Cool Walkability Planning

Shadeways (covered sidewalks) and pedways (enclosed, climate controlled walkways) can provide comfortable walkability in hot climate cities. The Cool Walkshed Index can help plan these facilities.

3 August 2023
By Todd Litman

Summary
As the world becomes hotter and more urban, pedestrians increasingly experience excessive heat, often exceeding 90°F (32°C) and sometimes 110°F (43°C). This makes urban walking uncomfortable, unattractive and dangerous, leading to ill health, isolation, traffic problems, automobile dependency and sprawl. To address these, hot-climate cities should plan for pedestrian thermal comfort. This can be accomplished by creating integrated networks of shadeways (shaded sidewalks) and pedways (enclosed, climate-controlled walkways) that connect homes, commercial buildings and public transit within urban villages (compact neighborhoods where most services and activities are easy to reach without driving). Although these cost more than basic sidewalks, they can greatly improve walking comfort and are far cheaper than motor vehicle infrastructure. They can provide many economic, social and environmental benefits. Analysis in this report indicates that pedway and shadeway networks can often repay their costs through road, parking and vehicle savings, and by increasing local business activity and property values.

This report examines why and how to improve urban walkability in hot climate cities. It describes the Cool Walkshed Index (CWI) which rates shadeway and pedway network quality, suitable for planning applications. Currently, most cities have CWI ratings of D-F, which makes walking unpleasant and dangerous during hot periods; they should strive to achieve A-C in order to ensure that residents and employees always have comfortable pedestrian access to common services and activities. Achieving such targets requires that decision makers recognize the unique and important roles that walking plays in an equitable and efficient transportation system, and prioritize walkability improvements in planning and investment decisions.
Introduction
Nearly all modern automobiles and transit systems have air conditioning for passenger comfort. In hot climate cities, parking lots are often shaded to cool vehicles, as illustrated below. This report investigates why and how communities can provide similar comfort to pedestrians.

Figure 1  Shaded Parking in Dubai

In hot climate cities parking lots often provide shade to keep vehicles cool. This report investigates why and how communities can deliver similar comfort to pedestrians.

Walking (including variants such as wheelchairs, hand carts, and lower-speed scooters) is the most basic mode of travel; it provides efficient mobility, exercise and enjoyment. Improving walking conditions and increasing walking activity can provide various benefits as summarized below.

Table 1  Walkability Benefits (Litman 2023a)

<table>
<thead>
<tr>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
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<tbody>
<tr>
<td>User savings</td>
<td>Improved fitness and health</td>
<td>Reduced noise</td>
</tr>
<tr>
<td>Road and parking cost savings</td>
<td>Crash reductions</td>
<td>Reduced air pollution</td>
</tr>
<tr>
<td>Increased retail sales and property values</td>
<td>Community cohesion and security</td>
<td>Reduced pavement area</td>
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Walking is a common mode of travel, serving 12-25% of total trips, as illustrated below, with higher rates in cities, in areas with good walking conditions, and among lower-income residents.

Figure 2  Pedestrian Mode Shares in Various Countries (Buehler and Pucher 2023)

In OECD countries, 12% to 26% of total trips are made by walking, with higher rates in more compact, walkable and lower-income areas.
Despite its importance, walking currently receives relatively little support. Most communities spend less than $50 annually per capita on sidewalks, crosswalks and paths, which is less than 2% of their total transport infrastructure spending (Litman 2023b), and far less than most indicators of walking demand such as share of total trips, traffic deaths, frequent users, and mode share targets, as illustrated below.

**Figure 3**  Walking Infrastructure Spending Versus Indicators of Demand (Litman 2023b)

This is unfair and inefficient. It makes walking uncomfortable and unsafe, particularly for vulnerable groups (children, seniors, people with disabilities and low incomes), and shifts travel to more costly and unhealthy modes for trips that, given better infrastructure, would be made by walking. Planners are starting to appreciate the unique and important roles that walking and its variants (wheelchairs, scooters, hand carts, etc.) play in an equitable and efficient transport system. Many cities are planning 15-minute neighborhoods, or what I prefer to call urban villages, where commonly used services (shops, schools, parks, public transit, etc.) are located within convenient walking distances of most homes and worksites.

Of course, the devil is in the details. Walkability planning must reflect a community’s unique conditions, including climate. Global warming and urbanization are increasing the portion of people living in cities that experience extreme heat, where temperatures often exceed 90° Fahrenheit (32° Celsius) and sometimes 110° Fahrenheit (43° Celsius). These conditions make walking uncomfortable, unattractive and unhealthy (GHIN 2023; Goodell 2023; Gössling, et al. 2023; Sherriff 2023; WHO 2018).

