CHAPTER-2
LITERATURE SURVEY

2.1 Introduction:
This chapter presents review of literature which is an assessment of a wide-ranging cross-section of published literature that emerged from multiple academic disciplines which includes architecture and planning, transportation research, and sociology, psychology which are found important to provide insights and to identify the factors necessary in developing analytical framework for this research. In this Chapter, available literature was reviewed focused on subject matter of this research where the central theme being sustainable transport and its relationship with urban land use. To address the themes, this Chapter undertakes a review of literature on individual components of the central theme and combinations of individual components. In addition the review of literature aims at providing detailed account of earlier studies in order to identify the gap that exists in the literature, which the thesis attempted to fill.

This literature review is presented in five parts where first part begins with an analysis of sustainability in context of transportation. The review examines Impact of Transport on Environment which is to be considered in more meaningful ways as a potential solution for transportation challenges. The section is followed by an investigation into travel behaviour various behavioural theories are looked in. In the third part transportation and its relation with land use is examined which include the concept of Land Use Planning and Transport Integration. In the fourth part sustainable transportation indicators are examined. In the fifth part mass transit system is analysed. Finally, the important aspects relating to the development strategies for efficient transportation system are analysed. Gap in literature identified and the findings from literature is summarized.

2.2 Sustainable Development and Transport:
Transport is an activity which affects humans and the natural environment to a very great extent. It is nevertheless vital for both the development of society as a whole as well as for the mobility of the individual. The ability to transport oneself and one's products wherever and whenever necessary is seen today by the majority of us as a
Sustainable Planning Strategies for an Integrated land use and Mass Transit System with Reference to Core and Fringe: “A Case Study of Pune”

matter of course. The design and development of the infrastructure for the transport sector and methods of transport are closely dependent on general social developments and have a decisive influence on the location of housing and industry. This is why coordinated efforts are necessary from actors who are active internationally, nationally, regionally and locally to assure maximum environmental compatibility as the transport system is being transformed.

Sustainable Development include sustainable mobility which is defined as the ability to meet society’s need to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values, today or in the future’ (WRI, 2004). For sustainable development there is a need for a sustainable transport system which allows the basic access and development needs of individuals and society to be met safely and in a manner consistent with human and ecosystem health which promotes equity within and between successive generations.

Sustainable strategies for transportation system are characterised by its affordability, efficiency in operation as well as it should offer a choice of transport mode, and supports a competitive economy, as well as balanced regional development. It is important that such a development limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land (VTPI, 2004). Sustainability has major implications for transport planning (Todd Litman 2005). The concept of sustainability is coherent part of transport sector. A balanced approach will enable to fulfil transport needs of people. The sustainable transport supports competitive economy. It balances regional development. It promotes equity within and between successive generations.
It minimizes all types of pollution. It limits emission by using non renewable energy sources. It is efficient with less maintenance. Transportation has significant economic, social and environmental impacts, and so is an important factor in sustainability. Previously, transport was evaluated primarily in terms of mobility (physical movement). But increasingly it is evaluated in terms of accessibility (people’s ability to obtain desired goods and services). Accessibility-based planning expands the range of solutions that can be applied to transport problems; for example, congestion can be reduced by improving land use accessibility or telecommunications, in addition to accommodating more vehicle traffic. The dimensions within the Definition of a Sustainable Transport System are explained in table 2.1.
### Table 2.1: Overlapping of dimensions of sustainability

<table>
<thead>
<tr>
<th>Dimension of suitability</th>
<th>Definition of a sustainable transport system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accessible</td>
</tr>
<tr>
<td>Economical and financial</td>
<td>✓</td>
</tr>
<tr>
<td>Asset condition</td>
<td>✓</td>
</tr>
<tr>
<td>Social equity</td>
<td>✓</td>
</tr>
<tr>
<td>Health</td>
<td></td>
</tr>
<tr>
<td>Ecology</td>
<td></td>
</tr>
<tr>
<td>Physical environment</td>
<td>✓</td>
</tr>
<tr>
<td>Air quality and noise</td>
<td>✓</td>
</tr>
<tr>
<td>climate</td>
<td>✓</td>
</tr>
</tbody>
</table>

Source: ADB

### 2.3 Impact of Transport on Environment:

The issue of transportation and its effect on environment is paradoxical in nature. On one hand transportation activities satisfy increasing mobility demands of people and freight on the other hand they had resulted in adverse effect on environment in terms of pollution, traffic congestion and accidents. (Ing. Baryalai, 2012)

Asia’s emissions from motorized transport have become a significant contributor to the global problem of greenhouse gas emissions that leads to climate change. Energy use in the transport sector is dominated by petroleum product fuels. The share of transport within total global greenhouse gas emissions, in particular CO2, is growing rapidly, with the vast majority of projected increases expected to come from developing Asia. In 2006 transport accounted for 13% of global greenhouse gas, while 23% of global CO2 emissions from fuel combustion were transport related. Asia accounted for 19% of total transport sector CO2 emissions in 2006 but by 2030, this figure will increase to 31%. (IEA2008) Addressing transport emissions in Asia are therefore crucial for global CO2 mitigation.
2.3.1 The ASI Approach:

Research established ASI approach based on principles of suitability aimed to achieve significant reduction in green house gas emissions, reduced energy consumption, less congestion in order to render cities liveable. The “Avoid” component is address the need of improving the efficiency of transportation system through land use planning, and transportation demand management. Component “shift” is to improve trip efficiency. It is characterised by a shift from private vehicle to mass transit system as well non-motorised transportation. The “Improve” component is focused on achieving fuel efficiency to check environmental pollution (SUTP)(figure2.2)

