including three districts Kathmandu, Lalitpur and Bhaktapur was around 2.52 million, where 1.5 million lives in urban areas and the rest in rural areas. Based on this population in 2011, Central Bureau of Statistics has projected the **population growth** up to year 2031 in national, urban and rural level. Assuming the population growth in the Kathmandu valley as same that of urban population of Nepal, the population of the valley has been projected up to year 2031 (Figure: 1). As per this projection the population of Kathmandu valley is now 3.87 million and by 2031 the estimated population will be 5.75 million. Japan International Cooperation Agency(JICA) in its report on a survey on Traffic improvement in Kathmandu Valley has estimated the annual population growth rate be 4.32%. Based on this estimation also the population of the valley has been projected as 3.84 million in 2022. This growth in the population will certainly create a huge travel demand and copious transport problems as well in five years from now.

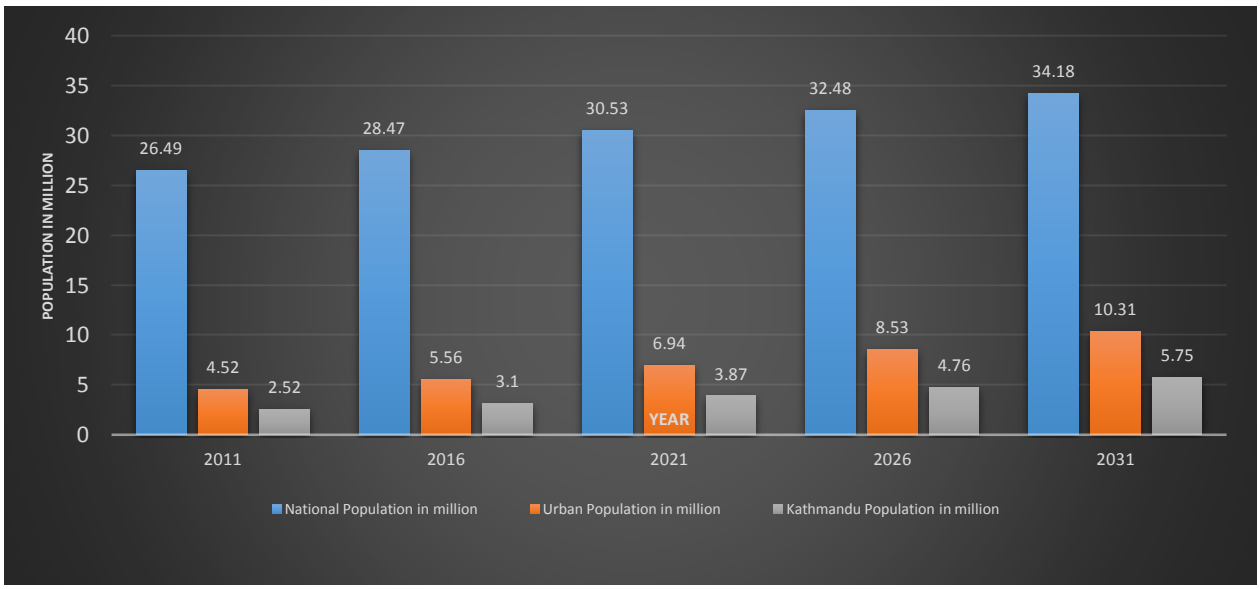


Figure 1: Population Projection National and Kathmandu Valley (Source: CBS 2014)

**Motorization and Public Transport:** Accessibility to transport services is critically challenged by traffic congestion, vehicular and pedestrian volume, unmanaged traffic and inadequate infrastructure, and in parts, public attitudes and preferences of private to public transport. This situation is further compounded by non-compliance of traffic regulations, limited improvements of roads by authorities, growth in the number of private vehicles, air pollution, and declining investment/interests by both the private and public sectors. The vehicular and pedestrian traffic is increasing in a geometric proportion; however, the road networks are not improved or widened to meet the current demand. The increasing number of traffic-related accidents and slower speed of vehicular transportation is directly attributed to increases in private motorcycles and unregulated traffic management at large. At present, mobility in Kathmandu city is essentially dependent on road networks. As of the year 2016, Kathmandu valley had roughly 530 numbers of strategic roads including strategic urban roads, the road density is average, at 54 kilometers (km) per 100 square kilometers. However main roads are often narrow clogged with parked cars and buses waiting for passengers. The average road area ratio in urban administrative units (metropolitan city and municipalities) of Kathmandu valley is around 6 % of the total urban area (Panta 2010). Such figure for the road ratio falls in the lower bound range even by the standards in the developing countries. In the recent past, the Government of Nepal (GoN) implemented road widening projects in urban areas of Kathmandu valley and roads along river corridors. Despite such continuous efforts, the pace of road network, expansion, and improvement lags far behind the speed of motorization. The **rate of motorization** in Nepal is alarmingly high, the total number of vehicles by 2015 being 1,995,404 out of which a large population of about 78% is motorcycles. According to the Department of Transport Management, the number of registered vehicles in Kathmandu city in 2014 accounts for 755,546 that is 43% of the national figure. The increment in vehicles, both for private and public purposes, indicates that the anciently built roads of Kathmandu do not bear the capacity to handle such traffic volume. Much of the increment in the vehicles in Kathmandu valley is reported to be two-wheeler motorbikes. Out of the total 755,546 vehicles registered 601,951(79.67%) vehicles were motorcycles. From 2008 to 2013 average annual growth figure for motorcycles and light vehicle

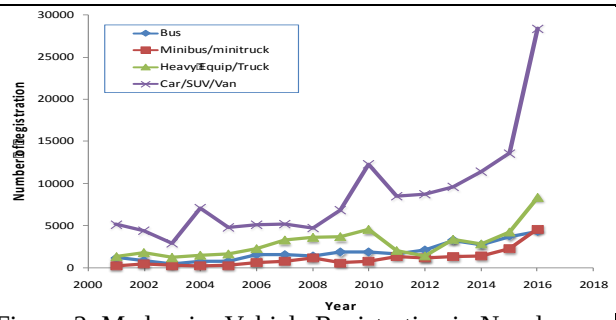


Figure-2: Mode wise Vehicle Registration in Nepal

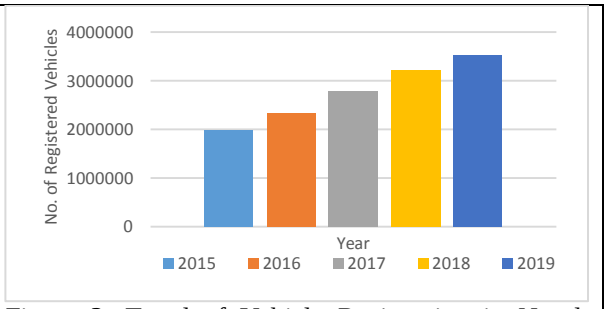


Figure 3: Trend of Vehicle Registration in Nepal, 2015 to 2019 (Source: DOTM)

