Transforming our World Through Design, Diversity and Education
G. Craddock et al. (Eds.)

doi:10.3233/978-1-61499-923-2-357

Diversity of "Pedestrians on Wheels", New Challenges for Cities in 21st Century

Delfín JIMÉNEZ[a,1] Yolanda DE LA FUENTE [a,2] and Jesús HERNÁNDEZ-GALÁN [a,3]
[a] *Phd Architecture. CEO of EQAR (Architecture Office)*
[b] *Phd in Law. University professor at the University of Jaen*
[c] *Phd in Forestry Engineering. Director of Accessibility at Fundación ONCE*

Abstract. Traditionally, pedestrians were identified as singular entities with standard needs. Reality shows us that pedestrian diversity is a reality that is becoming increasingly complex. How does urban design face the changing reality of pedestrian typologies? In the same way that in the 20th century the car set aside horse carriages and pedestrians, in the 21st century pedestrians are returning to take centre stage with regard to motor vehicles, but with new formalizations that imply new considerations in the design of streets, many of they are still unsolved. Citizens strolling on scooters, skates, skateboard, segway, unicycles, are added to the already traditional baby strollers, wheelchairs, and suitcases with wheels ... "pedestrians on wheels" that pose new challenges of coexistence and design. Own functional requirements to walk and maneuver, to see and be seen ... functional requirements of coexistence with other pedestrians that make a different use of the street (people looking at shop windows, pedestrians with umbrellas, reading on the smartphone...) or changes of use of the same space when the conditions are different: snow, strong sun, fog, at night ... These are considerations of Universal Accessibility and Design for all that we cannot leave out while our society progresses. This paper identifies some of these new needs and studies this new pedestrian mobility is carried out through a progressive analysis in three phases: 1 classification of the different user of the street, 2 study of the Personal Mobility Devices (PMD) and 3 the new accessibility barriers that arise with the use of PMD. As a result, some action strategies are pointed out to respond to the difficulties of accessibility derived from this new reality and to integrate them into the Universal Design of the urban public space.

Keywords: Accessibility, pedestrians, wheels, Universal Design, Diversity

1. Introduction

All of us are pedestrians every time we walk on public roads. However, not all of us act and behave in the same way and that is the reason why there are specific categories that include each human routine when moving through public spaces and behaviours with regard to unpredicted situations.

[1] Corresponding Author, Phd Architecture. CEO of EQAR, Architecture Office; E-Mail: d.jimenez@eqar.es
[2] E-Mail: ymfuente@ujaen.es
[3] E-Mail: jhernandez@fundacionONCE.es

1.1. Evolution of the concepts of pedestrian and diversity

The term 'pedestrian' comes from the French word 'piéton'. A pedestrian is an individual who walks through open-air public spaces. Baudelaire's description of Flaneur is a clear example. Flaneur is a solitary, distracted individual who does not follow a precise direction and by whom the French writer tries to represent the daily life of the urban Walker within the traffic-trade dualism of roads.

figure 1 Le Flaneur. Paul Gavarni 1842

Throughout history, the term 'pedestrian' has been related to the shape of a male adult who has a perfect physical capacity and who walks without any mobility-limiting element (walking stick, umbrella, suitcase, baby carriage, etc.). Such approach is a limiting view that distorts reality since it does not consider variables such as walking speed, capacity to pay attention and react, manoeuvrability, guidance capacity and so forth.

figure 2: Pedestrians. Buenos Aires 1930

Over the years, the use of additional elements associated with pedestrians started to be considered: Wheel chairs, baby carriages, wheeled suitcases, etc., as well as small personal mobility vehicles such as bicycles or scooters. These vehicles do not have engines and they move at low speed on sidewalks, so they are regarded as linked to pedestrians. Hence, if we refer to a more contemporary definition of pedestrians, we see that: "A pedestrian is an individual who circulates on foot through public roads without driving. Those individuals pushing any small vehicle without engine and those with reduced mobility who move with a wheel chair either with or without engine are also considered pedestrians." (Directorate-General for Traffic, Spain)

This definition shows how diversity is starting to be included in the concept of pedestrians, although it is focused on aid elements not in relation with the environment based on the different functional capabilities of individuals.