![Avoid-Shift-Improve approach](image)

Figure 2.2: Avoid-Shift-Improve approach, Source: (SUTP)

2.3.2 Economic Aspects of Urban Transport:

With almost 3.9 billion people, Asia has 53% of the world’s population. Its share of the world’s urban population rise from 9% in 1920 to more than 48% in 2005, and is expected to reach 54% in 2030. (WUP, 2014). By 2015, projected populations of the largest cities Jakarta, Karachi, Mumbai, and Shanghai will be in the 20 million–30 million range, and a further 9 cities with 10 million–20 million. It has been estimated that 80% of Asia’s new economic growth will in future be generated in its urban economies, because of availability of jobs and employment opportunities (Lohani, 2005). These trends are placing an enormous strain on transport and mobility in urban
areas. Road congestion already costs Asian economies an estimated 2%–5% of GDP every year due to lost time and increased transport costs. In response to growing urban transport needs and rising congestion, there has already been a sharp rise in investment in urban transport systems, including ring roads and mass transit systems (ADB).

2.3.3 Road Accidents and Emerging Social Issues:

One of the most serious adverse effects of the rising traffic on Asia’s roads has been growing road accidents. Out of an estimated 1.18 million deaths and millions of injuries globally each year due to road accidents, 60% occur in Asia. (30 ADB. 2005. Arrive Alive. ASEAN Regional Road Safety Strategy and Action Plan (2005–2010). Manila.) This reflects not only traffic growth but also high road accident rates. Accident rates in developing countries are much higher than in advanced countries, among the member countries of the Association of Southeast Asian Nations (ASEAN) alone, road accidents cost an estimated $15 billion each year. (WHO, 2009)

Road safety depends not only on having safer infrastructure and vehicles, but also on changing driver behaviour and supporting law enforcement, emergency response, and medical facilities. Countries need effective safety legislation and institutions, and good safety practices. They also need systematic, comprehensive accident reporting systems; safer engineering design and safety audit systems; education and awareness programs, aimed particularly at children; improved driver training and vehicle testing; effective enforcement of legislation; and emergency rescue systems.

Figure 2.3: Opportunities for New and Enhanced Sustainable Transport (By author)
More effective approaches are also needed for addressing other social dimensions of transport, including gender mainstreaming, participation, and social risks. There are a number of issues that dictate sustainability of a transportation system (Fig)

There is close relevance between freight traffic and pollution. Increase in freight movement is function of urban economy and population. 10% of total urban traffic is freight traffic. In urban area 40% of pollution due to transportation is result of freight transport. Furthermore, the freight delivery vehicles require considerable time for loading and unloading of goods at different points of the city. In dense part of the cities, all these contribute to traffic congestion. (SUTS) A sustainable transportation system minimizes the amount of freight traffic in the city as much as possible by improving the efficiency of the freight transport operations through facilities such as consolidation centers or freight villages and through the use of web-based technology and Intelligent Transport System (ITS) (Ref: - Ibid.)

2.4 Travel Behaviour:

Travel is an integral part of everyday life facilitating people to access other persons, locations and services but it also proved amongst the most crucial threats for humans and the environment. Considering these architects, planners, policy-makers, and
researchers are aiming at measures that permanently shift people’s travel behaviour towards more sustainable mobility. This phenomenon calls for, a fundamental understanding of individual travel behaviour and its driving forces and influencing factors is necessary (McFadden 2007).

The satisfaction of individual needs of human being ranging from basic needs like eating and sleeping up to the need for self-fulfillment is a fundamental condition for human existence (Maslow 1943). Transport itself is one of the human needs that can’t be met in situ as to meet these needs, people or goods has to cover distances (Becker et al. 1999). It depends on interactions among various individual factors like attitudes, opportunities and accessibility of places of activities in terms of distribution in space, infrastructure. Research and scholarship analyzed such these interactions in a spatial-temporal context to describe the duality of constraints and possibilities (Hägerstrand 1970). For a deeper understanding of psychological factors for travel decisions it is necessary to study various behavioural theories which have influence on individual mobility behaviour.

2.4.1 Rational Choice Theory:
One of the most influential and far-reaching models of human behaviour is the Expectancy Value model based on rational choice theory. This theory underpins Western neoclassical economics and as such is widely used to explain behaviour and justify policies (Jackson, 2005). It is based on the assumption that people make deliberate and reasoned choices which maximise their personal utility. To do this, people must know what the outcomes of all possible actions will be so they can then attach value to such outcomes, thus allowing them to weigh up the costs and benefits of each choice (van den Bergh, et al., 2000). Any social behaviour that occurs arises from individuals maximising their own utility, which may or may not happen to coincide with the social good (Scott, 2000; van den Bergh, et al., 2000). An application to travel behaviour can be made by using the “Rational Choice” theory. Research indicated that the attractiveness of a means of transport is defined by travel time, travel costs and quality as the main factor for travel behaviour decisions (Mahmassani and Jou 2000)
2.4.2 Theory of Reasoned Action:
It was a widely applied social behaviour theory that is still based on rational choice, but includes influences of an individual’s beliefs and subjective norms (Jackson, 2005). The rational choice component is where an individual’s attitude towards behaviour is formed from beliefs about the outcomes of an action and the values that they attach to those outcomes (Jackson, 2005). Additionally, what the individual believes others, whose opinion they value, think they should or should not do forms the subjective norm. This subjective norm is therefore dependent on what others might think. These two factors (attitude and subjective norm) combine to create an intention to behave in a certain way, which directly leads onto behaviour (Ajzen, 1991).