in Bagmati zone recorded as 12.4% and 7.9% respectively (DOTM, 2014). The trend of mode wise vehicle population registration in Nepal till 2016 is given in Figure 2. (Source: DOTM). The trend of total vehicle population registration in Nepal till 2019 is given in Figure 3. (Source: DOTM). Most of the vehicles registered in the district ply in the urban centers of the Valley, prominently in Kathmandu. Due to excessive motorization, the Kathmandu valley is facing severe congestion, vehicular and pedestrian conflict, environmental degradation, road accidents and poor public transport operation and services. Traffic congestion in Kathmandu has become serious – cross-city journeys are measured in hours not minutes. JICA (2012) reports that the average traffic speed within the ring road is less than 20 km/hr., while Ale (2004) estimates a decrease in traffic speed over the last decade to be less than 20 km per hour. If vehicle ownership continues to increase at current rates, the capacity of widened roads would soon be exceeded. Selective improvements may be justified to remove bottlenecks or provide alternative routes, but continuously expanding the urban network is neither a sustainable solution nor an equitable one since road space is increasingly saturated by private vehicles, benefiting a small portion of the population (17% of Kathmandu valley households) (KSUTP, 2010). A more skewed reality demonstrates that public transport vehicles (19% of total registered vehicles) meet most of the public mobility demand (57% of total demand) while motorcycles (42% of total vehicles) meet only 6% of the total public travel demand. Since 2001, the excessive increase in the purchase of motorcycles is due to the financial services such as easy credits promoted by local finances and banks (KSUTP Final Report 2010, p. 3).

Kathmandu valley found its first **public transportation** in 1959 with the establishment of the Nepal Transport Service, serving more than 10000 passengers daily. However, it lived only up to 1966. In 1961 state-operated 'Sajha Yatayat' started mass transport service as urban transport inside Kathmandu valley and intercity

transport outside the valley as well. The introduction of an electrified Trolley Bus which provided services along Tripureshwor (Kathmandu) to Surya Binayak (Bhaktapur) in 1975 was a landmark in the urban transport history of Nepal. Although both Sajha Yatayat and Trolley Bus provided effective mass transport services in Kathmandu valley for many years, they failed to retain the glory after 1990 when they suffered from poor management and political interference, while the private sector came in front aggressively into transportation sector with large numbers of operators with low occupancy vehicles-minibusses, microbuses and tempos accounting for 94% of total transport vehicles and the share of large buses is only 6% (JICA, 2012) The travel mode share of different modes in Kathmandu valley in 2011 (JICA 2012) is shown in Figure 4. These bus mini-bus and tempo compete with them and with other modes rather than complementing each other. This unhealthy competition leads to duplication of services in many areas and hence proves to be uneconomical. Facilities of mass transit in Kathmandu valley are utterly insufficient for providing fast comfortable and convenient travel. The shift of commuter patronage from public mass transit to large numbers of private and/or personal transportation has caused a huge increase in low occupancy vehicles ownerships. The resultant effects are increased traffic congestion, transport borne pollution, heavy fossil fuel consumption and poor service to the commuters.

Approximately 2000 private operators own about 1560 buses and mini-busses, 1800 LPG and battery-operated 3-wheelers, 2500 microbuses, and 3700 taxies for public transport in the city. The composition of the vehicle fleet in Bagmati zone is shown in Figure 5. However, these vehicles are neither regulated nor systematically assigned to a particular route/s. After discontinuation of state-operated transport service in 1990 till 2013 when Sajha Yatayat resumed its services with a small fleet of large buses, microbuses, minibuses and tempos only constituted the public transport in the city centre which is still one of the main reasons for congestion and accidents because of haphazard driving The projections of the number of trips by modes show that the growth of vehicles by types is inversely proportional to the preferred mode of the citizens. The maximum trips by mode are of pedestrians followed by bus, making 68.3 % of the trips.

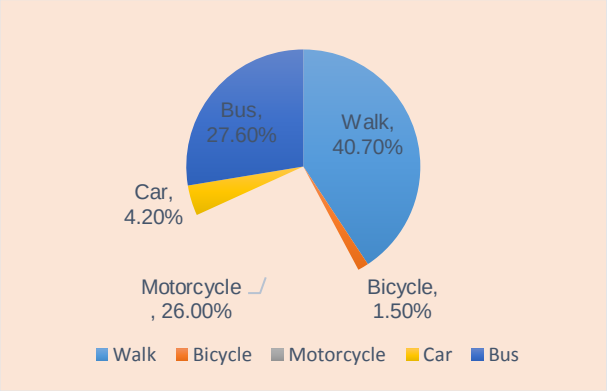


Figure 4: Travel mode share of Kathmandu Valley in 2011

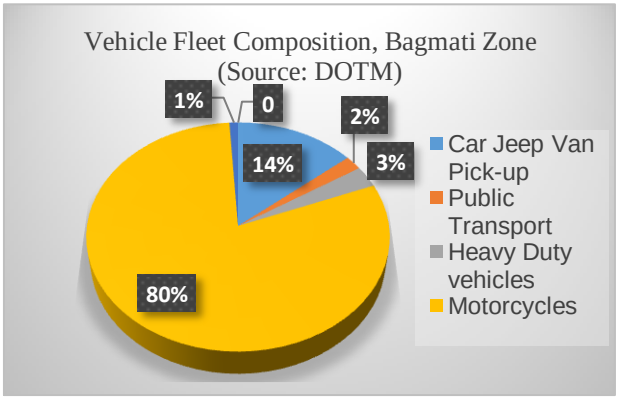


Figure 5: Composition of registered vehicle fleet in Bagmati Zone (Source: DOTM)

**Non-Motorized Transport (NMT):** Although walking, a **non-motorized transport (NMT)** mode is still the major mode of travel in Kathmandu valley, it has significantly declined from 53.1% in 1991 to 40.7% in 2012 (JICA, 2012). A large part of walking and cycling share is replaced by motorcycle, whereas mode share of public transport has almost remained the same, the study further forecasted that walking mode share will decline to 38.8% in 2020. The infrastructure for walking is insufficient, unsafe, and poorly maintained. Pedestrians use narrow, badly paved walkways; have difficulty in crossing roads; are obliged to give way to vehicles, even in the historic city center, and have safety impaired. Figure 6 gives the number of traffic accidents registered from 2011/12 to 2013/14.(JICA 2017) The total numbers of injured victims of the accidents from 2011/12 to 2013/14 are 11568. Out of this 11.57 % were either seriously or fatally injured and rest were the normal injured victims of the accidents.

