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# Design criteria for Streets around stations through Transit Oriented Development (TOD).

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***ABSTRACT:*** *Transit Oriented Development (TOD) is essentially whether the development is macro or micro. TOD focuses on the area around the transit stop and the facilitates which provide complete ease of access to the transit facility, there by inducing people to prefer to walk and use public transportation over personal modes of transport.*
*This paper discussed reviewed many cities problems which are currently growing with a "3D" model of development such as distant, dispersed, and disconnected. Expansion without proper planning leads to spatial and social segregation, while also increasing congestion, pollution, and daily travel times. So, the research explained the Transit-oriented development (TOD) as approach for planning sustainable urban communities, then explain its elements.*
*public realm is the most important elements of TOD that connects the transit station to its surrounding district. The public realm is a network of collective spaces—sidewalks, parks, plazas, streets, and even the outdoor and storefront areas of private businesses This paper will focus on one element of public realm which are streets and put design criteria to make TOD success.*
***KEYWORDS:*** *Transit oriented development; public realm; streets; Identity, Sustainability*

## I. INTRODUCTION

Transit Oriented Development (TOD) is an admitted tool to implement Smart Growth and Sustainable Development. TOD refers to an urban design formation which achieves pedestrian-friendly, mixed-use, mixed-income, high-density and location efficient communities centered on public transport nodes. The developing of the station area relatives to its surroundings, and this doesn't mean that all TOD is uniformly big—far from it. as the surroundings have many different varieties of compactness and density.

Achieving TOD needs rich mix uses and design for public realm to create a "transit villages" livable places where the clustering of uses achieves the people's need. The full menu of activities doesn't need to be found at every station, however a lively mix of uses strengthens the link between transit and development, as station areas became places where people use transit at night and on weekends. In a TOD environment, a grid of small and navigable blocks has sidewalks throughout, with attractive amenities, lighting, and way-finding. The streets, sidewalks, plazas, and stations are safe, active, and accessible. Transit-oriented development (TOD) is a type of development that encourages public transit and a transit-friendly urban environment [8].

Peter Calthorpe codified the concept of Transit-Oriented Development (TOD) in the late 1980's and, while others had promoted similar concepts and contributed to the design, TOD became a fixture of modern planning when Calthorpe published "The New American Metropolis" in 1993. TOD has been defined generally as "a mixed-use community that encourages people to live near transit services and to decrease their dependence on driving."

## II. PUBLIC REALM OF STATION IN TRANSIT ORIENTED DEVELOPMENT

The public realm connects transit to nearby uses and gets people to and from activities. These are the collective spaces sidewalks, parks, plazas, streets, and even the outdoor and storefront areas of private businesses—that are enjoyed by transit riders, visitors, shoppers, residents, and workers. They are also the elements that physically frame the community and generate the vibrancy, the visual interest, and the ease of access that make TOD work. Good public realm design is also essential in mixing uses within a compact built environment, and in realizing

the sustainability, reduced energy use, and green building design that are increasingly recognized as a benefit of TOD. Public realm includes all publicly accessible areas including public spaces, streets and path. Public realm belongs to everyone. It comprises the streets, squares, parks, green spaces and other outdoor places that require no key to access them and are available, without charge for everyone to use as shown in figure 1[6] [8] [12] [3].

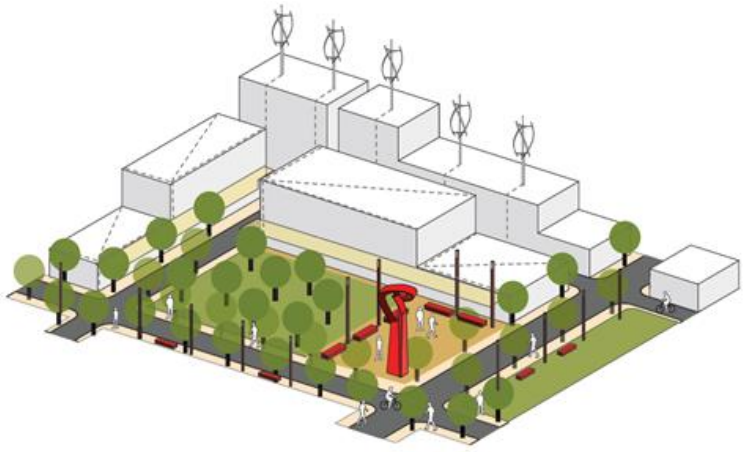

Figure 1.Public realm components [3]