1.2. The new mobility of the 21st century

Today, urban mobility is not featured by the traditional modal split anymore (walking, riding a bicycle, using public transport and private vehicles). Devices and small vehicles that are increasingly proliferating otherwise feature it. These devices and small vehicles allow additional types of mobility and must necessarily coexist with traditional means of movement.

The fast proliferation and increasing trend of these new pedestrian mobility models in cities, along with the weak legal situation in terms of regulation is causing certain mobility problems.

figure 3: pedestrians using different Personal Mobility Devices (PMD)

The increasing use of electric vehicles (cars, motorbikes, bicycles...), which are difficult to detect by hearing imply a new urban obstacle regarding accessibility, and particularly concerning certain groups of people such as blind individuals, old people, etc.

This matter is becoming more and more relevant, and particularly regarding future years, since such vehicles are being used and promoted as the new sustainable mobility for cities in the 21st century. This trend could entail the use of such vehicles in numerous

places. Current urban tours using PMDs to discover the city that are already being offered in many tourist destinations is a perfect example.

2. Study methodology

We carried out an analysis of Pedestrian Diversity and environmental obstacles that lead to a different use of public spaces. We also analysed the different types of pedestrian mobility devices and their features. By assessing the basic requirements of the different groups of pedestrians and the characteristics of the different types of devices, we obtained the different situations that affect accessibility in public spaces, either negatively or positively. We hereby detail the outcomes of the different study phases:

3. Pedestrian diversity

Public roads comprise a great variety of users. So, excluding those who move in traditional motor vehicles, either as drivers or passengers, we focus on users who use sidewalks or cohabitation areas.

The study of pedestrian mobility can be carried out from various approaches: based on speed, with fast and slow pedestrians; based on company, where there are solitary individuals, couples and small or large groups of individuals; based on their apparent objective, either be window shopping, wandering, using public transport… The present study, nevertheless, is based on the functional relation with the immediate environment. Therefore, numerous variables are taken into consideration, along with some of the aforementioned variables such as speed or attention, which are hereby detailed:

Table 1: Users in Public Roads **[**Source: compiled by authors]

A. Those using motor vehicles	1. Drivers 2. Passengers
B. Those using personal mobility devices (PMD)	3. Personal Mobility Aid 4. Bicycles 5. Personal Mobility Device
C. Pedestrians on foot	6. Pedestrians without specific use requirements 7. Pedestrians with certain specific requirements related to movement or Action-Reaction 8. Pedestrians with special requirements for Observation-Detection of elements and situations in public roads
D. Other users who do not move	9. At resting areas 10. Performing leisure activities 11. Working in public roads

Groups B and C are hereunder developed in order to make a comparison of the requirements enabling the assessment of coexistence between both groups. Group B includes the different types of Personal Mobility Devices (PMD) used in public roads and which eventually coexist with the rest of users in public roads.

Table 2: Users moving with Personal Mobility Devices (PMD) **[**Source: compiled by authors]

(Continuing with the numbering reference of table 1)

3.- Personal Mobility Aid	Wheelchair Motorised wheelchairs Mobility scooters
4.- Bicycles	Conventional Bicycle Taxi-bikes, 'trixie' Large basket bicycle Electric bicycle
5.- Personal Mobility Device	Kick-scooter Electric scooter Hoverboards Segway Unicycles

Group C is related to the variety of pedestrians who move on foot, by analysing relational obstacles regarding the environment of public roads.