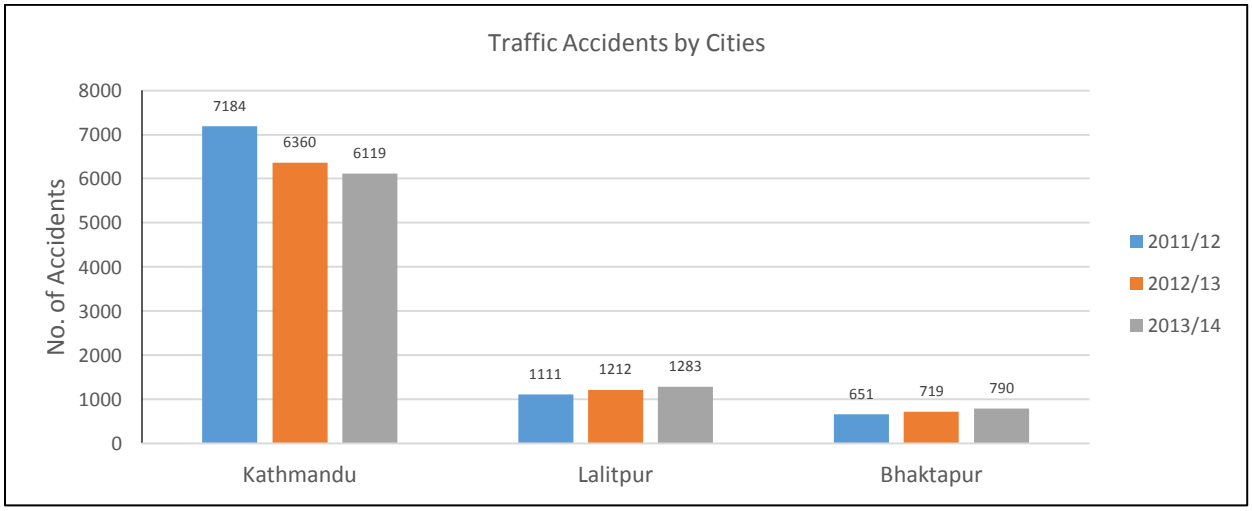


Figure 6: Traffic Accident in Kathmandu, Lalitpur and Bhaktapur (JICA 2017, Source : DOTM)

**Air Pollution: Air pollution** caused by vehicular emissions is one of the key public health concern in Kathmandu valley. MoEP (2005) reported that air pollution is responsible for 1600 premature death annually in Kathmandu valley. Increasing dependence on private modes of transport and related consumption of imported fossil fuels, aging vehicles, inefficient engines and poor quality of fuel is primarily responsible for emission of pollutants adversely affecting the air quality. Transport sector is the biggest producer of carbon dioxide ($CO_2$) emissions in Nepal. Due to the significant rise of registered vehicles in recent years, the consumption of petroleum products in the transport sector has increased by an average annual growth rate of 9%. About 50 % of the national gasoline consumption and 27 % of the national diesel consumption occurs in Kathmandu Valley. The majority of $CO_2$ emissions stem from heavy commercial vehicle category (truck, fuel tanker and lorry), followed by passenger vehicles (cars, SUVs and pickups) and buses as well as minibuses/microbuses. 36% of total registered vehicles in Nepal are registered in the Kathmandu Valley. Of these vehicles, 92% are private motor vehicles (cars and motorbikes). The sector consumes about 68% of total diesel consumption in the country. Total $CO_2$ emissions from the transport sector rose at an annual average rate of 11% during 1994 and 2013 but is particularly accelerating since 2015 as shown in the following Figure-7 (Source: TNC, UNFCCC). The emission from transport reached 5.4 $MtCO_2/a$ in 2018. This represents approx. 10% of country's total emission. With an increase in vehicles this is expected to rise dramatically (two to three times) in the next 10 years together with particulate matter ($PM_{10}$) and total suspended particulate (TSP) (KSUTP, 2010).

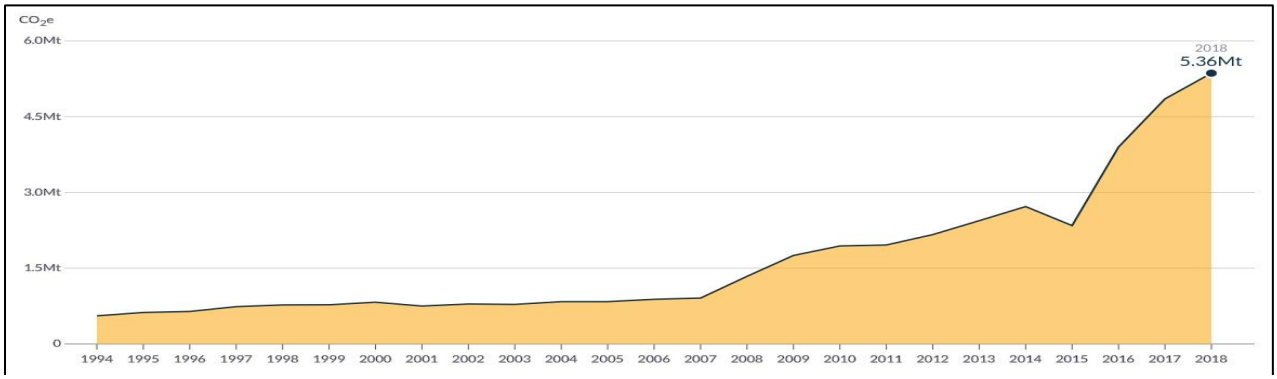


Figure-7: $CO_2$ Emission from Transport Sector in Nepal (Source: Nepal's Third National Communication to UNFCCC)

## II. Initiatives for Sustainable Urban Transport

Kathmandu Sustainable Urban Transport Project (KSUTP) is a part of ADB's extensive venture - Sustainable Transport Initiative (STI) in five pilot cities in Asia. Ministry of Physical Planning and Works coordinated the project with the financial assistance of ADB. The main visions of the project were to improve the public transport operations and introduce pedestrian areas in the city center of Kathmandu, and eventually improve the air quality of the city. Several government departments, Kathmandu Metropolitan City office and Metropolitan Traffic Police were consulted and were involved in the project. The project had four components

whose aims are to: a) improve public transportation, b) manage traffic in the city center, c) improve pedestrian mobility in the city center, and d) improve air quality respectively.