**Figure 4**  Cities Predicted to Experience Extreme Heat by 2050 (UCCRN 2018)

Approximately 200 million people in 350 cities currently experience summer temperatures exceeding 35°C (95°F). Even at this level heatwaves are the deadliest of all climate risks. Scientists predict that by 2050 around two billion people living in 970 cities, shown in this map, will experience extreme heat, including temperatures over 43°C (110°F).
Here in Canada we face a similar but opposite problem: extreme cold. Many cold climate cities have extensive pedway networks; enclosed walkways that connect buildings to commonly-used services and to public transit stations, making it easy to get around by walking during unpleasant weather. Chicago, Edmonton, Montreal, and some Asian and European cities also have well-developed pedways networks.

A good example is Toronto’s PATH Pedway Network. It has 30 kilometers of enclosed walkway that connect the City’s downtown, entertainment and financial districts, including more than 75 buildings, six subway stations, the main train station, three major department stores, nine hotels, and many tourist and entertainment attractions such as the Hockey Hall of Fame, Roy Thomson Hall, and City Hall. Each pedway segment is managed and maintained by the owner of the property through which it runs; about 35 corporations are involved. Their operating costs are repaid through higher property values and rents paid by shops incorporated into the network.

Figure 5  Toronto PATH Network (Toronto 2021)

This report investigates ways to improve and encourage walking in hot climate cities. It describes how planners can evaluate pedestrian comfort using the Cool Walkshed Index (CWI) which rates pedway and shadeway network quality, suitable for planning applications. It analyzes the potential savings and benefits from shadeway and pedway networks, and how these can be financed through value capita. Some of the concepts can also be applied to bicycling (Williams 2023). This information should be useful for pedestrian advocates and planners in hot climate cities.
Walkability Planning
Pedestrian access is measured by walksheds, that is, the area that can be reached on foot within a reasonable time period; typically 5-15 minutes (0.2 to 1.0 miles, or 0.3 to 1.5 kilometers) for errands and 10-30 minutes (0.4 to 1.5 miles, or 0.6 to 2.0 kilometers) for commutes (Steuteville 2017). Simplistic walkshed indicators measure walking distances as the crow flies, but crows don’t walk and pedestrians can’t fly! New mapping systems show realistic walksheds, taking into account sidewalk networks and geographic constraints, as illustrated below. This can be described as an urban village.

**Figure 6** Walkshed Map (*Esri 2018; Zurn 2021*)

A successful urban village needs enough people (residents and employees) to support commonly-used services (shops, schools, entertainment and religious institutions) and high quality public transit within its walkshed. **Walk Score** is a useful indicator; it measures the density of services within walking distance but provides little information on walking conditions such as the quality sidewalks and paths, road traffic and topography. Various pedestrian level-of-service, walkability indices and **Universal Design Standards** rate walking conditions. Climate, including cold, wind, rain and heat, also affect walkability. The following section describes ways evaluate pedestrian thermal comfort, particularly in hot climate cities.

**Figure 7** Walk Score Map of Nashville (*Walkscore*)

Walk Score maps indicate the density of services and activities within walking distances, but provide little information on the quality of walking conditions.
Hot-Climate Walking Comfort
Outdoor physical activity, including walking, is uncomfortable and unhealthy in temperatures over 90°F (32°C), particularly with high humidity (WHO 2018). Many communities already experience extreme heat, and this is likely to increase with global warming and urbanization (UCCRN 2018). A recent study, “Quantifying the Human Cost of Global Warming,” predicts that climate change will increase the number of people who suffer from excessive heat from about 600 million now to about 2 billion by 2030 and 3.7 billion by 2090 (Lenton, et al. 2023).

Extreme heat is particularly severe in cities due to the heat island effect, which increases ambient temperatures 1-7°F due to more dark surfaces (pavement and roofing), reduced greenspace (such as tree cover), and heat-generating activities (fuel and electricity consumption) (USEPA 2023). Pedestrians experience heat discomfort and risks when walking on unshaded sidewalks because they are physically active and absorbing heat from the sun above and radiated from below.