Table 3: Types of pedestrians based on different use requirements in public roads. **[**Source: compiled by authors]

(Continuing with the numbering reference of table 1)

6. Pedestrians without specific use requirements
7. Pedestrians with certain specific requirements related to movement or Action-Reaction
    - 7.1. Pedestrians with wheeled elements
        - Pedestrians with baby carriages (single, twins...)
        - Pedestrians pushing shopping trolleys, luggage or any wheeled elements
    - 7.2. Pedestrians who require greater space to move
        - Pedestrians who suffer from obesity or carry packages or luggage
        - Pedestrians who are accompanied by an assistant, guide dog, pet...
        - Pedestrians with technical assistance: walking frame, wheelchair, crutches...
        - Pedestrians with umbrella, pedestrians who are very tall...(when there are canopies, awnings, signs...)
    - 7.3. Pedestrians with requirements related to stability and support
        - Pedestrians who require flat surfaces without gaps or holes: individuals wearing high heels, walking sticks or crutches...
        - Pedestrians who have balance problems susceptible to paving irregularities, sideways slopes or lack of stair rails at troublesome spots
        - Pedestrians who require specific adherence conditions to the road surface: poorly fitting shoes, poor surface area...
    - 7.4. Pedestrians with limited effort capacity
        - Pedestrians who have difficulties travelling long distances
        - Pedestrians who have difficulties climbing steep slopes
        - Pedestrians who have difficulties facing gradients
        - Pedestrians who experience walking speed difficulties
    - 7.5. Pedestrians who require easy-to-use urban elements
        - Pedestrians who have difficulties regarding non-ergonomic elements
        - Pedestrians who have difficulties handling elements that require specific psychomotor skills
        - Pedestrians who have difficulties reaching elements
    - 7.6. Pedestrians requiring more reaction time
        - Pedestrians who require more reaction time regarding informative signs (stop and pass signs) or danger signs (horn, lights...)
8. Pedestrians with specific requirements related to movement or Action-Reaction
    - 8.1. Pedestrians with special requirements for identifying elements of pedestrian routes

- Visually-impaired pedestrians regarding identification of basic elements of the environment
- Pedestrians of a certain height who have difficulties catching sight of elements

8.2. Pedestrians who have difficulties understanding public spaces
- Pedestrians with navigational difficulties
- Pedestrians with reading difficulties
- Pedestrians from other cultures and different traditions

8.3. Pedestrians with special communication requirements concerning public roads
- Pedestrians who have difficulties making themselves understood or understanding verbal messages

8.4. Pedestrians with special requirements in order to identify and understand dangerous situations
- Individuals with limited interpretation skills due to age: children, old people
- Deaf individuals at limited visibility spots
- Individuals with cognitive disabilities in complex or unexpected situations
- Inattentive pedestrians due to distraction (i.e. using a Smartphone)

There are therefore numerous groups of pedestrians that are very different from each other in terms of their functional relation with the immediate environment within urban public spaces.

4. PMD (Personal Mobility Device)

New technologies have lead to the development of urban mobility solutions favouring pedestrian displacements through new vehicles or devices that break with the traditional division between pedestrians and motor vehicles. These devices are not considered as typical of pedestrians, but neither are they considered as motor vehicles. This fact causes an intermediate situation, even ambiguous, that in some cases causes conflicts with other vehicles or pedestrians. These devices are not pedestrians neither motor vehicles.

figure 4: Examples of PMDs

In some occasions, these groups of "pedestrians" have been given a name, such as 'Superpedestrians' or 'Wheeled pedestrians'. However, the best defining form for this group of individuals would be 'PMD users'.

PMDs are classified based on their maximum speed, distance, weight and the existence of dangerous angles that can harm individuals in case of accident. The following chart is a classification of PMDs:

Table 4: Types and features of PMDs. [Source: compiled by authors based on data from the Spanish Directorate-General for Traffic]

Type	*Max. Speed*	*Max. Distance*	*Weight*	*Models*
Type A	20 km/h	1 m	≤ 25 kg	 Unicycles Hoverboards Kick-scooter
Type B	30 km/h	1,9 m	≤ 50 kg	 Segway Electric scooter
Type C0	45 km/h	3,1 m	≤ 500 kg	 Large basket bicycle (for personal use)
Type C1	45 km/h	3,1 m	≤ 500 kg	 Taxi-bike 'Trixie' Taxi-bike* (*With passenger backwards)
Type C2	45 km/h	3,1 m	≤ 500 kg	 Basket bicycles for distribution of goods

According to these features, some of these models can be used and others cannot, usually depending on the route: pedestrian path, bicycle lane or shared paths or sidewalk. It is also interesting to include other types from group B such as bicycles and Personal Mobility Aid users. These criteria vary from one country to another, being the possibility or not for bicycles to transit through sidewalks one of the most controversial matters.

