Cohesive City: Built Environment and Active Transport

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Abstract: **- Cotemporary development has transformed the city structure and urban fabric. Several studies in public health domain contemplate premeditated active transport as one of the major decisive factor in enhancing urban dwellers' quality of life. Active transport and human powered transportation includes walking, cycling and variants such as cycle rickshaws, skateboards, push scooters, hand carts, etc. These modes provide both transportation and recreation and are especially important for short trips that form the largest share of trips in urban areas. Since the built environment is the setting in which the use of active transport manifests, if a sufficient condition is not provided, it may deprive the individuals of any opportunity for the activity to occur at all. This is why it is important to study the built environment as a factor of walkability and develop knowledge about creating urban environments that are conducive for active transport. This paper discusses active transport factors at various levels. Further, the paper dwells on investigating the attributes of built environment at the street and building level.**

Key Words**: Built environment, Active Transport, Built form, Density, Connectivity, Land use diversity**

I. INTRODUCTION

Great cities provide ample prospects for all of its inhabitants to enhance their lives and ensure an unrivalled level of sovereignty, security and creativity. Several studies in public health domain contemplate premeditated active transport as one of the major decisive factor in enhancing urban dwellers' quality of life. Active transport and human powered transportation includes walking, cycling and variants such as cycle rickshaws, skateboards, push scooters, hand carts, etc. These modes provide both transportation and recreation and are especially important for short trips that form the largest share of trips in urban areas.

Active transportation is being emphasized as a sustainable form of mobility in urban planning / urban design and in public health as an opportunity for increasing recommended levels of physical activity for better health. Active transport is an easier mode of travel for different purposes for younger and elderly alike. Along with reducing congestion and having low environmental impact, it has social and recreational value while promoting physical and mental wellbeing. Built environmental attributes such as connectivity, walkability / cycleability, varied land use mix, and density have been found to be related to physical activity. Active transport needs to be considered as a legitimate transport to augment social recreational activity and to decrease the level of socio-economic as well as environmental stress. Opportunity to commute as a pedestrian /cyclist is extremely influential in one's perceptions and experiences of urban life.

A. Importance and benefits of using active transport

Apart from health benefits (such as exposure to natural space, improved physical activity and psychological health, enhancing creativity), usage of active transport provides a numerous of benefits. Walking and cycling allows in forming a place- based connection with the background, context and community of the neighbourhood and city. Furthermore, engaging in active transport facilitates social interaction strengthening a sense of place and belongingness.

Forty decades ago, urban dwellers spent one tenth of their income on personal transportation. However, today urban dwellers are spending one fifth of their income on transportation, revealing a harsh economic reality. For ex: An average Indian family spends 15% of its income on transportation only. Living and working preferences have seen a major shift, as approximately 65% of urban populace are identifying active transport as a high priority. In this context, a combination of urban planning, urban design, land use patterns and multi-modal transit systems that promote active transport will help create active, healthier and more liveable communities.

B. Correlation between Built environment and active transport

Built environment refers to manmade surroundings (city blocks, neighbourhoods, streets, open spaces, etc.) that are provided for inhabitant's activities. One of the decisive aspects that affect the use of active support either positively or negatively is built environment. Association between active transport and built environment differ across people, culture and socio-economic status. Active transportation of an urban area is the extent to which the built environment supports and encourages walking/cycling by providing for user's comfort and safety, connecting people with varied destinations within a reasonable amount of time as well as effort while offering visual interest throughout its network. The quality of built

environment is the key aspect for encouraging inhabitants to choose active transport. Analysis of built environment for the appropriateness and desirability of active transport has been considered in various fields such as transportation, urban planning, urban design, architecture, geography, psychology as well as public health. Walkability/cycleability and built environment consist of representing the correlation of active transport with distance to transit, density, destination accessibility / connectivity, street design, built form, and diversity of activities (land use mix).

Fig. 1 Attractive, articulated active transport environment

II. MEASUREABLE BUILT ENVIRONMENT ATTRIBUTES ASSOCIATED WITH ACTIVE TRANSPORT

Built environment is the backdrop in which use of active transport manifests. The condition of the built environment is often the dominant factor that influences the quality of using active transport, determining how convenient, appropriate, safe, pleasant and stimulating it becomes. A range of economic, socio-cultural associations as well as gender and age influence the way in which individuals are affected by or use of the built environment.