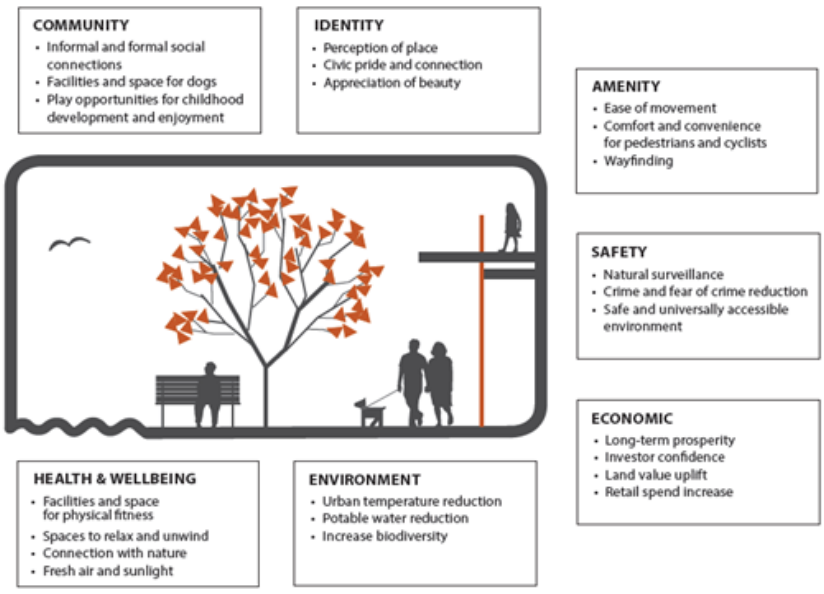


Figure 2.The value of public realm [3]

## III. THE VALUE OF PUBLIC REALM

High quality public places are vital for creating harmonious, socially inclusive communities. It is increasingly recognized that investing in quality public space generates tangible, fiscal benefits; stimulating growth in the visitor economy, raising property values and increasing income and profit for local businesses. Public realm investment has been shown to boost confidence in an area, reverse the cycle of decline and stimulate inward investment as shown in figure 2 [12].

## IV. STREETS AROUND STATIONS

A challenge for transit planners and urban designers in providing or improving access to a transit facility is in managing the approach to a transit stop or station by all the different modes of travel, which may be in conflict with one another. The fundamental goal in the design of any transit stop must be a good passenger experience. To that end, design must address several key passengers needs so they should follow from these six performance goals and should be considered in that light:

- **Connectivity:** People should be able to move directly between their origin, the transit services and their destination.
- **Universal design:** All people, regardless of physical ability, should be able to easily and safely access transit services without any unavoidable impediments or barriers
- **Safety:** People should be able to reach the transit vehicle from their origin point or reach their destination from the transit vehicle with minimal risk of being hit by a vehicle, being a victim of crime or otherwise being injured. they should feel as if they are at minimal risk .
- **Comfort:** The experience of using transit should be pleasant. People should be protected from climatic extremes like direct sun on a hot day, heavy winds or extreme cold. Where they must wait, they should be able to do so comfortably.
- **Legibility:** People getting off the transit vehicle should be able to easily identify how to get to nearby destinations. Conversely, passengers leaving nearby origins should be able to identify the existence of transit service and how to get to it [1] [6].
- **Quality:** People should perceive all public spaces as being well built and well maintained like tactile paving and color contrast, high-quality materials and signage, landmarks and good sightlines [2] .

To achieve these goals must Taking into consideration street connection, street design, Identity, Sustainability, interface, amenity and community.