There are many ways to reduce urban heat exposure including designing building for natural and mechanical cooling, providing shade, and increasing greenspace and tree cover (Chaudhry 2011; Ladd and Meerow 2022; Litman 2022). Pedestrians can be protected with shadeways (shaded sidewalks) and pedways (enclosed, climate-controlled walkways). The Abu Dhabi Urban Street Design Manual (ADUPC 2009) and Abu Dhabi Public Realm Design Manual (ADUPC 2010) include detailed design guidelines. To be effective these must be planned as integrated networks to provide convenient and comfortable pedestrian connections between homes, services and public transit within a compact community.

Figure 8  Traditional Streets are Narrow and Shaded (John & Tina Ried)

*Traditional hot climate urban design includes narrow, shaded streets that provide natural cooling.*
Some traditional urban buildings have colonnades that provide cool walking corridors.

A line of large trees can provide excellent shade for sidewalks and paths, but they require adequate space plus reliable water, and take many years to grow.

Trees can provide beautiful shade, as illustrated above, but they require adequate space plus reliable water, and take many years to grow. Trees alone seldom provide sufficient shade (more than 80% of sidewalk coverage); structures are often needed. There are many possible designs, including metal, wood, bamboo and fabric, as illustrated below. Awnings also provide protection from heavy rain. In extreme dry heat, walkways can incorporate misting systems to provide natural outdoor cooling, but these add costs, consume water, and are not generally suitable for large areas (The Plumber 2016).
Figure 11  Structured Shadeway in Dubai

Figure 12  Commercial Shadeway Structure (Darshan Industries)
Shade canopies can incorporate solar panels, such as the 196 meter walkway connecting the Singapore Discovery Centre with a nearby bus-stop, illustrated below. These can power pedway cooling systems.

Sidewalk canopies, such as this 196 meter walkway in Singapore, can incorporate solar panels to provide both shade and electricity.

Currently, most shadeway and pedway planning is ad hoc, built where they are visible and convenient to construct, not necessarily where they are most needed. A more systematic approach is needed to plan integrated hot-climate pedestrian networks.
The Cool Walkshed Index

To facilitate hot climate pedestrian planning I designed the Cool Walkshed Index (CWI) summarized below. This can be used to evaluate pedestrian thermal comfort for a destination or area. CWI ratings can indicate which sidewalks, paths and roads have inferior, adequate or excellent hot-climate walkability. CWI maps can be used to evaluate a building or neighborhood’s hot weather pedestrian accessibility between homes, services, jobs and public transit; identify where shadeways and pedways are justified, and set targets for improvements.

**Cool Walkshed Index (CWI) Ratings**

A: Connected to a continuous, enclosed, climate controlled pedway that provides access to commonly-used services (shops, restaurants, social and cultural activities), and high quality public transit stations.

B: Located within 1,000 feet (300 meters) of a pedway entrance where ambient temperatures frequently exceed 100° Fahrenheit (38°Celsius); and within 300 feet (100 meters) of a pedway entrance where temperatures frequently exceed 110° Fahrenheit (43°Celsius).

C: Connected to a continuous shadeway (walkway with at least 80% shade coverage during mid-day) that provides access to commonly-used services and high quality public transit, with shaded transit waiting areas.

D: Connected to a continuous but unshaded walkway that provides access to commonly-used services and high quality public transit.

E: Connected to an incomplete walkway that provides inadequate access to local services and public transit.

F: Has major barriers to walking to local services and public transit.

Cool Walkshed Index (CWI) indicates the quality of walkability that serves a destination or area, taking into account thermal comfort. These values may be adjusted to reflect specific conditions and needs.

Currently, most buildings and neighborhoods have CWI ratings of E (incomplete and largely unshaded sidewalks and paths) or D (complete but largely unshaded sidewalks and paths) to nearby services and activities. Few neighborhoods have well-developed shadeways that provide C ratings, or pedway networks that provide B or A ratings.

CWI ratings can help individuals make better location decisions and communities make better planning decisions. For example, families may choose homes with higher CWI rating, and can rationally pay more if improved walking comfort increases their exercise and enjoyment, and reduces their vehicle expenses. Developers and property owners can justify helping finance neighborhood shadeways or paying for a pedway connection in order to raise their CWI ratings.