Regarding restructuring of Public Transport, the project proposed three-tier hierarchy of public transport route based on demand and width of road infrastructures. The project proposed 8 primary routes, 16 secondary routes and 40 tertiary routes plus two in historic places. The major highlights of component A – public transport can be outlined as follows: (a). Assignment of routes according to the size of the vehicles, for instance larger buses will be assigned routes on the peripheral terminals along wider roads, while smaller tempos will operate on tertiary routes in the city centre. (b) Reorganization of independent public vehicle operators into smaller groups/cooperatives with a responsibility of an entire route (as shown in Figure-9) (c) Construction of new bus stop for long-distance bus journeys, and remodeling of present old bus park for Valley transport services only; and improvement of bus interchanges for people without obstructing the flow of traffic in the city centre (d) Reintroduction of trolley buses in existing infrastructure, increase in the fleet of large-sized buses, and a corresponding decrease in the medium and small sized vehicles. € Formulation of new rules and amendments on existing regulations for the improvements (f) Facilitation of technical support to make public transport efficient, acceptable, and affordable to all groups of the society. (KSUTP Final Report, 2010)

The component B – traffic management relates to the aim of improving the circulation of motorized vehicles within the city centre of Kathmandu. The existing junctions in the city center to be reconfigured with further construction to increase the capacity to handle greater traffic volume. Physical construction includes installment of eight sets of traffic signals, 21 pole mounted swivel CCTV cameras, and 21 radio headsets for traffic police. Congestion and delays in the movement of traffic to be decreased by the designation of urban clearways and prohibition of street parking. (KSUTP Final Report, 2010)

Another component-C of the project is the pedestrianization of the city's historic center and improvement of accessibility and safety of the pedestrians. The roads and alleys within the city centre will be designated for pedestrians only, by restricting the entrance of motorized vehicles into the historic core. Many discovery routes will be selected and improved for the promotion and conservation of historic architecture and cultural heritage. The movement of public vehicles will be restricted within the centre while private vehicles will be regulated according to designated hours of the day/night. The construction an enforcement program will be undertaken by KMC. (KSUTP Final Report, 2010)

The last component-D of the project involves the improvement in the air quality in Kathmandu city in general. This is expected with the reintroduction and extension of trolley bus service. Air quality will be improved by the reduction of fuel-powered vehicles and introduction of zero emission vehicles. Regulations on emission and mechanical standards of existing and new vehicles will be enforced to ensure less emissive and standard vehicles in operation. The fuel quality will be standardized to Euro III standard, which will emit less greenhouse gases (GHG)s, and overall improve the operation of the vehicles. In addition, public awareness campaigns will be held to inform the public about the risks associated with polluted air. (KSUTP Final Report, 2010)


Figure-8: Restructuring of the primary public transport network in Kathmandu valley as proposed by KSUT Project

**Reintroduction of Sajha Yatayat**

In order to improve the standards of public transportation system in Kathmandu and offer better services to the public, in April 2013, Sajha Yatayat once again resumed its services with 16 large 55-seater buses with Euro 3 emission standards. Although Sajha Yatayat's services, is currently limited to two major routes in the city, this has brought new hopes for improving the quality public transport service in the city. The main objective of the Sajha Yatayat is to operate as model public transport service provider providing efficient, affordable and safer services to the city dwellers.

Some of the key changes that Sajha Yatayat has introduced in public transport sector is as follows:

- The buses are large, new and environment friendly (EURO III standards)
- The routes go from one end of the city to another instead of ending in the central business district, thus reducing congestion in central Kathmandu
- Buses follow a schedule and do not wait for too long for passengers
- Buses only stop at designated stops
- Buses operate from early in the morning till late at night (6 am to 10 pm)
- All buses are fitted with close circuit cameras for safety
- Passengers are required to get on through the back door and get off through the front door.
- Drivers and driver assistants are well trained to provide customer-friendly services
- One of the drivers and several of the conductors are women.

**Safa Tempo Electric Three-Wheeler**

As part of a USAID-supported project, seven electric three-wheelers locally known as "Safa Tempo" were introduced in Nepal. The number of Safa Tempos increased significantly after diesel-powered three-wheelers were banned in 1999. The safa tempos are locally produced in Nepal and they provide environment-friendly mobility to about 100,000 commuters daily. The introduction of electric vehicles in large masses for public transport is first of its kind in the world and has been a model for other cities. There are currently 600 safa tempos operating in 17 routes within Kathmandu valley. Many of these three-wheelers are operated by women.

**Other Plans/Programs for Transport Improvement**

**Kathmandu Valley Urban Development Program** is still an ongoing program to alleviate congestion by widening the arterial/radial roads. Kathmandu Valley Development Authority(KVDA) was formed and assigned to clear right of way in coordination with the Department of Roads (DOR) and Municipalities. DOR and Municipalities implemented the widening and improving those roads.

**Ring Road Improvement Project**

In 2011 Government of Nepal (GON) and Government of China (GOC) signed an agreement to improve the southern section 10.39 km. of the ring road which is now constructed to 8 lane standard in the first phase. For the second phase, there is a plan to widen the ring road from Kalanki to Maharajganj where presently, the relocation of utilities 'are under way.

**Outer Ring Road Construction Project**

Outer Ring Road was proposed to mitigate the urban development externality and reduce the growing disparity between the city central area and suburban area of the valley. The proposed total length is 72 km. whereas the proposed number of lanes is 8 lanes with 4 main lanes and 4 lanes for the service road.

**Policy, Regulations, and Strategy**

The Government of Nepal has enacted policies, regulations and some strategies with regard to the transportation sector. Brief introduction of some of them are as below:

The **National Transport Policy 2001** envisages developing a transport system that is sustainable, reliable, cost-effective, safe, comfortable, and self-reliant. However, it focuses mainly on developing road infrastructure rather than applying a holistic approach of transport management. In the urban context, it recommends developing urban infrastructure based on the master plan prepared by local agencies with support from the central level. It needs updating to reflect current and forecast conditions including the impacts of mass transit. A new draft policy has been prepared and is under consideration.