2.4.3 Theory of Planned Behaviour:
The Theory of Planned Behaviour (Ajzen, 1991) is adopted from the Theory of Reasoned Action which addresses situations where the individual does not have complete freedom to control their behaviour. It illustrates Perceived Behavioural Control (PBC) based on the Theory of Reasoned Action (Fig 3). Here PBC indicates people’s perception of the ease or difficulty of performing a particular behaviour which they find of their own interest” (Ajzen, 1991) which represents both intention and behaviour (Ajzen, 1991; Jackson, 2005).

![Figure 2.5: Ajzen's Theory of Planned Behaviour (Gifford, et al., 2011)](image-url)
This theory like the “Rational choice” theory focuses on a maximization of satisfaction of needs as a basis for decisions which is supported by including social norms and rules and accounting for subjective perception. Hence, the “Theory of Planned Behaviour” allows a more detailed view on travel behaviour and mobility decisions. This theory is used by many researchers to get insights in the nature and structure of travel choices (Hunecke et al. 2007, Anable 2005). This theoretical approach may be proved instrumental in explaining and analyzing habitual character of individual travel behaviour (Gärling and Axhausen 2003).

2.4.4 Norm-Activation Theory:
The Norm-Activation Theory (Schwartz, 1977) illustrates a model for altruistic behaviour based on personal norms which dictate what the individual believes they should or should not do irrespective of what others believe. These personal norms are established on the basis of an awareness of the consequences of actions well as on a feeling of responsibility associated with the perceived consequences.

Figure 2.6: Norms Activation Theory Source: Bamberg & Moser, 2007

Here the norms are not based on what the individual believes others will think of their actions alone, as is the case with subjective norms (Bamberg & Moser, 2007). They
influence an individual’s personal norms, awareness and responsibility which in turn affect behaviour.

Research indicated that the link between personal norm and behaviour become stronger with the greater awareness and sense of responsibility which a person possesses (Jackson, 2005). In transportation research this model has been used by Bamberg and Schmidt (2003) which was later adapted by Bamberg and Möser (2007) to analyse transport choices. As per norm-activation model a cognitive process followed by environmentally damaging or environmentally friendly behaviour which undergo many phases as shown in figure 2.7

![Figure 2.7 showing phases of environmentally damaging or environmentally friendly behaviour Source: http://www.mdpi.com/2079-9276/3/1/1/html](http://www.mdpi.com/2079-9276/3/1/1/html)

### 2.4.5 Theory of Interpersonal Behaviour:

The Theory of Interpersonal Behaviour states that intentions immediately precede behaviour, as seen in the theories of Reasoned Action and Planned Behaviour.
In addition to this habits are also influence behaviour and the effects of both of these factors are controlled by contextual factors referred as ‘facilitating conditions’ (Jackson, 2005; Triandis, 1979). Intentions are mediated by attitude, social factors and emotions; habits.

The strength intention largely depends on the frequency of past behavior as well as on the context through which the person is living which represents a particular behaviour. (Triandis 1977). Following factors influence behaviour:

- Society and social norms
- Emotional responses
- Past behaviours
- Personal beliefs about the individual’s role in society
- Norms, morals and deliberative thought.

Theory of interpersonal behavior if of importance because of its ability in explaining observed behaviour more comprehensively.
2.5 Transportation and City Development:

Identification of clear goal with reference to city development is critical for urban planner, policy makers. The problems faced by every cities are different while some problems are universal transportation is one of them. Cities are going through globalization where use of advanced technology resulting in change in pattern of demography, new living standards and product cycles. The opportunities of city depend upon geographic location, the size of city population and economic base, the city’s history and the spatial relation of one city to others in a region.

Availability of infrastructure in city is essential as it encourages and increases speed in economic as well as human activities. Major infrastructures are highways, rail network, airports, docks and harbours. It is at the heart of entire economy of city. Role of advance communication technology has made these infrastructures more efficient. (Kuby and Reid, 1992) There is indirect impact of cost of transportation and technology on the urban form. The study conducted by Fishman (Fishman, 2000) shows that decentralization of housing is the result of efficient network of interstate highway. According to traditional theories for the growth of city systematic interaction of people can be achieved through neatly planned infrastructure and well coordinated economic activities. It is also influenced by local context. The urban growth results into the suburbanization and sprawl. It is the result of depopulation or migration of population from rural area (E.Besussi et al 2010)

2.5.1 Urban Sprawl:

The surrounding area of a larger city comes under the influence of city itself. Such area is called as ‘peri-urban area’. It is having urban-rural mix. It comes within limits of regional planning. It lies beyond limits of the Municipal Corporation or planning authority. The zone of peri urban area varies from city to city. Research established that in developing countries land development management at the State or municipal level is facing great challenges, stemming from uncertainties concerning local government controlled development on the urban fringe, for example in Africa India and Indonesia (Kombe, 2005, Ze´rah, 2007 and Ranis, 1994).
2.5.2 Transport and Land Use Relationship:

Land use and Transport are intricately linked to each other. Transport system includes modes of transport, different technologies of transport, the infrastructure, institutional set-up, and policies concerned with transport system. The land use system consists of the socio-economic and demographic characteristics of the region. Land use system determines the demand for travel. Transport system determines the supply to fulfil the current demand. The objective of land use plan is to protect eco sensitive lands. It frames a spatial framework to create liveable human society for future urban expansion which is explained in following table.