Of course, shadeways and pedways must be properly designed and managed. They should reflect universal design principles to accommodate all types of users including people with disabilities, families with children, travellers with hand carts and wheeled luggage (NTA 2021). They should be designed with sufficient capacity to avoid crowding, and well maintained for comfort, safety and attractiveness. Shadow analysis can help evaluate shadeways (Rodriguez 2020). Shadeways should block at least 80% of sunlight on sidewalks and paths during summer mid-days (10:00 am to 4:00 pm).
Pedway Network Examples

Many cities have pedway networks (basement versions are called underground cities and elevated versions are called skyways), although most are limited in scale, serving only a portion of destinations and walking trips (Cui 2021). Toronto’s PATH network, described earlier, is one of the most complete, with more than 30 kilometers of enclosed walkway that connect directly to or close to most downtown buildings, public transit stations, and attractions (Toronto 2021). Chicago, Edmonton, Montreal are other cold-climate cities with extensive pedways.

**Figure 15  Downtown Chicago Pedway Map (Style Chicago 2017)**

Downtown Chicago has approximately five miles of underground and overhead pedways that tens of thousands of pedestrians use each day to access public and private buildings, rail stations and popular attractions such as parks, museums and recreational facilities.

There are also pedway networks in hot climate cities. Hong Kong has two multi-level walking networks, the Central System and the Admiralty System, which connect many buildings, transit stations and attractions. It was built over the last half-century by the Hong Kong Government and major downtown developers. The network includes wide elevated and shaded pathways separated from traffic, plus air conditions corridors in commercial buildings. It straddles Connaught Road Central, a busy expressway (Tan and Xue 2014). This network is criticized for favoring automobile traffic over walking, and reducing sidewalk activity (Ponting and Lim 2015).

**Figure 16  Hong Kong’s Pedway Network (Wikipedia)**

Hong Kong’s pedway network includes wide elevated pathways separated from traffic, and mostly shaded, with and some air conditions corridors in commercial buildings.
Bangkok’s Skyway system is suspended between the elevated Skytrain tracks. It is promoted as a convenient and comfortable alternative to walking on city streets with cracked and crowded sidewalks and crossing busy traffic, but as of 2020 only 15% of the proposed system is completed and progress is slow (BigChili 2020). It is financed by private businesses, with minimal government support. Kuala Lumpur’s Bukit Bintang Walkway, completed in 2012, is a 1.2 kilometer enclosed and air conditioned pedway that connects the Convention Centre, shopping malls, hotels and other major destinations.

Figure 17  Bukit Bintang Walkway (Foongpc 2013)

Kuala Lumpur’s KLCC - Bukit Bintang Walkway connects a convention center with shopping malls, hotels and public transit stations in a downtown that is otherwise not very pedestrian friendly.

Singapore’s J-Walk is a network of approximately 25 kilometers (15 miles) of elevated and underground pedestrian walkways that connect commercial, health-care and institutional developments to public transport stations. It is developed by Singapore’s Urban Redevelopment Authority, which has plans to create pedways around major transit stations, as illustrated below (Leow 2008).

Figure 18  Singapore Western Region Pedway Plan (URA 2019)

Singapore’s Urban Redevelopment Authority has plans to develop J-Walk pedestrian facilities around most rail stations, creating walkable, transit-oriented neighborhoods. It envisions widening existing footpaths and bike lanes, and lining them with shade trees for a pleasant walking and bicycling experience.
Seoul, South Korea has a well-developed underground network that connects metro stations to popular attractions such as shopping centers and museums; Myeongdong and Hoehyeon underground streets are the most famous. Taipei, Taiwan has underground pedways connecting many metro stations, a large underground shopping mall that connects to the main train station. Underground streets connect the Taipei Station with nearby shopping malls and other attractions.

Many Chinese cities have underground pedway networks. The largest is in Zhujiang New Town which connects metro stations to the basements of over 35 office towers, numerous shopping malls, medical centers, and other downtown attractions. Harbin has several large, multi-level underground shopping areas such as the roundabout intersection of Xida Zhi street and Hongjun street, where three levels of markets following streets from four directions meet under a giant atrium. Hangzhou’s Wulin Square has an underground mall to a subway station and nearby office buildings. Guangzhou has more than 16 pedways around rail stations. Nanjing has an underground mall around Xinjiekou metro station. Qingdao has two small underground shopping areas.

Dubai’s Metro system has beautiful stations, some with enclosed walkways over busy highways, such as the half-mile pedway between the Burj Khalifa Station and the Dubai Mall, illustrated below. Dubai has proposed but not built enclosed air conditioned bikeways (Leigh-Hewitson 2023).