Figure 3.TOD Modal Hierarchy [5]

**4.1 street access**

passengers who arrive on foot receive the highest planning priority, followed by those who arrive by bicycle or by feeder bus. A walk-in trip to the station uses no fuel and causes no traffic congestion to promote sustainable, transit-oriented development and people walking to and from stations is its defining characteristic [8].

**4.2 Street connectivity**

street connectivity is measured by block length. Shorter blocks facilitate more direct travel, placing more area within walking distance of a stop. Shorter blocks can also simplify transfers between transit routes operating on different streets. In a less regular street pattern, intersections per square 1.6 km can be a useful measure. More intersections represent more connections and more direct travel [1] .

**4.2.1 Street connectivity guidelines:**

- Blocks guideline as shown in table1 and figure 4,5,6

**Table 1.Stations area block guideline [ 14]**

| Thresholds | All new development blocks are encouraged to have:<br>One mid-block accessway for block lengths greater than 130 meters or two mid-block accessways for block lengths greater than 200 meters. | | | |
|---|---|---|---|---|
| Element | Block Dimension | Mid-Block Accessway | Alleys | stormwater detention |
| Within 400 Meters of Station Platform | 100 m width x 200 m length block size (max) . Rectangular blocks are to be oriented with the width facing the LRT alignment/corridors and the length perpendicular to the LRT alignment/ corridor. | 10 m width (min). | May be appropriate for blocks 85 m wide or greater.<br>For the Neighborhood Station Area: Provide a 6 m (min) alley width, including a 4 m vehicle throughway.<br>For all other Station Areas:<br>• Provide a 6 m (min) alley width, including a 6 m vehicle throughway.<br>• Provide lighting at 50 m max. spacing | Located in vaults or in bio-swales within curb extensions and Prohibit stormwater detention (bio-swales) adjacent to the station platform. |

- Provide streets with adequate right-of-way to support transit approximately every quarter to 800 m to create Arterial with bus service.
- Ensure connectivity between bike lanes and transit facilities, especially in low-density suburban areas and Provide pedestrian links through large sites to increase permeability of the urban fabric and provide choice for pedestrians.