Table 2.2: Transport and land-use relation

<table>
<thead>
<tr>
<th>No</th>
<th>Impact demands for travel</th>
<th>Improves attractiveness and leads to land value change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Interaction between activities.</td>
<td>Investment decisions</td>
</tr>
<tr>
<td>+</td>
<td>Transport decisions mode.</td>
<td>Location activities</td>
</tr>
<tr>
<td>Land use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: skin pdf Toolkits Land use Transport Integration Toolkit.pdf

Table 2.3: Relationship between transport and land use

<table>
<thead>
<tr>
<th>No.</th>
<th>Land use</th>
<th>No.</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Compact cities</td>
<td>1</td>
<td>Reduce trip length</td>
</tr>
<tr>
<td></td>
<td>A-Polycentric</td>
<td>2</td>
<td>Reduce personal vehicle dependence</td>
</tr>
<tr>
<td></td>
<td>B-Higher population and densities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C-Complete network and streets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Mixed use</td>
<td>3</td>
<td>Greater transit and non-motorized vehicle use</td>
</tr>
<tr>
<td>3.</td>
<td>Quality and quantity public transport</td>
<td>4</td>
<td>Improving access to employment, facilities and amenities</td>
</tr>
<tr>
<td>4.</td>
<td>Local access</td>
<td>5</td>
<td>Reduce green house gas/pollution</td>
</tr>
<tr>
<td>5.</td>
<td>Quality public places</td>
<td>6</td>
<td>Affects land value and affordability</td>
</tr>
</tbody>
</table>

Source: skin pdf Toolkits Land use Transport Integration Toolkit.pdf
2.5.3 Land use and Transport planning:
A number of factors influence energy use for urban transport which includes the location of employment and residential locations. In wake of urbanization all over the world most cities have been increasing their dependence on the automobile and subsequent decreasing dependence on public transport. In many cases increasing motorization is the result of deliberate planning which is referred as ‘predict and provide’ (Goulden, 2014). During the second half of the 20th century this planning and programming process played a central role in developed countries. In many developing countries like India, the process of motorization and road construction process is not well organized, but is generally following the same motorization path, often at an accelerated rate.

Income plays a central role in explaining the process of motorization where each city have a different pattern of motorization as mode shares vary dramatically across cities, even within single countries. In most Asian, African and Latin American cities, and in Japan and Western Europe the share of trips by walking, cycling and public transport is 50% or higher. Coordination of land use and transport planning is key to maintaining these high mode shares. The high urban densities are associated with lower levels of car ownership and car use and higher levels of transit use. These densities are decreasing almost everywhere. Which perhaps the most important strategy and highest priority to slow motorization is to strengthen local institutions, particularly in urban areas (Newton 2008).
Land use is understood affect transport in a number of significant ways as dispersed land use patterns result in high levels of automobile dependence while concentrated land use is more commonly linked with higher levels of public transport patronage. As per European Commission’s (EC) TRANSLAND study:

- Higher residential densities and mixed development can lead to shorter trips and lower levels of automobile use.
- Traditional neighbourhoods can have shorter trips and lower levels of car use than car-oriented suburbs.
- Higher employment density leads to greater public transport use.
- Developments close to public transport can generate higher levels of public transport use (Paulley and Pedler 2000).

Transport has both direct and indirect land-use impacts (Table 2.4). Direct impacts result from the amount and location of land used for transport facilities while indirect impacts arise from transport decisions which affect land use accessibility (ibid).
Table 2.4: Examples of transport’s direct and indirect impacts on land use

<table>
<thead>
<tr>
<th>Transport decision</th>
<th>Direct impacts</th>
<th>Indirect impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased parking supply</td>
<td>Increases paved area</td>
<td>Reduces density; encourages urban fringe development</td>
</tr>
<tr>
<td>Expanded urban roads</td>
<td>Increases paved area; degrade urban landscapes</td>
<td>Encourage urban fringe development</td>
</tr>
<tr>
<td>Public transport improvements</td>
<td>May require new facilities (rail lines, stations)</td>
<td>Make urban areas more accessible.</td>
</tr>
</tbody>
</table>

Adapted from Litman, 2007, p.2.

The relationship between land use and transport decisions is a complex phenomenon which includes a range of socio-economic factors like car ownership, housing demand, income etc making it difficult to predict precisely the impacts of specific decisions.

Research established that development of automotive transportation allowed and encouraged radical changes in the city form and land use pattern. Availability of land at cheaper rate at city fringes became more attractive to developers and as result there is a mass change in land use pattern from agriculture to residential and commercial. (Litman, 2005). This phenomenon have resulted in significant increase in environmental, social and economic problems including air pollution, increasing carbon dioxide (CO2) emissions and community severance that are now seen as putting ‘at risk the urban environment and the health of city and suburb inhabitants’ (European Conference of Ministers of Transport 2002, p.8).

Various urban planning theories established the relationship between land use and transport comprises as a significant element which promote more sustainable urban forms, often described as compact cities, new urbanism and smart growth. These theories are becoming influential in informing land use policies both internationally and in India are seen as ways of addressing problems of automobile dependence and associated environmental, social and economic impacts.

It has been stated that that land-use policies to increase urban density or mix land use will have only limited effect if they are formed without accompanying transport
measures to restrict car use and provide alternatives to car use. (EC 2004). It has been suggested that the most effective results can be achieved by using both ‘push’ and ‘pull’ measures, coupled with land use controls.

![Push and pull factors in land use planning](image)

Figure 2.10.: Push and pull factors in land use planning

### 2.6 Concept of Land Use Planning and Transport Integration:
Travel pattern largely influences city form, as development of improper urban form has been noticed as one of the root causes of many transportation problems throughout the world [Road Management & Engineering Journal 1998 by Tran Safety, Inc.]. In developing courtiers like India rapid, unplanned and uncoordinated growth of cities has dispersed their populations, with more people moving from the city centres to the urban fringes. This phenomenon has reduced access to public transportation and made the cost of construction and maintaining new public transportation systems prohibitive. Land use planning system is imperative to improve the environment for various reasons (Hayashi 1989) such as:

- For controlling urban sprawl to keep the infrastructure development cost within acceptably limit.
- For infrastructure improvement which provides benefits not only to users, but also to owners, tenants and developers of land properties in the vicinity.