In 2009 the Dubai Road and Transport Authority (RTA) announced plans to build air-conditioned pedways to link major buildings, shopping centres, Metro stations and bus stations (Ahmed 2009). The RTA presented a pedway planning methodology at the 2011 International Association of Public Transportation meeting. The engineering firm Arup developed various pedway designs that include air conditioned and naturally-ventilated walkways, and shaded sidewalks (Dunn 2009). They explain,

Arup’s microclimate experts modelled thermal comfort and sensations over time starting from walking in the winter sun to define a comfortable transient sensation level. They analysed transient comfort, considering walking speed, metabolic rate and walking distances. This led to the proposal that the pedway would need air conditioning at regular intervals to bring thermal sensation back down between naturally ventilated sections.
Benefits and Costs
Potential shadeway and pedway benefits and costs are described below. For additional information on these impacts see “Evaluating Active Transport Benefits and Costs,” (Litman 2023a).

Benefits

Improved user comfort and fitness. Pedestrian improvements directly benefit walkers, and by increasing walking activity improve public fitness and health. Because physically and economically disadvantaged people tend to rely more than average on walking and particularly vulnerable to heat, they can benefit significantly from shadeways and pedways that accommodate their travel needs.

User savings. Residents of walkable urban villages typically own about half as many vehicles, drive about half as much, and spend about half as much money on transportation as in automobile-dependent areas (Housing + Transportation Affordability Index; Schneider, Handy and Shafizadeh 2014). This can provide thousands of dollars in annual savings per capita.

Increased property values. Residential and commercial property values tend to increase with improved walkability and access to high quality public transit services (Boyar 2016). One study found that 10-point increase in Walk Score is associated with a 5% to 8% increase in commercial values (Alfonzo 2015) with even larger gains from proximity to high-quality transit stations (Smith and Gihring 2022).

Increased local business activity and tax revenue. Businesses located in walkable commercial districts tend to have more customers and sales (ALR 2013). One major study found that improving walkability can increase local sales up to 80% (Alfonzo 2015). This can increase property and sales tax revenues.

Reduced traffic problems. Improving active travel conditions can reduce automobile travel and associated costs. Urban village residents typically make about half as many vehicle trips as in conventional, automobile-oriented areas, which reduces road and parking facility costs, traffic congestion, crash risk and pollution emissions (Schneider, Handy and Shafizadeh 2014).

Travel Impacts
Many shadeway and pedway benefits depend on the amount that they increase walking and reduce automobile travel. Shadeways and pedways can significantly increase walking and reduce driving, particularly in affluent cities where many travellers can afford to drive (CPSTF 2017). Neighborhoods with excellent walkability often have 20% to 50% walking mode shares and much lower vehicle ownership and use than in auto-oriented areas (Buehler and Pucher 2023; C40 2019). Ambient temperatures significantly affect walking, particularly by women, children and seniors (Shaaban, Muley and Elnashar 2017). Shaaban and Muley (2016) found that in Doha, Qatar, walking trips declined 57% during summer days, when temperatures ranged from 35-42°C (95-108°F), compared with winter when temperatures ranged from 20-28°C (68-82°F). Public transit ridership also declines in hot conditions (Shaaban and Siam 2021).

To maximize benefits shadeways and pedways should be developed in compact, mixed urban villages where many homes and worksites are located within walking distances of commonly-used services (shops, restaurants, schools, and high quality public transit); with excellent taxi/ridehailing, carsharing and public transit services, so households do not need to own private automobiles; unbundled parking so residents and workers are not required to pay for parking facilities they don’t need, and with transportation demand management (TDM) incentives that reward travellers for reducing their vehicle ownership and use. Together, these factors can maximize travel impacts, benefits, and economic returns.
Costs

Shadeways and pedways are relatively costly compared with basic sidewalks and paths. A typical sidewalk costs $50 to $150 per linear foot, depending on materials and conditions (Litman 2023a). Adding a sturdy canopy can double those costs, and enclosed pedways are even more expensive, particularly if they require tunneling or overhead structures, with escalators and elevators for universal access. However, they are inexpensive compared with urban highways and parking facilities. Property owners may face additional construction, operating, administration and liability costs.

Urbanists sometimes criticize pedways for being sterile, privatized spaces that remove pedestrians from the public realm, reducing access to smaller shops and street activity, and excluding lower-income people (Ponting and Lim 2015). They are also criticized for their air conditioning energy consumption. Such criticisms may be legitimate to the degree that travellers choose between walking in pedways or vibrant public sidewalks but not where travellers choose between pedway walking and driving. Well-designed pedways networks can reduce automobile traffic and associated costs, making city living more attractive and successful, reducing sprawl and sprawl-related costs.