In urban context, active transport is short distance travel. High speed transport and the quest for efficiency are the primary reasons for declining rate of active transport. Most of the streets are losing their intimate scale as well as permeability and are devoid of public life as they are increasingly being planned and designed as automobile centric. Urban dwellers tend to choose active transport over other modes of transport, if walking/cycling is readily available as a safe, connected and pleasant activity. Perceptions of built environmental attributes influence active transport. In order to develop the knowledge on the use of active transport, it is imperative to acknowledge and understand the complexity behind walking/cycling behaviour. Walking /cycling behaviour is influenced by lifestyles, socio-cultural traditions, conscious decisions, and the built environment. These factors may also vary for different users or different kinds of active transport.

A. Quantitative measurement of Active transport

Measurement of walkability is a specific concern connected to physical aspects of built environment. It is necessary to measure the effective physical variables of built environment on walkability. Quantitative active transport measurement can be classified into direct or indirect objectives (refer Table 1).

TABLE 1: ACTIVE TRANSPORT MEASUREMENT

	Active transport measurement	**Direct method**	**Indirect method**
1	Objective measurement	Field observations referred as active transport audit	Evaluation of secondary data using different techniques and information systems
2	Subjective measurement	Surveys with potential stakeholders	Evaluation of built environment

B. Experiential qualities of the built environment

Medium to high density area with diversity and short distance access to different activities / services coupled with public transit stops can create conducive physical setting for the potential use of active transport. To positively support active transport, a built environment must have a sufficient pedestrian network to make accessible area. However, pedestrian accessibility is an important factor to make an area suitable for active transport. Variables such as environment, network and destination are the primary effective parameters of built environment and active transport (refer Table 2).

TABLE- 2: EFFECTIVE PARAMETERS OF BUILT ENVIRONMENT ON WALKABILITY

	Variables	**Features**	**Parameters**
1	Environment	• At the human scale, active transport permits for maximum appreciation and experience of the urban area. • High density neighbourhood encourages mixed use development improving accessibility to various functional and recreational activities associated with active transport.	• Aesthetics • Safety • Building orientation
2	Network	A network provides safe and comfortable use of active transport.	• Accessibility • Sidewalks • Cross walks
3	Destination	Active transport street system is efficiently used if the network provides different levels of access to various destinations.	• Land use mix and pattern • Diverse activities

Statistical analysis of active transport studies have provided evidence that walking/cycling behaviour is related to the condition of the built environment. Correlation analyses

between different attributes of the built environment and the amount of time spent commuting using active transport by individuals aim at identifying walkability factors of the milieu. Perceptual qualities such as imagebility, transparency, complexity, enclosure and human scale define the accessibility of the context and legibility of the urban structure, which affects the way people move through the city and their perceptions of the spaces.

1) Urban Structure

Urban structure is defined by the pattern and spatial composition of built forms, open spaces and streets which influence the engagement with the places that are used and the quality of public spaces in the physical sense. Well-articulated city presents imagebility of the place. It functions as the innate human ability to detect and remember patterns. Its elements are easily identifiable and grouped into an overall pattern. The urban structure is translated into route networks (i.e. streets, paths and open spaces) and the urban form (i.e. plots, blocks and buildings). The frameworks of routes and spaces connect locally and more widely the way developments, routes and open spaces relate to each other (refer Fig. 3).