#### 2.6.1 Sustainability aspects of integrated land use and transport planning:
Land use planning and transport planning have key roles in delivering social, economic and environmental sustainability in urban areas and to shape them. In order to achieve these outcomes strong integration of land use and transport planning is
required. The definition of sustainable transportation include the broad sustainability considerations of concern for welfare of present as well as future of society and of conservation of natural resources. According to him a sustainable urban land use and transport system composed of the following three aspects:

- Provision of access to goods and services in an efficient way for all inhabitants of an urban area
- Protection of the environment, cultural heritage and ecosystems for the present generation
- Without endangering the opportunities for future generations to reach at least the same level of welfare as that of the present generation, including welfare derived from the natural environment and cultural heritage.

It should focus on moving people and goods instead of automobiles. Land use-transport integration (SUTPINDIA) provides this focus with facilitating a city by:

- Reducing the need to travel
- Reducing the length of trips
- Making it easier and safer for people to access services and facilities
- Reducing transport impacts on communities
- Providing for the efficient distribution of goods and services to businesses and the community
- Providing choices in travel modes, and
- Ensuring flexibility now and in the future to address changes in demand in the economy and in society.

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2.6.2 The key concepts of LUTI:

**Accessibility:** Accessibility is defined as ‘the ease for people to participate in activities from specific locations to a destination using a mode of transport at a specific time’. The primary role of accessibility in the key decisions that underpin urban development and urban activity can be observed in ‘Wegener’s Wagon Wheel’ model of the urban development process which illustrates the interaction between the
land use and transport systems. As per this model decisions of investors and consumers regarding Location are made on the basis of the relative accessibility of different areas of the city. This accessibility is affected by the travel choices of the users, which leads to the development of congestion and hence the actual (time) separations between localities. While subject to external shocks (such as geo-politics and overall economic conditions) the system is effectively closed and is evolutionary.

2.6.3: Theories of Land Use and Transportation Planning:

Random Utility Maximization (RUM) Theory: As per Random utility maximization (RUM) theory the decision-maker always selects the best alternative for him or her-self, the one with the highest utility (a scalar measure of value when making a choice from a set of discrete alternatives. For predicting discrete choices RUM theory provides a mathematical means to account for these random components of utility.

2.6.4: Land Use/Transportation Feedback Cycle:
The transportation and land use systems closely interact with each other as illustrated by the land use/transport feedback cycle (TFResource (2015)).

Figure 2.11 The land-use transport feedback cycle (Wegener and Fürst 1999)
Urbanization and the growth in motorized traffic have mutually reinforced each other. The relationship between land use and transport is demonstrated in what is referred as the transport land use feedback cycle (Wegener, Fürst 1999; Meyer, Miller 2001; Giuliano 2004). There is, however, the need to add a layer of complexity to this common interpretation.

As per this cycle patterns of land use determine the places at which people live, work; engage in leisure pursuits, etc. Movements between these different locations of activity have to be taken care of by the transport system and transport system developments are intended to be adapted accordingly. In turn, transport developments determine the accessibility of locations and, with that, their attractiveness as a location for certain land use developments.

2.6.5 Schneider’s theory of routine mode choice:

As per this theory the decisions process regarding selection of travel mode include five sequential steps. The first step is awareness and availability which determines the travel modes available for which user subsequently makes rational trade-offs. In the second step, travellers consider the safety and security from traffic, crime which the mode offers. In the third step users give a thought to convenience and cost of each mode, including money, time, and effort.

![Figure 2.12: Theory of Routine Mode Decisions (Schneider, 2013)](image-url)
In the fourth step it is the consideration for enjoyment as well as perceived individual, social, and global benefits which traveller gets from a particular mode.

The fifth step, habit, prior experience and choices influence future decisions through feedback and closure of the decision loop.

In the second, third, and fourth steps the situational tradeoffs between the considered modes occur, either sequentially or simultaneously. Here socioeconomic factors play an indirect role by influencing how individuals evaluate each of the first four steps (Schneider, 2011).

Figure 2.13: Conceptual Framework of the Theory of Travel Decision Making.
Source:http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=2493&context=open_access_etds

2.6.6 Theory of Travel Decision Making:
As per the theory of travel decision-making’s there are 7 major components and relationships:
1. Activity: Demand for travel is derived from a demand for activities.
5. Decision Rule: People may use different rules to make decisions.

6. Decision Contexts and Outcomes: This theory applies to many, even multidimensional, travel decisions.

7. Feedback: Past travel outcomes influence the current decision-making process.

According to the research on the significance of integrating land use with transportation by Conder and Lawton (2002) a Delphi Panel initially suggested substantial demand for new housing north of the Columbia River near Portland, OR. Testing this scenario in an integrated land use/transportation model revealed that not many households decided to move north of the Columbia River because congestion on the four bridges across the river made commute travel times very long. This research has provided a classic example of the land use/transportation feedback cycle. Increased density north of the Columbia River led to additional travel demand, but the congestion reduced the accessibility of neighborhoods north of the Columbia River, which in turn limited the attractiveness of those areas for additional development. (http://tfresource.org/Category:Land_use-transport_modeling

2.7 Barriers to integration:

There are a number of barriers which hinder successful integration of land use and transport planning. The barriers for integration of land use transport may be grouped into four categories as shown in figure. (May et al. 2005).