Pedways can be planned to maximize walking quality and community cohesion. They should be interesting and attractive places that provide opportunities for spontaneous social interactions. Pedways can include places to sit, viewpoints and artwork to enjoy, and non-commercial community spaces such as museums, galleries, libraries and indoor playgrounds. They can be extensions of public transit stations. Toronto’s PATH pedway network includes many family activities, and Chicago’s pedway network has underground attractions that attract many visitors.

Air conditioning has economic and environmental costs, so it is important that buildings and pedway networks rely on passive cooling, where possible, and maximize cooling system efficiency (Litman 2022). However, passive cooling can be inadequate in extreme heat, so some mechanical cooling may be needed. With modern high performance solar panels and air conditioning systems, shadeway solar arrays can power a major portion of these cooling loads. Pedway energy costs are likely to be much less than what is required if travellers drive rather than walk.

Table 2 summarizes shadeway and pedway benefits and costs. Because they are expensive, pedways are mainly justified in dense urban villages where they can connect many high-rise buildings. It would be very expensive to connect all buildings, including smaller buildings (CWI A); a more realistic goal to locate most buildings within a short walk of pedway entrances, such as no more than 1,000 feet (300 meters) if temperatures frequently exceed 38°C (100°F), and no more than 300 feet (100 meters) if temperatures frequently exceed 43°C (110°F).

Table 2  Shadeway and Pedway Benefits and Costs Summary

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Costs</th>
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<tbody>
<tr>
<td>• Increased pedestrian comfort and enjoyment.</td>
<td>• Additional construction costs</td>
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<tr>
<td>• Increased walking improves public fitness and health.</td>
<td>• Pedways can be sterile and isolated</td>
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<tr>
<td>• Vehicle and parking cost savings.</td>
<td>compared with outdoor sidewalks.</td>
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<tr>
<td>• Increased property values for connected and nearby properties.</td>
<td></td>
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<tr>
<td>• More local business activity and tax revenues.</td>
<td></td>
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<tr>
<td>• Reduced traffic problems (congestion, crashes, pollution, etc.)</td>
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Shadeways and pedways can have various benefits and costs. Comprehensive evaluation considers them all.
Business Case Example
This example evaluates the benefits and costs of a typical pedway network.

As previously described, most jurisdictions currently spend about $50 annually per capita to build and maintain public sidewalks and paths. A few jurisdictions, such as Albuquerque, Denver, Los Angeles, and Washington State spend about twice that to complete their sidewalk networks and meet universal design standards. Building shadeways on main sidewalks (those on arterials, around shopping districts, and to schools) would probably require an additional $50 annually per capita.

Assume that pedways cost on average $10 million per mile to build, which is comparable to the cost of adding an urban arterial lane in a large U.S. city (FHWA 2014). Of course, this will vary depending on conditions, with lower costs for pedways developed in conjunction with building and roadway projects, and higher costs when they are retrofitted or where conditions are particularly challenging.

Assume that in a typical transit-oriented village, a basic pedway network that provides CWI B (most homes and businesses are located within a 300 to 1,000 feet walk of a climate-controlled pedway) requires two pedway miles, and a more complete pedway network that provides CWI rating A to most homes and worksites (they connect directly to a climate-controlled pedway that accesses commonly-used services and a major transit station) requires four pedway miles.

The figure below compares the costs of achieving various CWI ratings. CWI E (the incomplete sidewalk networks that currently exist in most communities) costs about $50 annually per capita (APC). CWI D (a complete sidewalk network) costs about $100 APC. CWI C (shaded sidewalks on main routes) would probably cost about $150 APC. CWI B (a basic pedway network that provides enclosed walkways close to most homes and worksites) would cost between $550 APC if the costs are distributed among 50,000 residents/workers or up to $4,150 if distributed among just 5,000 people. CWI A (a complete pedway network connecting most residences and commercial buildings) would probably cost between $950 and $8,150 annual per capita, depending on village population.