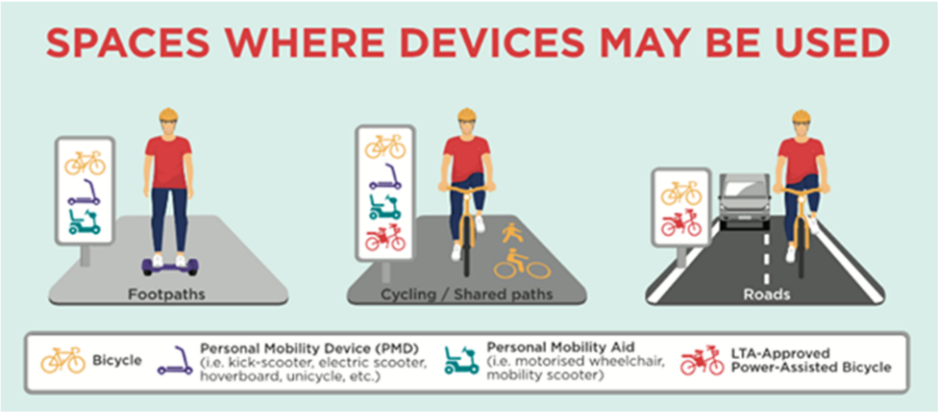

figure 5: Spaces where devices may be used. Example from Active Mobility Act. Singapore

4.1. The Singapore study case

The case of Singapore is an interesting one, where the LTA (Land Transport Authority) implemented a pioneering regulation for pedestrian mobility and the use of different mobility elements. The following considerations from such regulations are worth noting:

1. Rules for users:
    - Speed limits of 15km/h (running or leisurely cycling speed) on footpaths, and 25km/h (normal cycling speed) on shared paths and cycling paths
    - Devices must be equipped with lights visible from the front and back, which must be switched on during hours of darkness
    - Cycling maximum two abreast is allowed on all roads with at least two lanes in that direction, except those with bus lanes during the bus lane operational hours
    - No cycling against the flow of traffic on roads
2. Code of conduct (key practices)
    - Always give way to pedestrians on footpaths and shared paths. Remember also that pedestrians have the right of way on pedestrian crossings
    - Slow down and be prepared to stop when approaching high pedestrian-traffic areas such as bus-stops
    - Either 'walk your bicycle' or dismount and push at high pedestrian-traffic areas
    - Stop and look out for on-coming traffic when approaching pedestrian crossings, and cross only at walking speed
    - Always stop to render assistance and exchange when involved in an accident

5. New accessibility obstacles: coexistence between pedestrians

After the aforementioned description of the different groups of users in public roads, we may now focus on coexistence problems that have a clear impact on accessibility in groups B and C: PMD users and walking pedestrians.

In some cases, these vehicles have a higher mass than individuals and move at a higher speed. Consequently, and due to the lack of a specific lane or space for them in roads, PMD entail risky situations since they share the urban space with the rest of users. Existing regulations make reference to these devices in terms of height and dangerous angles that can cause harm to individuals in case of accident. However, in practice such devices are not subject to restrictions or circulating criteria.

Since there is a lack of specific regulation to control their use, they can be seen circulating on sidewalks and bicycle lanes similarly to bicycles. In some cities (i.e. Bilbao) public space regulations establish that these devices are not allowed to move at a higher speed than 4 kilometres an hour when circulating through sidewalks, although they can move at a higher speed if they do so through bicycle lanes.