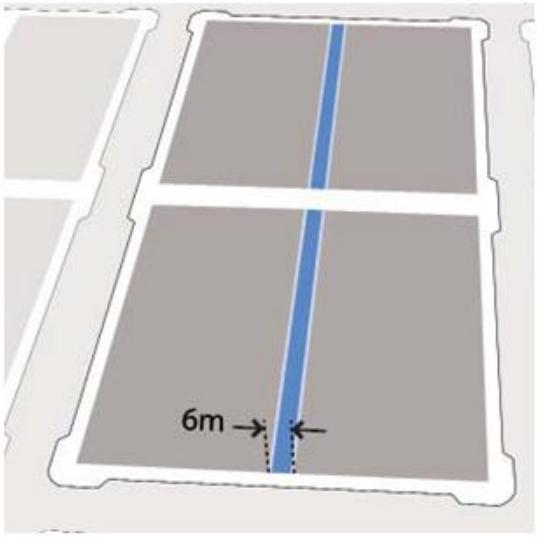


**Figure 4. Alley Accessway [14]**

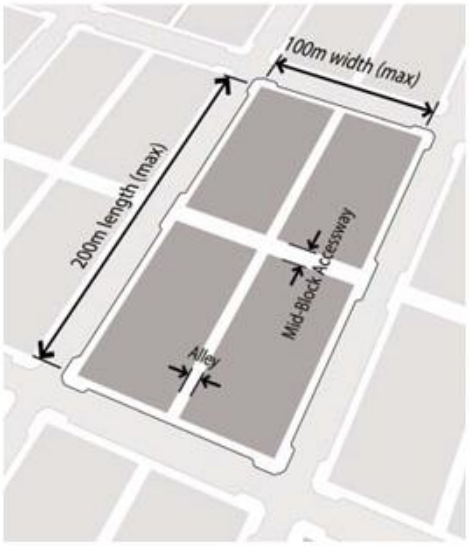


**Figure 5. Maximum Block Size [14]**

When considering a destination's distance from transit, it is important to consider the actual walking distance, rather than measuring as the crow flies. For example, a poorly connected network with large blocks and many cul-de-sacs means that the actual walking distance is much longer than the crow-fly distance. Even destinations that are physically close to a transit stop or station may still require a long walk, reducing the attractiveness of that transit service. In contrast, a fine-grained street network with many connections for pedestrians will shorten the walk to transit and other destinations by providing more direct walking routes. The traditional grid of the streetcar suburb, with main streets spaced about 800m apart and local blocks no more than 150m long, is a very effective street network for providing both a fine-grained network of pedestrian routes and efficient transit operations as shown in figure 7,8. In places where the street network is already built, it may be possible to improve connectivity for non-motorized modes by creating short-cut pathways for pedestrians and cyclists across larger development sites or to connect cul-de-sacs [7].

**4.2.2 street design**

street design must meet the needs of people walking, driving, cycling, and taking transit, all in a constrained space. The best street design also adds to the value of businesses, offices, and schools located along the roadway.

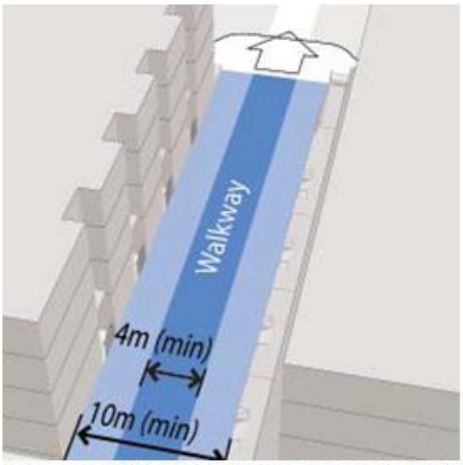


**Figure 6.Mid-Block Accessway [14]**

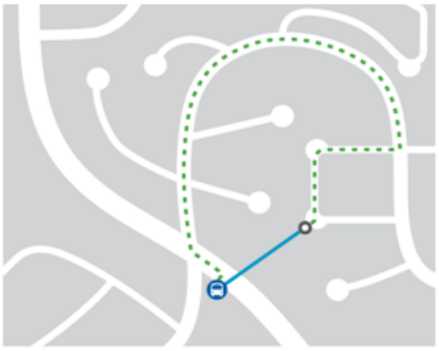

**Figure 7.Disconnected street network full of cul-de-sacs results in long walking distances and less efficient transit operations [6]**

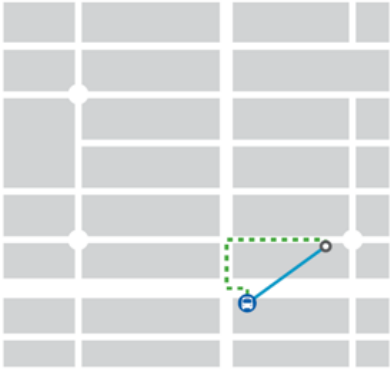

**Figure 8.A well-connected, fine-grained street network enables shorter, more direct walking connections [6].**

Building streets to support transit entails considering passenger's trip from start to finish. People walking to the transit stop should find their path safe and inviting. Dedicated transit lanes, appropriate base signal timings, and operational traffic improvements ensure that the transit vehicle experiences minimal wait

time at intersections and can move freely regardless of traffic congestion, providing a passenger experience competitive with driving. They have the potential to enhance the quality of the public realm when integrated with certain key features, such as quality bus shelters, wayfinding maps, and real-time information systems [11].
There are a variety of names to describe different types of streets. A typical street hierarchy, from large to small:

- regional collectors
- arterials
- main streets
- collectors
- local collectors
- local streets

Each functional classification in the hierarchy has a different cross-section or allocation of space. A freeway has six or more travel lanes for high-speed vehicles and no pedestrian access, while a local street may have two lanes, on-street parking and slow traffic mixing with pedestrians. It is important to realize that a street classification alone does not fully describe the functional needs of a street. The surrounding context greatly affects the use of a street. In a commercial area, an arterial may have one or two travel lanes in each direction, parking to support adjacent shops and wide sidewalks to provide for large numbers of people strolling, outdoor cafes and amenities like trees and benches. The same street in an industrial area may have more lanes, no parking and basic sidewalks.