The **National Vehicle and Transport Management Act 1965 and Regulation has** provisions for regulation of operation of public transportation vehicles, licensing drivers and operators, insurance of passengers and drivers and providing route permits and fare fixation.

The **National Transport Management Strategy 2013** has provision to establish a National Transport Authority to maintain national transport policy and coordinate plans and programs. It has also provision for Kathmandu Valley Transport Management Committee chaired by KVDA to prepare Kathmandu Valley Master Plan covering services and infrastructures including roads.

The **National Urban Development Strategy 2017** has the provision of rational objectives to resolve key issues such as the weak institutional and legal framework and limited human and institutional capability for urban planning and management. It also proposes strategies including Special Purpose Vehicle (SPV) to implement large scale infrastructure projects with equity shares held by municipalities Pilot implementation of large scale projects such as Bus Rapid Transit (BRT) in the Kathmandu is also proposed.

The **Public Transport Code of Conduct** was brought in 2010 to ensure safe easy and convenient ride especially for women and children and differently able people in public transport vehicle.

## IV. Plans for Mass Transit in Kathmandu Valley

**Mass Rapid Transit (Metro Rail):** In 2012 Department of Railways (DoRW) conducted a feasibility study of **Mass Raid Transit (Underground and Elevated Metro Rail)** System in Kathmandu valley with the purpose of resolving traffic congestion, connecting key nodes in the city, reducing the environmental deterioration and making the journey safe, fast, reliable and comfortable for the residents and the commuters of Kathmandu valley. The report mentions that Kathmandu valley has one of the fastest urbanization rate in the South East Asia with the built up area spreading out from the centre and agricultural land, forest covers, open spaces and water bodies decreasing rapidly. With this back drop the feasibility study report suggests that, for the huge population of about 4.0 million residents, permanent and temporary, residing in five municipalities of three district of Kathmandu Lalitpur and Bhaktapur covering only 660.70 sq. km of land in the valley, Metro Rail System(MRT) is the only option to solve the problem of traffic congestion, and movement of large numbers of passengers in the cities. Provision of strategic actions as mass transit, LRT and high capacity buses with physical integration with highways and airports in Kathmandu valley have also been recommended by National EST Strategy for Nepal. The feasibility report suggest five metro lines with total route length of 77.28 km. 57 stations and 5 depots as shown in Figure-9 and Table-1.

Presently the preparation of detailed project report (DPR) of line1: Narayangopal Chowk to Satdobato, the most feasible route, is underway.

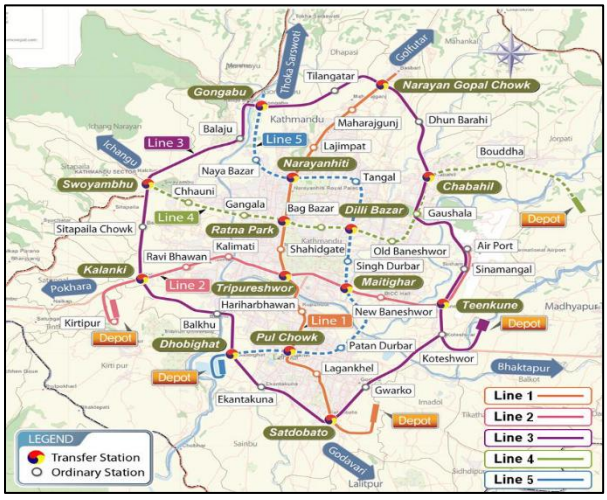


Figure 9: Metro Rail lines (5) Proposed for Department of Railways (DoRW) in 2012 (Source: DoRW)

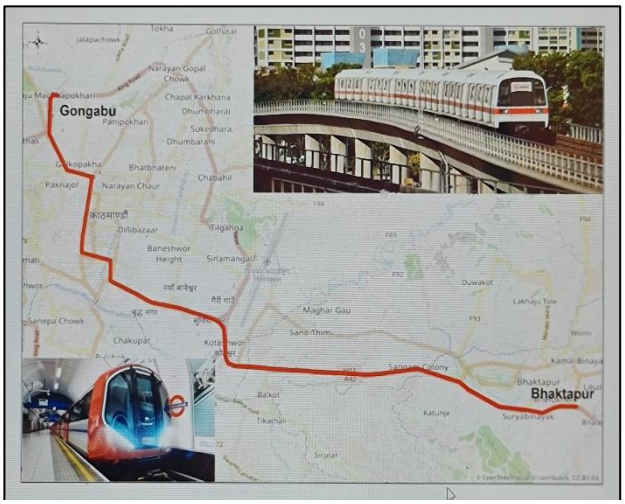


Figure 10: Priority Metro Line Proposed by KSUTP Mass Transit Options and Priritization Study

| Line | Route | Length | Number of Stations | Type |
|---|---|---|---|---|
| 1 | Satdobato-Pulchowk-Tripureshwor-Ratnapark-Narayanhiti-Narayangopalchowk | 12.1 km | 11 | Elevated |
| 2 | Kirtipur-Kalanki-Kalimati-Tripureshwor-Nayabaneshwor-Tinkune-Airport | 11.15 | 9 | Elevated |
| 3 | Koteshwor-Chabahil-Gongabu-Kalanki-Satdobato-Koteshwor | 28.53 | 17 | Elevated |
| 4 | Swoyambhu-Ratnapark-Dillibazar-Old Baneshwor-Gaushala-Chabahil-Bouddha | 11.70 | 10 | Underground |
| 5 | Dhobighat-Pulchowk-Singh Durbar-Tangal- Narayanhiti-Nayabazar-Balaju | 13.80 | 10 | Underground |

Table-1: Mass Rapid Transit (Metro Lines) Proposed for Kathmandu Valley

Another **Mass Transit Options and Prioritization Study** conducted in 2018 financed by ADB under KSUTP recommended that the steel rail mass transit system (metro rail) is the most suitable mode for the Kathmandu valley and identified Gongbu Bhaktapur corridor as the priority for first implementation.(Figure-10) Along with its main recommendation, it also proposes three key areas of reform as pre-requisites to support mass transit even if mass transit is not constructed, as necessary to improve mobility, alleviated congestion and reduce pollution from vehicle: consolidation of fragmented paratransit industry into a manageable number of corporate industry, deployment of large buses in primary and secondary routes, development of effective agency to plan monitor and procure and regulate public transport.