Amongst the main conflict of issues regarding accessibility as the central axis, the following are worth mentioning:

- Detection difficulty particularly when approaching individuals from the back, since
- Their higher speed as compared to traditional pedestrian pace reduces the time for reaction when there is a need for manoeuvre. This is particularly difficult for the old people or individuals with technical assistance (crutches, walking frame, wheelchair…)
- The danger of a possible collision. When the abovementioned factors (difficulty of detection and higher speed) are combined with the fact that these devices are significantly heavy, a potential collision could seriously harm any pedestrian.
- The identification or confusion of Personal Mobility Devices (PMD) with Personal Mobility Aid (PMA). The former represents an improvement of mobility for certain pedestrians, while the latter is a fundamental element enabling certain pedestrians to move. As an example: the scooter that an individual with mobility difficulties uses is not the same thing as the Segway that tourists use. Therefore, these devices cannot be regulated, described or considered jointly.
- The lack of regulation regarding their use causes certain users to make use of them in a dangerous way with regard to other pedestrians.
- The lack of awareness concerning Universal Design in the trading of different PMD models, which limits their use for many individuals: difficulty to understand their use, handling devices, balance and necessary movements…

6. Conclusions and Study strategies

With the present study, it is evident that pedestrian flow analysis has not yet incorporated pedestrian diversity in the design of pedestrian facilities. And therefore the consequences on accessibility derived from the use of PMD are not considered either.

As a conclusion, the following are presented some accessibility strategies to be taken into account in pedestrian coexistence from the functional diversity, including the use of the PMD

6.1. In the Universal Design of the Built Environment

Analysis of the new incidences of the environment on the individual with the use of the PMD to guarantee an adequate urban accessibility:

- Regulation for users: training that includes the consideration of the functional diversity of pedestrians to designers, vendors, users of PMD and responsible for the management and control of their use. Possibility of license need for the use of some types of PMD
- Regulation of use, depending on the different types of PMD: place of use (exclusive traffic lane, roadway of vehicles or pedestrian sidewalk) and control of the maximum speed of use.

6.2. In the Universal Design of the PMDs

Considerations in the design of PMDs to improve security of coexistence with other pedestrians, taking into account the functional diversity:

- Ease of detection: Using easily identifiable colours. Inclusion of sound or light mechanisms to facilitate detection of PMD.
- Diversity in body size (people of short stature, obese people…) and reaction rate (old people, deaf people, people with difficulties in understanding a dangerous situation ...), thus minimizing damage to the impact: PMD's weight, sharp edges ...

References

[1] ASIA'S LEADING ONLINE. BAIKBIKE.COM. 2016 Singapore's Active Mobility Bill. [recuperado 22-05-2018] http://baikbike.com/must-read-singapores-active-mobility-bill/
[2] CÍRCULO DE BELLAS ARTES. Atlas Walter Benjamin. [recuperado 22-05-2018] https://www.circulobellasartes.com/benjamin/index.php
[3] DIEGO HERNÁNDEZ MEDINA. El flaneur Baudeleriano en la Posmodernidad. 2011. La Ciudad Viva. [recuperado 22-05-2018] http://www.laciudadviva.org/blogs/?p=11243
[4] DIRECCIÓN GENERAL DE TRAFICO. El Peatón. 2014. Ministerio del Interior.
[5] JIMENEZ MARTÍN, DELFÍN. 2015. Tesis Doctoral: La accesibilidad de los espacios públicos con plataforma única de convivencia. [recuperado 22-05-2018] http://oa.upm.es/40009/1/DELFIN_JIMENEZ_MARTIN.pdf
[6] JIMENEZ MARTÍN D, HERNÁNDEZ-GALÁN J & DE LA FUENTE ROBLES, Y. 2015. Diversidad de peatones, los diferentes usos de la vía pública: una aproximación desde la accesibilidad. Revista Ciudad y Territorio nº 183. Ministerio de Fomento.
[7] LOCAL TRANSPORT AUTHORITY (LTA). Singapore 2016. Active mobility advisory panel recommends rules and code of conduct for safe sharing of paths [recuperado 22-05-2018] https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=58df0753-54c0-42d4-971e-220bef2e991f
[8] URBANING. Censo de los vehículos de movilidad personal y ciclos de más de 2 ruedas. 2016. [recuperado 22-05-2018] https://urbaning.cat/es/proyectos/movilidad/
[9] XATANA. 2013. Los diez vehículos personales que alguien piensa que usaremos [recuperado 22-05-2018] https://www.xataka.com/automovil/los-diez-vehiculos-personales-que-alguien-piensa-que-usaremos