Transit corridors including light rail (LRT), streetcar, and bus rapid transit (BRT), promote economic development around high-quality transit service while fostering a pedestrian scale in which walking and biking actively complement public transit. As major generators of pedestrian traffic, heavy surface transit routes should be prioritized for pedestrian safety improvements in both the immediate surrounding area and major access routes within the transit access shed [11] .

**Street design considerations:**

- The travel way realm of the street:

Provide lanes that are as narrow as is reasonable. Wide travel lanes promote higher speeds and increase pedestrian crossing distance. Where right-of-way is limited, wider lanes also mean less space for the pedestrian realm. Every added lane increases pedestrian crossing distance, pedestrian travel time and the risk of auto-pedestrian accidents.
Vehicle speed plays a critical role in the cause and severity of crashes so looking at how appropriate street design can make our cities safer as shown figure 9 [10].

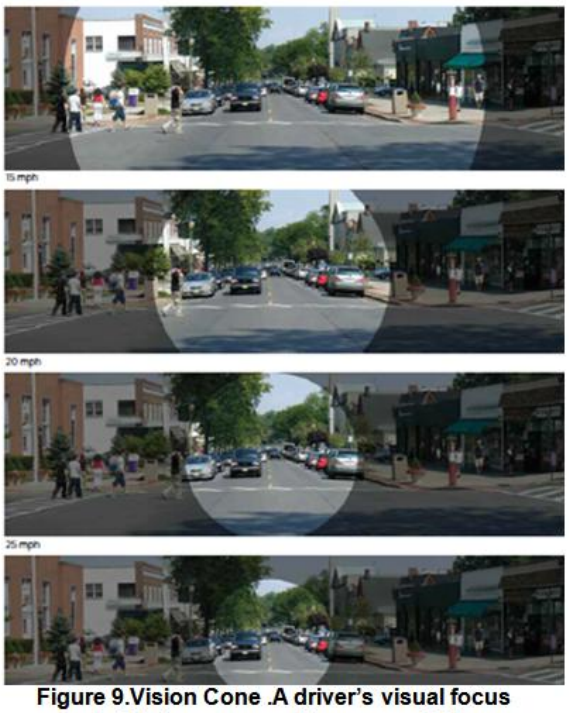


**Figure 9.Vision Cone .A driver's visual focus diminishes as speed increases [10].**

Design intersections with corners as tight as possible. This makes intersections safer for pedestrians in two ways: reduces the length of crosswalks and forces cars making right turns to slow down. It increases pedestrian space at intersections, where pedestrians bunch up as they wait to cross.

Design streets to accommodate bicycles. Bicycles can be accommodated with shared lanes, with striped bike lanes, or with separate bike lanes. Careful street design and signage can minimize the risk of accidents. Shared travel lanes should be included on smaller streets with marked, separate paths for bicycles on primary routes. Streets with speeds exceeding 35 mph should include a separate, striped bike lane. Bike lanes must have smooth pavement. Grates can be a hazard to bicyclists and should be designed and located carefully [9].

Provide on-street parking whenever possible. On-street parking provides a buffer between pedestrian and other motorized or nonmotorized traffic.

- Intersections

Crosswalk markings delineate a safe path for pedestrians to crossing while also signaling to motorists to prepare to yield or stop which Provides a direct, visible, and accessible path for pedestrians to cross the street , Improves and reinforces the pedestrian environment , Provides safe access to destinations and Alerts motorists to stop for pedestrian crossings [15] [16].

Decorative pavement materials can utilize different colors, textures, and patterns to distinguish crosswalk markings and/or intersections in certain environments as shown in figure 10.