Figure 20 Estimated Costs of Achieving Cool Walkshed Ratings

<table>
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<tr>
<th>Village Population</th>
<th>Annual Per Capita (APC)</th>
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<tr>
<td>50,000</td>
<td>$50</td>
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<td>25,000</td>
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<td></td>
<td>$1,750</td>
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<td>$8,150</td>
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CWI E (incomplete sidewalk networks) cost about $50 annually per capita (APC). CWI D (a complete sidewalk network) costs about $100 APC. CWI C (shaded sidewalks on busy routes) costs about $150 APC. CWI B (pedway access within 300-1,000 feet of most buildings) costs $550 if costs are distributed among 50,000 residents/workers, or up to $4,150 for just 5,000 people. CWI A (complete pedway network connecting most buildings) would cost between $950 and $8,150 APC, depending on village population.
Are these facilities expensive? To develop comprehensive shadeway and pedway networks requires large increases in pedestrian spending, which makes them seem costly. However, compared with what governments currently spend on roads and traffic services (about $1,000 annually per capita), what businesses spend on parking facilities (more than $2,000 annually per capita), and what motorists currently spend on vehicles in automobile-dependent areas (more than $6,000 annually), pedways are inexpensive. If shadeway and pedway investments allow road, parking and vehicle costs to decline 5% to 20% they will more than repay costs and provide other economic, social and environmental benefits. They become more cost effective if developed in during building and roadway construction (which minimizes their costs); if implemented in compact urban villages (which maximizes their usefulness); and if implemented with TDM incentives (which increases their use).

**Figure 21** Estimated Walkshed and Automobile Costs for 25,000 Population Village

In an urban village with 25,000 residents and workers, a complete pedway network (CWI A) is estimated to cost about $1,750 annual per capita (APC). This is more than is currently spent on sidewalks (about $50 APC), but small compared with the annual costs of urban automobile travel including roads ($1,000), parking ($2,000) and vehicles ($6,000).

The table below summarizes the value chain from shadeway and pedway investments. By improving walking conditions they can significantly increase walking, which increases enjoyment and health. By reducing driving they reduce vehicle and parking costs, and local traffic problems. These changes tend to increase local property values and business activity, leading to higher tax revenues. These additional public revenues can rationally be reinvested into shadeways and pedways.

**Figure 22** Shadeway and Pedway Value Chain

<table>
<thead>
<tr>
<th>Shadeway and Pedway Investments</th>
<th>Shadeway and pedway investments can improve walking conditions, which increases walking, and therefore enjoyment and health. It also reduces driving which reduces vehicle and parking costs, and local traffic problems. These changes increase local property values and business activity, increasing tax revenues, which can rationally be reinvested into shadeways and pedways.</th>
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<tbody>
<tr>
<td>Better Walking Conditions</td>
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<tr>
<td>More Walking</td>
<td>Less Driving</td>
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<tr>
<td>Increased Enjoyment and Health</td>
<td>Vehicle and Parking Cost Savings</td>
</tr>
<tr>
<td>More Valuable Housing and More Local Business Activity</td>
<td></td>
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<tr>
<td>Higher Tax Revenue (which can be reinvested in pedestrian facilities)</td>
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Previously mentioned studies indicate that improved walkability often increases property values 5-15%, and access to high quality public transit can doubles that value. This occurs because improved non-auto access provides vehicle and parking facility savings that can be reinvested in rents and mortgages. A pedway network that connects dozens of residential and commercial buildings can generate millions of dollars in total annual savings and economic benefits. Some of this value can be captured through connection fees or special taxes.

**Figure 23**  Potential Property Value Gains

Large commercial centers often contain dozens of high rise buildings each worth more than a hundred million dollars. If pedway connections increase their value by 5-15%, by improving pedestrian access and reducing vehicle and parking costs, the property value gain can total billions of dollars.

Fees and taxes should be structured to encourage pedway connections and more compact development. Parking minimums should be reduced or eliminated for buildings with higher CWI ratings so owners can capture potential parking cost savings. Fees and taxes should be implemented gradually to avoid discouraging development in catchment areas. For example, if a pedway connection is estimated to increase a building’s future value by 10%, a connection fee or value capture tax should be 0% the first year and increase one percentage point each year for five years, so cost burdens are initially low but increase as building revenues grow, so property owners see a financial gain from pedway connections and proximity.
Factor to Consider in Shadeway and Pedway Planning
The following factors should be considered when planning shadeways and pedways.

Local Climate and Topography
Shadeways and pedways benefits are greatest in areas with extreme heat, cold, rain, snow, air pollution smoke or dust. The more severe and frequent these conditions the greater shadeway and pedway benefits. Shadeways tend to be helpful in temperatures over 85° Fahrenheit (30° Celsius), and pedways over 90° F (32° C), particularly with high humidity or steep terrain that makes walking unpleasant.

Development Density and Mix (Urban Villages)
The more people, jobs and services located within a walkable area, the more people will walk and benefit from pedways and shadeways. Pedways require an urban village with more than 10,000 residents or workers within a walkshed with less than a mile radius. Since shadeways are less expensive they can serve lower density areas, but still require compact and mixed development.