![Figure 2.14: Barriers to Integration](http://tfresource.org/Category:Land_use-transport_modeling)

Effective implementation of sustainable policy strategies for urban travel needs active involvement of diverse and divergent interests of stakeholders in the urban transport system.
2.7.1 **Sustainable transportation Indicators:**

Indicators can measure various levels of impacts, from the planning process to travel behaviour, impacts on people and the environment, and economic effects. Indicators may reflect the external trends (change in population, income, economic activity, political pressure), decision-making process (the quality of planning), responses (travel patterns), physical impacts (emission and accident rates), effects these have on people and the environment (injuries and deaths, and ecological damages), and their economic impacts (costs to society due to crashes and environmental degradation). Following criteria should be considered for choice of indicators of sustainable transportation.

![Figure 2.15: Criteria for choice of indicators of sustainable transport, by author](image)

The measurement of transit performance has been, and will continue to be, an important concern for allocating resources among competing transit agencies. Performance measurement is fundamental for assessing management performance of the transit service in relation to community expectations, for assessing management problems regarding costs of the service, and as a monitoring tool for improving the service (Transportation Research Board, 1994). In addition, the measure of performance allows the behaviour of organizations to be compared over time or/and across space (De Borger et al., 2002). Tyrinopoulos and Antoniou (2008) propose a methodology based on the application of two different statistical methods, factor analysis and ordered logit modelling, for analysing the variability of the users’ behaviour and their level of satisfaction from
the use of diverse transit systems. Iseki and Taylor (2008) examined transit users’ perceptions of the quality of service and infrastructure at bus stops and train stations around metropolitan Los Angeles. In this study, an importance–satisfaction analysis was effected to examine which stop and station attributes matter most in transit users’ experience. Other studies adopted more advanced statistical techniques, like path analysis, latent variable and structural equation models. Stuart et al. (2000)

2.7.2 Importance of indicators:

A mechanism is needed to determine if the transportation system is progressing towards sustainability. The indicators many purposes like benchmarking, monitoring progress towards sustainable development over time, comparing between cities and evaluating effectiveness of policies and actions.

2.7.3 Indicators to assess progress in development of sustainable urban transportation system:

Organization of urban land use greatly impacts the sustainability of a transportation system. One of the goals of sustainable transportation is to enhance the public transit system and to reduce the usage of personal vehicles. This is why transit system and usage of personal vehicle are important aspects of sustainable urban transportation system. Safety and security is also essential for a transportation system as accidents have socio-economic impact (Black et al.). These include national, regional and local levels of government, politicians, public sector transport and land use planning agencies, environmental authorities and advocacy groups, private sector transport operators and other service providers, as well as real estate developers and users. It is difficult task to bring them together and ensure required co-ordination and co-operation among these stakeholders. This is a complex and resource-intensive process which is essential to long-term implementation of sustainable strategies.

2.7.4 Urban Mass Transit Systems:

Public mass transit includes various services that provide mobility to the public, including buses, trains, ferries, shared taxi, and their variations. It is an efficient and equitable transport system which provides affordable travel options for non-drivers as well as proves a catalyst for more efficient land use development. Urban mass transit systems include various travel modal options that are operating on streets under normal traffic conditions that are capable of carrying up to 5,000 passengers per hour.
in one direction at average speeds of approximately 12–15 km/h in case of buses. While a Metro systems capable of carrying up to 60,000 passengers per hour in one direction at average speeds of up to 60 km/h (ITA Working Group, 2004).

The types of mass transit systems include underground metro/subway, light rail, heavy rail, elevated rail, tram, bus-based systems, ferries as well as light rail (Mackett and Edwards, 1996). In last decade metro and light rail transit systems have been used as a popular mode of transport in many cities across the globe (Marin and Jaramillo, 2008; Marin and Garcia-Rodenas, 2009).

Large scale urbanization and urban sprawl resulted in increasing need for mobility, longer journeys traffic congestion in city core and fringe areas. In developing countries like India bus based public transport has been considered a more cost-effective option compared to rail investment especially (Currie and Wallis, 2008; Hensher, 2007).

<table>
<thead>
<tr>
<th>Category</th>
<th>Improved transit service</th>
<th>Increased transit travel</th>
<th>Reduced automobile travel</th>
<th>Transit oriented development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicators</td>
<td>Service quality (speed, reliability, comfort, safety etc.)</td>
<td>Transit ridership (passenger– miles or mode share)</td>
<td>Mode shifts or automobile travel reduction</td>
<td>Portion of development with TOD design features</td>
</tr>
<tr>
<td>Benefits</td>
<td>-Improved convenience and comfort for existing users. -equity benefits (since existing users tend to be disadvantaged ) -option value (the value of having an option for possible future use.) -improved operating efficiency (if service seed increase) Improved security (reduced crime risk)</td>
<td>-increased user security, as more users ride transit and wait at stops and stations. -mobility benefits to new user. -increased fare revenue -increased public fitness and health (by stimulating more walking or cycling trips)</td>
<td>-Reduced traffic congestion. -road and parking facility cost savings. -consumer savings. -reduced chauffering burdens. -increased traffic safety. -energy conservation. -air and noise pollution reduction.</td>
<td>-additional vehicle travel reductions (“leverage effects”) -improved accessibility, particularly for non-drivers. -reduced crime risk -more efficient development (reduced infrastructure costs) -farmland habitat preservation.</td>
</tr>
<tr>
<td>Costs</td>
<td>Increased capital and operating costs and therefore subsidies. -land and road space -traffic congestion and accident risk imposed by transit vehicles.</td>
<td>-transit vehicle crowding.</td>
<td>-reduced automobile business activity.</td>
<td>Various problem Associated with more compact development.</td>
</tr>
</tbody>
</table>

Table 2.5: Public transport benefits and costs
Source: http://www.vtpi.org/tranben.pdf
2.8  **Bus Rapid Transit (BRT):**

Bus rapid transit (BRT) is a city-based, high-speed bus transit system in which buses travel on dedicated routes which is adopted around the world as a sustainable ways to transport. Research indicated that shows that BRT can reduce travel time by millions of hours for commuters worldwide based on its use in cities like Bogotá, Colombia; Mexico City, Mexico; Johannesburg, South Africa; and Istanbul, Turkey (EMBARQ). BRT provides higher quality of service than traditional urban bus operations because of reduced travel and waiting times, increased service reliability and improved user experience (Diaz et al. 2004).