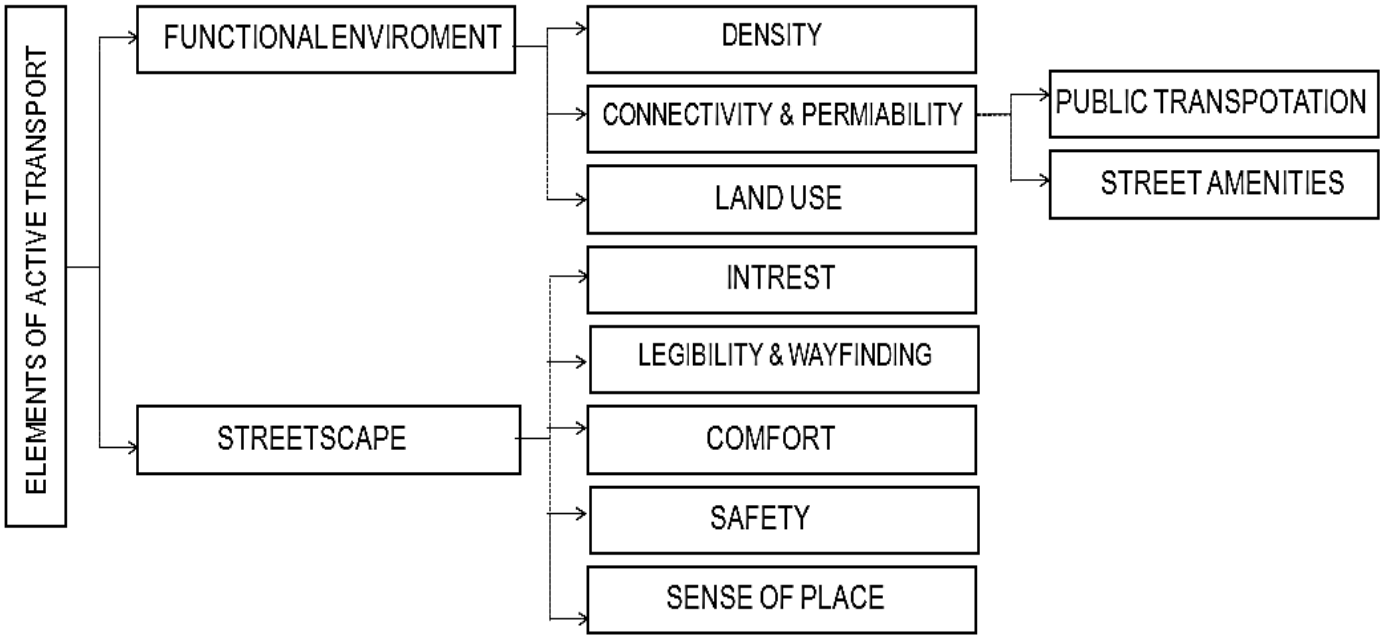

Fig. 2 Conceptual framework - Correlated elements of built environment and active transportation

The pattern of the arrangement of city blocks, plots and their buildings in a settlement produces either a fine or coarse grain. A fine urban grain creates a high level of enclosure and defined open spaces. An urban layout is more responsive to accessibility needs and way finding when it presents direct, short and legible walkways/cycle paths between places.

C. Performance dimensions of active transport oriented urban areas

1. *Density, Connectivity and fine grained land use diversity*

Density, connectivity and fine grained land use diversity factors are strongly associated with active transportation and can be explored and measured on different levels and scales which may capture different aspects of influencing the choice to use active transport. Connectivity of the path network is determined by the presence of active transport amenities. However, as patterns become finer grained and more interconnected, blocks become smaller with higher connectivity of paths. In addition to path distances to various points, it is important to examine the type of path choice. One can reach most of the daily services on foot within 10 to 20 minutes or 2 to 3 KM.

Density of path intersections and block sizes - A high density of intersections and small block sizes usually correlates with a high degree of connectivity. Barriers for active transport must be minimized. In most of the cases where a particular urban area is already built, connectivity retrofits are possible. In cases where the degree of land use diversity or density measured at the neighbourhood level is the same, the effectiveness of their influence on both the quantity and the quality of active transport may vary, according to how they are designed at the street and building level in accordance with the qualities, such as design of the ground level, number

and position of building entrances, design related to sidewalk-ground level interaction, building typologies, etc.

Land use diversity: Multiple and diverse activities encourage frequent trips covered by active transport. Diverse land use mix results in varied and interesting built environment, creating neighbourhoods which are conducive for using active transport. Beyond providing an internally well connected pedestrian network, it is important to provide connectivity with city and region through convenient and accessible links to other modes of transport within a reasonable distance - time (2 to 3 KM or 10 to 20 minute walk) to facilitate seamless navigation.

Fig. 3 Traffic control devices and pedestrian safety caution signs

2. Built form parameters

City blocks can lend both neighbourhoods and cities unique characteristics for all who live in and pass through them, while the building mass, height and street width can combine to create balanced street scenes and successful urban compositions. Besides the wide and comfortable pathways for active transport, the facades of the built forms help in connecting the people to the place. At the urban scale, the aggregation of building mass defines the form of urban blocks and streetscapes emerging into different patterns. A built form variation such as facade plane and building heights within an urban area reduce apparent mass, provides visual interest and creates a localised pedestrian friendly character.

Fig. 4

Fig.5

Fig. 4 & 5 Well articulated design - inviting and safe

Buildings should be humane in scale and provide comfort of use. The positive and transparent facades will portray more sense of welcoming which will create communication between the people and the place. The transparency of activities between the building facades will be able to facilitate the pedestrians to understand more about the place. While formulating design guidelines, investigations are required with respect to active transport in addition to developing the statistical analyses of the correlation between built environment attributes and active transport. Influences of the built environment on using active transport are examined at different levels and scales:

- Regional Planning Level- Provision of efficient multi-modal public transit
- Urban Planning Level – Density and land use diversity
- Urban design and architecture level- Street width, aesthetics, landscape design, street furniture, etc.
- Neighbourhood level – Built forms and façade permeability

3. Pedestrian density as a walkability factor

The density of active transport users in an urban area is the result of the conditions of the built environment. The temporal distribution and patterns of the number of pedestrians/cyclists are closely linked to the dynamism of the area and may enhance the experiential quality of engaging in active transport by providing increased chances of interaction (direct and indirect) with other people and activities during walking / cycling.