Facility Quality
To maximize benefits, shadeways and pedways should be well designed and managed: they should meet universal design standards, be clean, comfortable and safe, are seldom crowded, including clear wayfinding (signs and maps to help users navigate the system), and have points of interest to make them attractive destinations. They should be managed similar to other enclosed semi-public spaces such as public transit facilities and shopping malls

Integration
Because they experience economies of scale, shadeways and pedways should connect to the maximum number of homes, services and destinations. They should be integrated with overall pedestrian networks, with numerous entrance-ways, and with public transportation networks, with connections to air conditioned or shaded stations and stops. They should have standardized wayfinding. Their benefits tend to increase with TDM incentives such efficient parking pricing (motorists pay directly for using parking facilities), public transit service improvements, commute trip reduction programs, and traffic prioritization, so travellers are encouraged to shift from driving to walking and public transit.

Social Equity Goals
Because physically and economically disadvantaged people tend to rely more than average on walking and are vulnerable to extreme weather, integrating them into shadeway and pedway networks helps achieve social equity goals. For example, where possible, shadeways and pedways should be connected to affordable, senior and family housing, plus diverse and affordable public services.

Smart Business Models
As much as possible, pedways should be financially self-sustaining; their costs should be repaid through connection fees and rents. Pedways can be linear shopping centers, lined with commercial spaces that pay rents. Local governments can either require or provide incentives for building owners to connect and maintain their portion of the network. Public transit agencies can support pedways as extensions of their stations. Local governments and business associations can promote the networks to potential customers, and sponsor activities that attract visitors.
Conclusions

Improving walkability can provide significant benefits to people, businesses and communities, particularly in dense urban areas where vehicle traffic imposes high costs. Since extreme heat and cold can make walking uncomfortable and unhealthy, it is important to plan for pedestrian thermal comfort.

Well-designed shadeway and pedway networks in compact urban villages can provide convenient, comfortable and efficient non-auto access during extreme weather. They can create multimodal communities where residents, workers and visitors rely on walking and public transit, and minimize vehicle travel, which reduces user costs, infrastructure costs and traffic problems. Many cities have some shaded sidewalks and air conditioned walkways but few have comprehensive, integrated shadeway and pedway networks that serve a major portion of destinations.

To be successful these networks require public support. Their development requires effective planning and business models. They experience economics of scale; they become more effective and cost-effective as they expand and connect more people (potential customers and employees), businesses, and services. As a result, property owners should be encouraged or required to connect and support to them. Shadeways are slightly more costly and pedways far more costly than basic sidewalks, so creating these networks requires significant investments, but their costs are far less than what governments spend on roadways, businesses spend on parking facilities, and motorists spend on vehicles to access urban destinations. Although pedway air conditioning consumes energy, this is much less than what is required for automobile travel, and can be offset if shadeways have solar panels. These networks are most cost-effective if integrated into compact urban villages with at least 10,000 residents and workers located in their walksheds, and implemented with parking reforms and TDM incentives that encourage their use. Their costs can be recovered through value capture, with connection fees or special taxes.

The main obstacles to comprehensive pedway development are well-entrenched biases that favor motorized travel and undervalue non-motorized modes in transportation planning and investment. Transportation agencies have tools to plan and justify road and parking projects, and dedicated funds to build them, but lack comparable tools and funding for walkability improvements even if they are more cost effective and beneficial overall.

The Cool Walkshed Index (CWI) is a practical way to evaluate walking facility thermal comfort. It can be used to rate hot weather pedestrian access to a building or in area, to identify problems, and to set improvement targets. Currently, most urban buildings and neighborhoods have CWI E (incomplete sidewalk networks) or D (complete sidewalk networks). Moderate-heat cities should aspire to CWI C (shade sidewalks on busy routes); high-heat cities should aspire to CWI B (enclosed, climate-controlled pedways within a 300 to 1,000 foot walk); and extreme-heat cities should aspire to CWI A (enclosed, climate-controlled pedways connected to most residences and worksites).

Shadeway and pedway development can substantially improve the walkability in hundreds of cities, and improve the lives of billions of people.
Information Resources


Lucy Sherriff (2023), *Simple Ways Cities Can Adapt to Heatwaves*, BBC (www.bbc.com); at https://bbc.in/3O70gfS.


*Walkability Asia* (http://walkabilityasia.org) supports walkability improvements in Asian countries.


www.vtpi.org/cwi.pdf