**Electric Bus Rapid Transit (e-BRT):** Due to the significant rise of registered vehicles in recent years, the consumption of petroleum products in the transport sector has increased by an average annual growth rate of 9%. Growth rate of CO2 emission from fuel combustion is higher and share of transport sector in total CO2 emission in Nepal is 45%- comparatively higher in the world scenario. Diesel is the main fuel consumed in the transportation sector, followed by petrol and LPG. Transportation consumes about 68% of diesel and emits 1,741 Gg of CO2-eq, which is 37% of the total GHG emission. Nepal experienced a striking increase in direct $CO_2$ emissions during the last two decades. Against this background, Government of Nepal is planning to introduce Sustainable Transport through **Electric Bus Rapid Transit (eBRT)** in Kathmandu valley under *Green Buses Project* to be financed by the Green Climate Fund (GCF). The GCF *Green Buses Project* can initiate a low-carbon transportation pathway by promoting e-mobility solutions for public transportation services

## V. Integrated Multi-Modal Transport System (IMMTS)

**Relevance and Definition**

Conventional transportation planning which often focuses on the automobile as the primary mode of travel has become inappropriate in today's context of rapid urbanization and high demand for transportation in urban area. In the recent past, many countries have adopted mass rapid transit system like Metro Rails, Bus Rapid Transit High occupancy Buses and Mono Rails as public transport system in big cities rather than promoting private cars. Today in almost all research publications on transport policy, the words 'sustainability' and 'integration' can be found. Since the publication of the *Brundtland Report* (WCED, 1987). Since then, sustainable transport has become dominant in transport policy and planning and its relevance is more realized in developing country like Nepal. Reducing travel demand, maximizing use of high occupancy modes, effective and efficient use of transport system infrastructure and services, increasing energy efficiency and reduction of CO2 emission are main objectives of sustainable transport. Making best use of the infrastructures, transportation system and services produced with the scarce resources is the core of sustainability of developing country like Nepal. Hence higher mode share of public transport for example, is essential for sustainability, serving the purpose of economic efficiency (lower operating cost per pass-km), environmental sustainability (lower emissions per pass-km) and socially equitable and safe (NESTS 2014).

'Transport integration' an important transport strategy having much longer history in transport planning has been almost silent until concept of sustainability evolved after publication of *Brundtland Report* (WCED, 1987). Integration, even if it is not explicitly recognized, is probably still one of the most important means to advance sustainable transport and sustainability in general. (Givoni and Banister, 2010). Therefore, integration as an approach should be promoted to achieve the objectives of sustainable transport. Integration as a principle in urban transport policy is frequently advocated but rarely defined. (May, Kelly and Shepherd, 2006). Several government publications in developed countries have advocated an integrated approach specifying integration as an objective of its transport policy (UK, DETR 1998, DETR 2000). As far as Nepal is concerned, the National Sustainable Transport Strategy(NSTS) for Nepal (2015 – 2040) has identified and given priority focus on "the planning and development of integrated transport system" as one of the key components of NSTS. Such an integrated system allows making the best use of each mode offering flexible and high-quality transport services to the users. NSTS as an environmentally sustainable transport(EST) initiative highlights that it is important to achieve integration at the level of physical infrastructure (including land-use and transport coordination), intermodal and network coordination, service operation (coordinated scheduling and fare integration) and regulatory integration (level-playing field for competition between different modes). Similarly, Clean Air Network Nepal (CANN) in its MaYA Factsheet #4 recommends development of integrated mass transit system like Bus Rapid Transit(BRT) integrated with other public transport systems. Transport integration according to contemporary research, happens at three levels: Physical, Operational and Policy and Institutional as below.

- **Physical**: Different modes of transport and land use, intermodal transfer and network coordination- the main aim is to decrease the time of journey from origin to destination.
- **Operational**: Service Operation with coordinated scheduling and advantageous fares and comprehensible tariff system-aiming at reduced cost of travel
- **Policy and Institutional**: Policy relating to transport and other related sectors-aiming at social economic and environmental goals captured in the term 'sustainability'.

At policy level, the two objectives of strategic integration are considered to be: **pursuit of synergy** (May and Roberts, 1995) and **removal of barriers** (May et al, 2005b). The pursuit of synergy involves finding pairs or groups of policy instruments which reinforce one another in achieving changes in the transport system, such as modal shares, or improvements against strategy objectives such as efficiency or environmental protection. The **removal of barriers** implies identifying factors which hinder the implementation of an otherwise desirable policy instrument, and using a second instrument to overcome them. Barriers can be grouped into four categories (May et al, 2005b): Legal and Institutional, Financial, Political and Cultural and Practical and Technological. Integration can contribute to the removal of barriers allowing a given policy instrument being implemented and adopted strategies being more effective.Thus to have a transport system to be sustainable, it should have integration at all levels as described above and can be achieved by promotion of **Integrated Multi-Modal Transport System** as defined in the following paragraphs

**Integrated Multi Modal Transport System (IMMTS)** comprises of one trip that involves two or more than two different modes of transportation like metro, bus, car, tram, rickshaw motorbike etc.; either government or privately operated; where in-between passengers have to transfer in to other mode. Some modes of transportation have always been depended on other modes. (T Rawal, V. Devadas and N Kumar, 2014). In other words, the IMMTS can be defined as the integration of some or all of the different public transport modes (mainly trains, buses and taxis) into the public transport system in such a way that these modes support and complement each other and that they operate as a coordinated public transport system while providing effective efficient and affordable service to the user.

Multi modal transport planning refers to decision making that considers various modes, such as, walking, cycling, automobiles, public transit, etc., and connections among modes so that each can play its optimal role in the overall transport system (Litman 2012). This multi modal transport system can be helpful for the cities which have a fast rate of urbanization and higher population densities. The main aim of IMMTS is to promote public transport in urban areas. A coordinated integration of different modes brings about reduced congestion on the road, greater convenience for commuters, efficiency and cost effectiveness. In this context, a multi modal transport system is an integrated approach that incorporates all components of urban transport into a single system for efficient use of available transport resources and infrastructure for better mobility within a wide range of modal options for the commuters.

**Characteristic Features and Objectives of IMMTS**

**Characteristics:** The various characteristics of IMMTS are as follows (Kumar, 2009):

- Journey involving more than one mode of transportation.
- For various possibilities, use of different modes of transport is accepted.
- The policy generally does not fixate on one single mode.
- Development of seamless web of integrated transport chains, linking road, rail, and waterways.
- Competition between transporters instead of between transport modes.
- Transfer node and smooth interchange flow.
- Seamless travel an important characteristic of the system.