Therefore, pedestrian density contributes not only to the feeling of safety, but it becomes a factor promoting active transport and also possibly increasing the quantity of walking/cycling by providing the destination or reasons for walking / cycling.

4. Permeability of built forms

Assessment measures for the Permeability of built forms are produced in a form of measurement scale to determine the walkability of the study area. The assessment uses the numerical rating on a five-point scale of 1 to 5 for each of the variables. The highest point (5) is given to the areas that fulfil all criteria, which represents the highest level of walkability measured by the researchers. On the contrary, the one point scale (1) portrays the opposite condition. For example: The walkway with a width around 3 meters will score higher than the walkway with the width less than 3 meters. Notes and photographs of the actual conditions of the district and factors associated with it are notated to clarify the recorded patterns.

Fig. 6 Permeability of built forms

5. Qualities of active transport path network

Functionality of the active transport path network is important. As per "Metropolitan Sprawl Index" that considers residential density, land use mix, degree of compact development, street accessibility coupled with size of city blocks is more likely to be repeated than one that is unpleasant. The quality of the path and street network offering changing scenes and social encounters are the main factors in influencing active transport.

Along with the width of streets and paths that provide ease of movement, the identifiable landmarks, axes and nodes are important to make the places more legible and comprehensible. Apart from the street signs, the hierarchy of street patterns allows for differentiation of character and scales that can help people's orientation within the urban area.

Several qualities and attributes of active transport path network are:

- Efficient connectivity of path network, both locally and in the larger urban setting.
- Quality of paths- width, paving, landscaping, signage, etc.
- Mix of varied land use patterns
- Safety factor
- Path context- Visual interest of the built environment coupled with permeability and overall explorability

6. Active Transport: Safety and Path quality

Built environments that support fast and efficient automobile travel are not safe and interesting for pedestrians and cyclists. The non-cordial pedestrian path is the auto oriented strip, a treeless expanse dominated by several lanes of noisy traffic, polluted air, glaring lights and loud signage. Crucial streets amenities in most of the cities of developing world are nearly non-existent.

Idyllic pedestrian path will provide for the comfort and safety of pedestrians of different age groups and physical abilities. It should be wide enough, continuous with pedestrian scaled path lighting, without gaps and should have relatively smooth surface without any irregularities. Terrain can be a significant factor for active transport. Difficult terrains may require steps and railings to assist pedestrians. Encroachments into the pedestrian right-of-way should be discouraged. Landscape elements and vegetation insulate pedestrians from the vehicular traffic as well as harsh weather conditions while defining the street space. The quality of the open spaces and landscape influences the intensity of active transport.

Fig. 7 Traffic control devices and pedestrian safety caution signs

7. Active Transport: Quality of the Path Context

A safe, continuous and well-connected path network set in a monotonous physical setting is less likely to attract active transport. Mutually acknowledging aspects such as visually interesting coherence of built forms, human scale, street design, frontage permeability of the establishments, diverse activities and well framed vistas contribute positively to the quality of path context in most urban settings. Design attention should be given to create pedestrian scaled streets with varied architectural character and landscape. Design

details along the changing vista and focal points enhance experiential quality of active transport. Improved quality of several spaces on streets will enhance the overall context and structure of the district as a whole supporting active transport.

Fig.8 Attractive side walk conditions & trees for comfortable sidewalk shading

III. AMSTERDAM - KEY LEARNINGS

As compared to others, Europeans are engaged in using active transport for most of the commuting trips. In Netherlands and Germany, active transport increases with age and account for over the half trips for people age 75 and above. European countries with improvements that have been made in providing pedestrian amenities- traffic calming, pathways, signage, enforcing regulations, etc. Several clues can be taken from most of the European cities which have successfully experimented and implemented various methods for promoting active transport. Many European cities have had education and enforcement campaigns such as experimental city walks, vivid educating posters/advertisements on safety concerns, etc.

Fig. 9

Fig.10

Fig.9&10 Medium to high-density pedestrian environment with street amenities

Amsterdam can be easily placed on the top in the list of world's greatest cities owing to its ability to ensure basic necessities and lower degree of social problems. Amsterdam leads both Western European and USA in the proportion of trips made using active transport, with significantly reduced dependency on fossil fuels. Amsterdam city's sustainable urban transport systems, including an extensive network of streets, pathways, bike lanes and engaging street space for pedestrians and cyclists.