Advanced yield markings consist of a row of white triangles placed across each approach to alert motorists to yield for pedestrians at unsignalized or uncontrolled crosswalks [15].

Corner bulbouts are curb extensions at intersection corners, making vehicular turning movements safer and pedestrian crossings shorter as shown in figure 11.

Provide complete pedestrians crossings at every intersection. Forcing pedestrians to detour to a major intersection to cross a street can greatly increase trip time and thus discourage pedestrian activity. Provide safe and protected pedestrian crossings at each corner of the intersection. Eliminating a crossing on one side of an intersection can triple the distance and time it takes for a pedestrian to cross a street. This inconveniences pedestrians and encourages jaywalking.

Time traffic signals to allow pedestrians ample time to cross a street. Children and the elderly require one second for every 3.5 ft. Traffic signals must be designed to function for all modes, including bicycles and the visually impaired.

**Figure 10.Decorative pavement materials [15]**

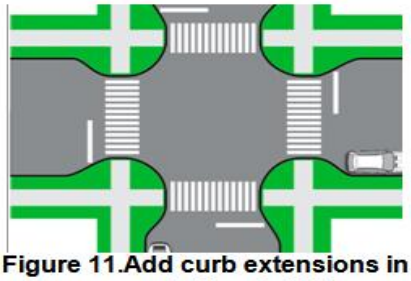

**Figure 11.Add curb extensions in corner bulbouts [15]**

Figure 12.Intersection serves cars, pedestrians, bicyclists and transit [1].

**Figure 13.Double ramps align with crosswalks directs pedestrians into traffic [1].**

Provide compliant wheelchair ramps (two per corner) at all intersections. A single ramp directs the disabled diagonally into the center of the intersection and into the path of traffic . it also encourage cars to cut the corner and Provide enough illumination to light all four corners of urban intersections with striped crosswalks as shown in figure 13 [1].

**4.3 street identity around stations**

Provide a unified approach to the design of each street consistent with the standard materials palette that aims to embed a long-lasting, legible and distinctly and the standard materials palette should be used for all new and future modifications to existing streets.

Ensure the choice and location of materials and street furniture assist the overall composition of streets by:

- Maintain consistent materials, layout and geometry regardless of staging of works to protect the street's visual character and support legibility and predictability and Minimize clutter and group streetscape elements together to ensure legibility and usability of the street.
- Use the simplest standard applicable to avoid unnecessary maintenance and ensure long-term functionality.
- Use the same materials and details in private and public streets [3].

**4.4 Improve sustainability of streets**

Design public streets to contribute to sustainable outcomes and maximize environmental values and encourage walking and cycling, minimize pressure on non-renewable resources and enhance the existing natural environment.

Streets are important landscape features within the urban environment. They accommodate tree planting and other landscape treatments that provide pedestrian amenity and improve biodiversity and microclimate. Streets can also contribute to sustainability outcomes through integrated functional solutions such as permeable paving and tree pits that filter and harvest storm water run-off.

Increase tree planting to reduce the extent of hard surfaces and improve canopy cover to reduce the heat island effect - aim to achieve 40% canopy cover in all new streets and Ensure adequate soil volumes and soil moisture is provided to enable healthy tree growth and Use permeable pavements where applicable to enhance street tree growth and Encourage Water Sensitive Urban Design for stormwater harvesting in streets.

Prioritize walking, cycling and public transport in streets to reduce the dominance of vehicles and minimize greenhouse gas emissions and local air pollution as shown in figure 14[3].

**Figure 14.Sustainable environment in streets [3].**

**4.5 Interfaces of street around stations**

An enjoyable street front experience for pedestrians is a hallmark feature of TOD. While streets in most conventional communities function mainly to move vehicles, the streets in transit-oriented towns and neighborhoods are designed primarily to organize social and economic activity. TOD streets certainly allow for automobile circulation, but they are also as much a part of the open space system as parks and. The zones between building fronts and streets are often the most dynamic of all collective spaces in the TOD. They purposely blur the line between public and private areas, encouraging shopping and

**Figure 15. Design the street front around the pedestrian [8]**

eating to come outdoors and directly engaging people as they walk by Creating a visually interesting, functional, and comfortable street front experience requires several inter-related elements, including high quality pedestrian zones between the building front and street, pedestrian uses, and pedestrian-scaled architecture as shown in figure 15 [8].