**Objectives:** An effective IMMTS should meet the following requirements and objectives (Pillay and Zly, 2000):

- Higher priority to public transport with sufficient facilities and services, utilization of scarce resources and expensive infrastructure;
- Main focus on the movement of people and not on the modes, and integration of transport and land use;
- Cooperation among and support of different government levels and various modes;
- Availability of funds through public-private-partnership (PPP) and clarity on policy of government;
- Formalization and regulation of public transport, legislative framework on national, provincial level, right institutional structures;
- Proper public transport planning and vision.

**Rationale for IMMTS in Kathmandu Valley**

The modal share of public transport (Buses) in Kathmandu as shown above in the year 2011 was 27.6 %. A survey conducted by JICA in 2012 has estimated, that the population, motorcycle ownership and car ownership in Kathmandu valley will increase by 1.57 (around 4 million by 2022), 1.72 and 2.4 times respectively in 2022. (Figure-11). The report also forecasts that the trip generation will increase by 1.59 times in 2022 as there will be huge travel demand due to population growth. If the present trend of encouraging personalized transport remains unchanged, the modal share of public transport will further decrease to add to the present chaotic situation of congestion and pollution. Several research work and studies conducted worldwide suggest increasing the modal share in favour of public transport with respect to population growth in the city. At least three reports of the Government of India (GoI) recommend a modal split in favour of public transport ranging from 30 to 50 % for a population of up to four million, while the National Commission on Urbanization,

(1987) India, recommends modal split in favour of public transport of 80 % for a population of five million. Different studies in Latin American and Asian countries have shown that increasing public transport (Buses) share has significant impact on decreasing carbon emission. Studies for the Asian Development Bank provide an indication of the scale of possible carbon dioxide savings from a bus-based strategy in India, Bangladesh and Sri Lanka (ADB 2006), Table 2. A paper for Comprehensive Development Plan 2041 for Pune city in India (Jatar, 2012) suggests to increase the number of large buses to 60 per one lakh population. Thus, we find that many research work and studies indicate that sustainable transport can be achieved by reducing fuel used in transportation for example reduce low occupancy vehicles, cars and motorcycles and switch to multimodal mass transit system including buses, monorail light rail transit (LRT) and metro etc. and integrate all modes to complement each other for effective and efficient public transport. Therefore, it is desirable to take initiative of establishing Integrated Multimodal Transport System (IMMTS) to achieve the goals of sustainable urban transport (SUT) in Nepal and particularly in the Kathmandu valley.

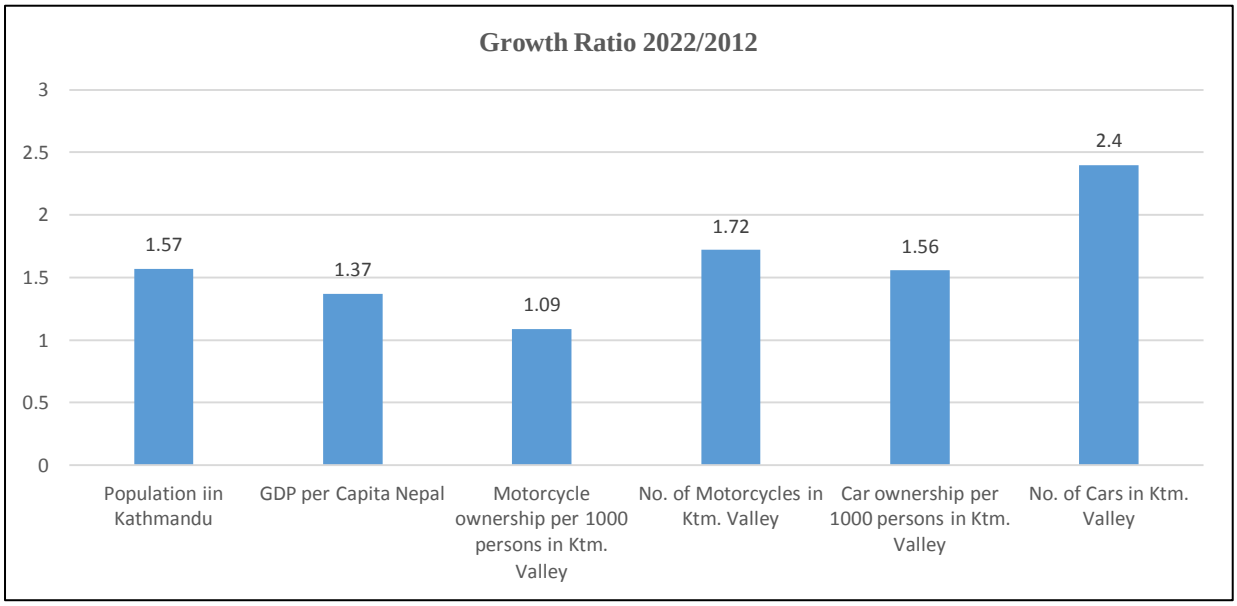


Figure 11: Growth Ratio of Population, Car and Motorcycle, Source JICA, 2012

| City | Increase in Bus share, % | Saving of Fuel, % | Reduction of total vehicles, % | Freeing of Road Space equivalent to no. of cars | Reduction of Carbon dioxide, % |
|---|---|---|---|---|---|
| Bangalore, India | 62 to 80 | 21 | 23 | 418,210 | 13 |
| Dhaka, Bangladesh | 24 to 60 | 15 | | 78,718 | 9 |
| Colombo, Sri-Lanka | 76 to 80 | 3 | 5 | 62,152 | |

Table 2: Indication of scale of CO2 Savings and Reduction of Congestion (Source: ADB 2006)

**Strategies for IMMTS in Kathmandu Valley**

Following the objectives of Asian Environmental Sustainable Transport (EST) initiatives, Nepal has prepared the draft "National Sustainable Transport Strategy(NSTS) for Nepal (2015 – 2040)". The NSTS has identified and given priority focus on "the planning and development of integrated transport system" as one of the key components of transport strategy. The issues under this strategic component include: transit oriented development(TOD); seamless public transport; competitive public transport; transport efficiency; higher mode of share of public transport and NMT. Some of the important strategic actions for urban transport under this strategic component are as below:

- Coordinate land use and transport
- Promote Transit Oriented Development (TOD)
- Plan for future MRT routes and high-density housing along MRT route
- Adequate provision for Transfer facilities (intermodal nodes)
- Integrated fare system
- Walk and NMT mode for improving public health