The highest rates of walking and cycling have lower rate of chronic life style related diseases. It is much safer for users of active transport in most parts of Amsterdam.

Fig. 11

Fig. 12

Fig.11&12 Amsterdam has explorable pedestrian scaled streets with varied architecture and landscape

Fig.13 Cycle pod

Fig.14 City walks and cycling can be designed to provide exciting sequence of revelations

Road facility designs, like street density, connectivity and proximity to other places, are associated with physical activity as well as other attributes of the built environment, like density and land use syntax. This is likely because most neighbourhoods of Amsterdam evolved during a time when non-motorised travel reigned supreme, meaning they are uniformly compact, mixed in their land use composition and have comparable levels of accessibility. Thus facility designs have influenced active transport and not generic land use attributes of neighbourhoods.

Fig.15 Amsterdam has done much to promote active transport, including street art

Fig.16 Engaging permeability of built forms

IV. CONCLUSION

If the view of the influence of the built environment on active transport is broadened, there are aspects of the urban environments that can be described more accurately in terms of affecting the quantity and quality of the walking/ cycling. While it is not an easy task to achieve cohesion between built forms and active transport as most of the cities have been built for automobiles, but it is not impossible to modify existing street networks with rigour and persistence. Increasing the modal share of active transport is possible in any urban area. However, the effectiveness depends on several urban area specific factors, including topography, climate, culture, political commitment, public awareness, governing policies, long term goals and attractiveness of the alternatives. One of the key parameters for active transport is urban density: Most cities in developing countries have high-density and therefore highly suitable for active transport oriented development and policies.

Several systematically planned stages should be considered to improve cohesive relation between built forms and active transport in most of the urban areas:

- Policy provisions should shift from auto-centric planning to promote active transport at all scales, from local streets to regional arterials. It is necessary to assess current active transport conditions, revise standards and regulations, behaviour of inhabitants in varied settings and pedestrian centric planning/design approach to promote active transport in urban areas.
- Regulatory authorities, planning and design professionals need to place emphasis on promoting active transport at all levels and scales. This aspect although poses several challenges, if addressed in a more proactive way can bring in substantial benefits for urban life. Cohesive city having mutually benefitting built environment and active transport can positively transform natural environment, public health and social relations.
- Current prevailing active transport conditions should be audited at various scales ranging from neighbourhood unit to region. This audit identifying several issues supports in developing more informed policies, strategies and plans that focus on active transport as a primary mode of commuting. Various stakeholders need to be involved at crucial stages of planning and designing the built environment.
- Active transport potential index can be developed to evaluate each street of an urban area, having contextual variables such as policies (policies and standards of zoning, street design, parking, etc.), built form variables (topography, land use mix, development of various destinations at different scales, connectivity, etc.) and contiguity factors (access to physical and social infrastructure).
- Exploration of behavioural patterns with regard to the use of active transport among different user groups is required to understand the most impacting design factors especially quality of the path context. Active transportation should be made operational through performance criteria.
- The major active transport factors should be quantified and assessed thoroughly at the street level as well as neighbourhood level including architectural level which would contribute to a better understanding of how and why they influence walking behaviour. Pedestrian facilities should be planned and designed to the maximum extent possible, rather than the minimum.
- Active transport is often a key element in successfully encouraging ecologically viable urban transport. It can be very attractive mode of transport for relatively short distances, which make up the largest share of trips in cities. Better active transport infrastructure, shorter travel times and enhanced safety and security are major factors in determining walkability of a city. Active transport is mostly used for short distance trips, with walking particularly relevant up to 3.0 Kms and cycling up to 7.5Kms. As up to 70% of vehicular trips cover less than 5Kms, active transport has a large potential to replace vehicular travel. Almost 5-10% of vehicular trips can be replaced by active transport provided good policies are in place. It is consequently of vital importance that the active transport modes of commuting should continue to be the transport mode of choice.
- Active transport environment can be improved with stronger linkages and better quality pedestrian network within the district as a whole. Length of some of the building blocks needs to be reduced by providing a green linkage crossing the buildings to improve permeability.

The key to reversing the trend towards more private vehicle use is making walking and cycling attractive, together with improving public transport. Active transport is a highly cost-effective transportation strategy and brings about large health, economic and social co-benefits for the urban dweller. Cities that promote active transport are more desirable as they encourage physical activity, stimulate local economies (increase property) and lessen environmental detriments caused by vehicular emissions. Generally, active transport policies and investments have a positive benefits-cost ratio, particularly when co-benefits for health, safety and quality of life are taken into consideration. Cohesive city is connected, convivial, comfortable and convenient.

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