Ensure all building interfaces with public streets contribute positively to the life of the street and encourage ground-level tenancies that contribute to the life and character of the street by:

- Provide ground-level tenancies with active frontages, such as retail or cafes, to public streets as a minimum 80% active street frontage for key areas of public activity and 50% active street frontage for all other areas.
- Ensure streets provide adequate space for uses such as outdoor dining.

- Provide ground-floor edges which accommodate a wide range of uses and provide a fine grain to streets. Fine-grain spaces relate to the scale of our bodies and offer a variety of sensory stimulations that can be appreciated at a pedestrian pace.
- Design external facades (facade depth, color, fenestrations, vertical or horizontal modulation, detailed articulation, texture and materiality) so they contribute to the human scale of the street and visual interest for pedestrians.
- Consider the macro scale (the appearance of the building from afar) and the micro scale (the sensorial experience materials and detailing provide to the pedestrian) in the building form and facade.
- Avoid large expanses of floor to ceiling glazing as this does not provide adequate variation or interest.
- Avoid the use of opaque, translucent or other non-transparent glazing treatments that restrict visibility between internal and external spaces. Whilst transparency is encouraged, it is also important to make provision in the design of facades for areas that require privacy or uses that will result in unsightly views from the street. In all instances, but, completely blank facades must be avoided.

Reduce and manage parking to encourage walking, cycling and other uses that are conducive to vibrant streets by ensure parking entries don't detract from pedestrian amenity and street interface and Minimize the impact of podium car parking on streets by sleeving the car park in active uses and/or animated treatments at first-floor level and above [3].

**4.6 Amenity movement around stations**

open to the sky' policy is favored for streets rather than an enclosed mall-type environment. Overhead bridges are also discouraged where they take public life and activity from the street level. This is not to say that weather protection might not be provided in the form of canopies or glazed atriums to fulfill a particular function

- Where possible, provide canopies along building frontages on streets particularly on key pedestrian routes
- establish a continuous and consistent street tree structure.
- Ensure safety, accessibility and visibility for all users including disabled and non-ambulant people.
- Provide amenities that support pedestrian and bicycle use such as compliant seats, bike racks, drinking fountains bins and public toilets.
- Ensure legibility of the streetscape and provide consistent signage and wayfinding to assist pedestrian movement.
- Provide a choice of protected routes as shown in figure 16 [3] [4].

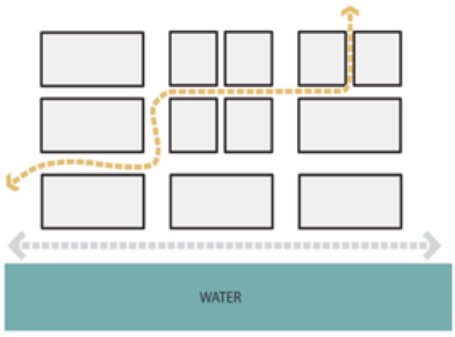


**Figure 16.Cities such as Brighton (UK) and Scarborough (UK) have intimate and protected routes in the 'hinterland' of the primary waterfront [3].**

## V. CONCLUSION

TOD is a tool for achieving great public realm, mixed use and density, and the careful integration of transit area. public realm is the most important elements of TOD that connects the transit station to its surrounding district. The public realm is a network of collective spaces streets, sidewalks, parks, plazas, and this paper focus on streets around stations which concentrate on streets access to stations and put passengers who arrive on foot receive the highest planning priority, followed by those who arrive by bicycle or by feeder bus and care with street connectivity and identity and interface of streets and achieve sustainability and amenity to streets and spaces around stations.

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