The various strategic actions spelled out in NSTS cannot be implemented without proper planning. As already mentioned, the GoN should prepare comprehensive transport plan (CTP) including short term, medium term and long-term plans, in view of the present transport status and changed political context of three levels of

government. Integrated multimodal transport planning a newer but different approach from conventional planning focuses on impacts like equity and IMMTS Some important actions, that should be implemented in phases, to improve the public transportation system are enumerated as below:

1. As a short term plan, full implementation of recommendations of Kathmandu Sustainable Urban Transport Project(KSUTP);
2. Formulation of Comprehensive National Transport Policy in coordination with other Sectoral Policies including policy for Integrated Multi-Modal Urban Transport; (Short term plan)
3. Formulation of National Master Plan for Integrated Transport including Integrated Multimodal Transport System for Kathmandu Valley (Short Term Plan). The plan for IIMTS for Kathmandu valley to include following actions:
    - Plan to increase modal share of Public Transport such as high occupancy electric and general buses;
    - Plan to prepare the Detailed Project Reports for Integrated e-BRT and Mass Rapid Transit (Metro Rail) as suggested in the feasibility reports (Department of Railways) and in Mass Transit Options and Prioritization Study conducted by KSUTP under MOPIT in 2018;
    - Establishment of High Level Single Entity to plan, monitor, procure regulate and coordinate the development works including public transport in the Kathmandu Valley.
4. Implementation of e-BRT and MRT (Metro Rail), integrated (physical, operational and institutional) with other public transport modes including NMT and private cars and taxis in Kathmandu valley. (Medium and Long Term Plan);
5. Timely completion of Kathmandu-Terai Fast Track Project (Short term) and implementation of Outer Ring Road Project (Medium term).
6. Timely completion of Kathmandu Valley Urban Development Project Works (Short term).

## VI. Conclusion

Rapid urbanization and exponential growth of vehicular population especially private cars, motor bikes and small occupancy micro-buses and unwarranted inflow of people in urban areas of Kathmandu valley are causing detrimental and deteriorating impacts on the traffic and environmental conditions like any other developing cities of the world. Some initiatives for promotion of sustainable transport has been taken in the previous years but due to poor implementation (for example KSUTP recommendation) of such initiatives, desired improvement in transport conditions in the valley could not be achieved. So there is an urgent need to improve the transport condition in the valley with available scarce resources in all fronts; economic, social and environmental, so as to create a sustainable transport system. One of the important strategy for sustainable transport is to increase the modal share of public transport including high occupancy buses, electric Bus Rapid Transit and Mass Rapid Transit (Metro Rails) and integrating with other modes like private cars and taxis, para transits, walk and NMT at physical, operational, policy and institutional level: which is often called as Integrated Multi-Modal Transport System (IMMTS). So it is desirable to make a sustainable transport policy and translate into achievable action plan for IMMTS with the efficient integration of infrastructure and services by implementing the plans of e-BRT and MRT which is in the pipeline of GoN, at the earliest possible and integrate with other modes presently in operation. However, there are challenges to achieve the highest level of integration of multiple modes by shifting modal share from personalized transport to public transport, there is a good scope of achieving effective coordination and integration in developing country like Nepal, as spatial and physical structure is just in the process of evolving.

## References

[1] Asian Development Bank (2006). Energy Efficiency and Climate Change: Considerations for On Road Transportation in Asia.
[2]. Central Bureau of Statistics, UNFPA (2014). Population Monograph of Nepal
[3]. Dimitriou, Harry T, 1990. Transport Planning for Third World Cities, Routledge Revivals
[4]. Givoni, M. and Banister, D. (2010). Integrated Transport from Policy and Practice, 2010
[5]. GON, 2001. National Transport Policy, Ministry of Physical Planning and Works.
[6]. GON, 2014b. National Environmentally Sustainable Transport (EST) Strategy for Nepal, draft document.
[7]. GON, 2014. National Environmentally Sustainable Transport (EST) Strategy for Nepal (First Draft)
[8]. GON, 2015. National Urban Development Strategy, Ministry of Urban Development.
[9]. GON, Ministry of Forest and Environment, (2021). Report on Nepal's Third National Communication to the United Nations Framework Convention on Climate Change
[10]. JICA, 2012. Data Collection Survey on Traffic Improvement in Kathmandu Valley. Japan. Int. Coop. Agency JICA.
[11]. JICA, 2017. The Project on Urban Transport Improvement for Kathmandu Valley, Japan. Int. Coop. Agency JICA.
[12]. Kumar, P. (2009). Design Approach for Multi-Modal Transport System. Architecture – Time Space and People
[13]. Litman, T (2012), Introduction to Multi-Modal Transportation Planning Principles and Practice, Victoria Transport Policy Institute
[14]. May, A.D., Kelly, C. and Shepherd, S.P. (2006) The principles of integration in urban transport strategies. Transport Policy, White Rose Research Online http://eprints.whiterose.ac.uk/
[15] Morichi, S., Acharya, S.R., 2013. Transport Development in Asian Megacities - A New Perspective. Springer Berlin Heidelberg.

[16]. Muzzini, E. and Aparicio, G. (2013) Urban Growth and Spatial Transition in Nepal, An Initial Assessment, The World Bank Washington DC
[17]. Pillay, K. and Zyl, O.V., (2000). Towards a Modal Integration Strategy for Guateng. Action in Transport for the New Millennium, South Africa.
[18]. Pokharel, R. and Acharya. S.R., (2017). Sustainable Transport Development in Nepal: Challenges, Opportunities and Strategies
[19]. Rawal,T. , Devadas, V. and Kumar, N. (2014). Integrated Multi-Modal Transportation in I ndia. Changing Spectrum of Human Settlement and Planning Education
[20]. Stead, D and Meijers, Policy integration in practice: some experiences of integrating transport, land-use planning and environmental policies in local government
[21]. UK, Department of the Environment, Transport and the Regions (DETR)(1998) (2000) A new deal for Transport better for everyone. The Government's White Paper on the Future of Transport,
[22]. UN, Bruntdland Report on World Commission on Environment and Development: Our Common Future, (1987)
[23]. UN DESA. (2014). World Urbanization Prospects: 2014 Revision. New York: United Nations Department of Economic and Social Affairs. http://esa.un.org/unpd/wup/FinalReport/WUP2014-Report.pdf
[24]. UNHABITAT(2014), Clean Air Network Nepal (CANN), MaYA Fact Sheet # 4 - Public Transportation In Kathmandu Valley, Restructuring And Reforming The System.