BRT has contributed to an urban transport transformation in the last decade. Today, more than 160 cities around the world have implemented 4,200 kilometres of bus rapid transit or high-quality bus corridors which carry nearly 30 million daily passenger trips (BRTdata.org 2013). In India Ahmedabad’s Janmarg BRT exhibited transformational benefits such as increased connectivity and increased access possibilities.

BRT is now in place in many Indian cities like Rajkot where BRT launched the first 10.7-km corridor of BRT system, Visakhapatnam, located in eastern India, opened an 18-km corridor, with 173 city buses permitted to use some portion of the BRT lanes, carrying a total of 109,000 passengers per day (Bachu 2013). Atal Indore City Transport Services Limited (AICTSL) launched trial operations for BRT-in April 2013. In Bhopal in 2013. The system is expected to eventually carry 70,000 passengers per day and include 20 high-quality air conditioned buses. The next BRT is launched at the end of 2013 in the city of Surat. Pune is currently upgrading a segregated bus corridor to a full-fledged BRT corridor and planning for full BRT systems is also advancing in Bangalore, Hubli-Dharwar, Naya Raipur, and Mumbai. (EMBARQ).

2.8.1  **Strategies for an Improved Urban Transport:**

In recent years a growing interest noticed in the development of Integrated Transport Strategies because of realisation that a “predict and provide” approach was unlikely to provide a solution to growing transport problems (Goodwin et al, 1991). It has been accepted that efforts to improve the supply of transport had to be matched by measures to control transport demand (IHT, 1996) in addition increased interest in the
role of land use planning as a complement to transport policy (Greiving and Wegener, 2003).

2.8.2 Transit Orient Development (TOD):
Research indicated that transit-oriented development reduces reliance on cars improves transit service and promotes development "without adding to sprawl". It also enables the young, elderly, poor, and disabled to access services where services are clustered together and served by efficient public transport" (Curtis et. al., 2009).

Table 2.6: Various areas for sustainable urban transport system

<table>
<thead>
<tr>
<th>Sustainable Urban Transport System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Transportation and planning governance.</td>
</tr>
<tr>
<td>Transportation planning in compressive plan</td>
</tr>
<tr>
<td>Capacity of transportation authority</td>
</tr>
<tr>
<td>2- Financing for the transportation system</td>
</tr>
<tr>
<td>Affordability of transportation system</td>
</tr>
<tr>
<td>3- Organization of space and Substations of travel by other means</td>
</tr>
<tr>
<td>Dense and mixed use developments</td>
</tr>
<tr>
<td>Road hierarchy system</td>
</tr>
<tr>
<td>Sidewalks, pedestrian ways and bike ways</td>
</tr>
<tr>
<td>Substitution of travel by other means</td>
</tr>
<tr>
<td>4- Public transport</td>
</tr>
<tr>
<td>integrated, balanced and well covered transport services</td>
</tr>
<tr>
<td>Urban freight transport</td>
</tr>
<tr>
<td>5- Personal vehicle</td>
</tr>
<tr>
<td>Uses of personal vehicles</td>
</tr>
<tr>
<td>6- Urban freight transport</td>
</tr>
<tr>
<td>Freight transport operation</td>
</tr>
<tr>
<td>7- Environment</td>
</tr>
<tr>
<td>Emission by transportation system</td>
</tr>
<tr>
<td>8- Safety and security</td>
</tr>
<tr>
<td>Safety of transportation system</td>
</tr>
</tbody>
</table>

Source: by author

2.9 Experiences from other countries:
In the United State, through Federal and State initiatives long term land use planning is coordinated through important actions like air quality controls and transportation
Sustainable Planning Strategies for an Integrated land use and Mass Transit System with Reference to Core and Fringe: “A Case Study of Pune”

There is emphasis on clear policy of compact physical development around transit stations and their routes. It is achieved through integration of public transit projects with transport planning. It consists of transport demand management techniques, public finance, impact fees, regulatory zoning controls and transfer of development rights now apply under comprehensive planning frameworks (ibid. 110-114). Much urban design in America today involves integration of public transport system with existing land use and building patterns in the interest of public (James 1996).

The strong political will can encourage greater use of public transport system via well defined land use policies. Community attitude in favour of cars is also very strong in Australia as evidenced by the predominance of strong car industries, clubs and magazines, etc., over those for cycling or greener pursuits.

The Transportation Association of Canada proposes new approaches to integrated land use, urban design, transportation planning and financing which is concerned about urban sprawl. Deteriorating built infrastructure and quality of life it proposes mixed land use strategies, innovative funding support, with balanced private and public transport. (James 1996). To create cities of social, economic and environmental equality the association demands integration of public transit system with other modes. This integration is supposed to optimize existing systems and manage trip demand.

In Britain an integrated transport and environmental policy has been a recent focus of attention. (James 1996). Planning has focused on traffic management. Public transport and pricing mechanisms are partial alternatives. Future policies for more efficient transport will require considerable change to current trends. As demanded by the British Royal Commission on Environmental Pollution (James 1996) it demands a strong shift to public transport like a light rail and parking controls to discourage vehicle usage. British cities are different from Australian in terms of their nature and lifestyles. European cities have much higher densities than in Australia. From the previous experience the green belt barrier has produced limited success in Britain to control development of urban sprawl.

The blanket application of European transport policies cannot be successful in Indian condition. There is need to consider local constraints. To achieve a balance between efficient road and public transport systems in the future city is a prime task. The alternative of freeway networks can lead to further sprawl, longer journeys and car
dependency and hence higher transport energy use and pollution rates. The problem becomes one of achieving a balance between efficient road and public transport systems in the future city.

2.9.1 Research Initiatives at International Level:

In 2000 the guidelines for environmentally sustainable transport were produced followed by development of the environmental Indicators towards the sustainable development in year 2001. In year 2003 a draft set of Sustainable Transportation principles was developed in National Round Table on the Environment and the Economy. (NRTEE - 2003) Ottawa, Canada which included concern like access, equity, individual and community responsibility, health and safety educations and public participation. Integrated planning, land and resources use result in pollution prevention and economic well being. The centre for Sustainable Transportation, Canada developed Sustainable Transportation performance indicators which defines a sustainable transportation system which has three components (Figure):.

![Figure 2.16: Transportation performance indicator in sustainable transport system](image)

Many academicians have contributed for sustainable transportation planning like Michel Neuman, from Texas university and Todd Litmen, Director, Victoria transport policy institute. Research has been carried out by Celko, J. Gavulova, A.(2009) Slovakia for modelling and simulating traffic relations where the transport network was imported into a micro simulation model in the VISSIM. New alternative transport solutions and the impact on the infrastructure loading were explored in
microscopic models. In another research real–time Information production and presentation using GIS-Based Maps for urban transportation planning was carried out by Balamohan N (2000). In this GIS Approach of Delineation and Traffic Assessment for the Traffic Analysis zone were calculated using Land use, cadastral and census data. The status of the city transport system was analyzed by Raja Noriza Raja Ariffina et al. which scrutinized the manner in which the policy schedule is adversely affected by the customs, behaviours and viewpoints of those employed in the transport-linked areas. In this research qualitative methods were used like semi-structured interviews.

Strategies to slow motorization by providing high quality public transport and coordinating land use and transport planning are effectively employed in many Asian cities like Hong Kong, Singapore and Shanghai with strong support from governments (Cullinane, 2002; Willoughby, 2001; Cameron et al., 2004; Sperling and Salon, 2002). There are many other examples of successful integration of land use and transport planning, including Stockholm and Portland, Oregon (USA) (Abbott, 2002; Lundqvist, 2003). The success in these cases s attributed to mixed-use and compact land use development with better public transport access to minimize auto dependence.

2.9.2 Indian Scenario:

In India research used a Bottom-up approach where identification and analysis of comprehensive set of transport problems were made. Potential solutions to the problem were assessed in isolation and in combination using a detailed transport model where combination which best solves the problems is taken as preferred strategy. Research issues in urban transport were identified as:

- Develop goal–oriented approach for developing urban transport strategies.
- Developing model that reflects the impact of changing Land use and/or control policies, slum development, etc., on transportation and vice versa.

Currently in India activity based modelling is not adequately developed and attempted. More realistic road layout modelling of modal split (Bi-cycle, Two wheeler, Auto, LMV, HMV walk, public transport modes) has to be developed.
2.9.3 Gap in Literature:

Plethora of literature is in existence which covers various aspects of transportation planning and its integration with land use. Most of the studies are at conceptual level where less focus on empirical work noticed particularly in Indian context. Scarce research found which address user’s perception. In establishing indicators of sustainable transportation less importance is given to contextual factors.

2.10 Summery:

This chapter presented review of literature focusing at various aspects of transportation with reference to land use. Research indicates, land use and transport decisions contribute significantly to shaping urban environments and integration of land use planning and transport planning is increasingly being acknowledged as an important component of creating sustainable cities.

Transportation problems in developing countries occur because of high densities of concentrated population. It calls for adequate land use planning to suit the conditions and environment may need to be considered to solve the transportation problems. It is evident that transport, land use and environment are inter-related in an urban development where a change in one causes an impact on the others. Transport influences not only the land use, that is the way the land is used, but also the users. Transportation problems generally occurs because of inappropriate spatial distribution of residential districts, offices, commercial complexes, factories, schools etc. as it creates inconvenience for people to travel longer through congested traffic. Inadequate land use planning result in urban sprawl characterised by an unplanned and unconstrained growth of urban development, which results in an inefficient and incomplete use of land and resources. It involves developments of low residential densities over a large land space which contributes to broader environmental problems through the interactive mechanism of urbanization and motorization. Increasing automobile dependency as a result of large scale per capita automobile travel, automobile oriented land use, and reduced transport alternatives. This is because dispersed land use patterns require a high level of mobility for a given level of Access which can be easily achieved from self-owned automobiles. It results in poor pedestrian and cycling conditions, limited transit service. Urban sprawl is inevitable phenomenon where inadequate land use planning may result in inefficient transportation network and adversely affect liveability. Behavioural theories can help
architects and planners in decision making process as people’s choice, preferences are largely dictated by their travel behaviour. Transportation planning has a strong bearing with land use pattern where integration of both is needed for sustainable development, Mass transit systems may prove instrumental in achieving sustainability goals. This chapter provided an overview of research scholarship with reference to transportation and land use integration to achieve sustainable development. The next chapter 3 presents context of research, core concepts, research methodology.