

Functional abilities of humans and identification of specific groups of pedestrians

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Abstract

This paper will present the main results and conclusions related to the research of functional abilities of humans and identifications of specific groups of pedestrians. The research was done during the four year COST Action 358: Pedestrian Quality Needs. The article is divided into three parts. In the first part will be presented the findings that are related to the abilities of humans manifested when they walk and which are necessary for a safe movement of all pedestrians. Abilities or characteristics of humans are divided into four main groups and consist of the physical (body), psychomotor, sensory and cognitive (mental) abilities. The next part of the article analyzes groups of pedestrians formed based on their abilities, and includes children, adults, older people and people with disabilities. The conclusion generally deals with recommendations and the importance of knowledge of various abilities/characteristics of different groups of pedestrians.

Biography

Milena Vukmirovic is teaching assistant at Department of urbanism at Faculty of Architecture University of Belgrade. She is a member of Management Committee of COST Action 358: Pedestrian Quality Needs. Milena Vukmirovic was a founder of the Civil Sector Organisation 5km/h which aim to promote walking as a sustainable modality of transport and to improve pedestrian environment. Now, she is doing PhD thesis which determines the relationship between quality of pedestrian environment and competitiveness of the cities.

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Introduction

The accepted definition of pedestrians in the "Pedestrian Quality Needs" project goes like this: any person who walks or spends time in public space, without any special requirements related to special forms of walking is a pedestrian, for example, people who run, or enjoy the areas outside urban areas, such as mountaineers. This includes children whose toy is a form of transportation and people with disabilities who use various forms of moving aids (sticks, crutches, wheelchairs or scooters with 3 or 4 wheels). People who use scooters, stilts, Segways or other forms of transport means for fun are not in the category of pedestrians.

Pedestrians are a diverse group of participants in traffic, and this reflects the general characteristics of the population. When shaping the environment and the places where different forms of transport meet with the pedestrian infrastructure, it is necessary to keep the pedestrians with different degree of ability in mind, as a basic principle of design, whenever possible. This approach will enable the removal of barriers and creating a pleasant, appropriate environment for all pedestrians.

The special approach in design, guided by a consciousness of the diversity of users, is indicated by the term "Design for All" (D4A). Design for All has roots in the Scandinavian functionalism since the `50s and ergonomic design from the `60s of the 20th century. The socio-political background of the concept Design for All was recognized in the Scandinavian social policy, which produced the concept of "Society for All" in the late `60s. This ideological belief is transformed into the United Nations Standard Rules on the equalization of opportunities for persons with disabilities, accepted by the UN General Assembly in December 1993. Focus on the standard rules of accessibility with a clear concept of equality inspired the development of the philosophy of design for all, which became the generally accepted concept in EIDD¹. (European Institute for Design nad Disability, 2004).

Considering the diversity of pedestrians, design production includes a wide range of user needs, including needs of children, persons with movement difficulties, and the elderly. All over the world, statistics indicate that the population is ageing. This means that there is an increase of people over 65 years of age.

To understand the approach, the problem of the different abilities of pedestrians in the next chapter will identify different groups of pedestrians and discuss their characteristics and needs. Based on the characteristics observed and needs of different groups of pedestrians, the following work discusses the system established around the specific influence on abstract levels of decision making (strategic, tactical and operational).

Physical, psychomotor, sensory and cognitive abilities concerning walking

The very nature of a human determines the characteristics of its movement. When it comes to pedestrian movement, two characteristics in particular stand out: the provision of views in the direction of movement and paths of movement.

¹ EIDD – European Institute for Design and Disability

One of the most important characteristics of pedestrians is to look towards the goal they are moving to. For that, the width of view extends 15 ° to the horizontal line of sight. Turning to the specified line view happens when we let other phenomenon attract our attention. Small changes in the nature and height of surface area at which we move will not be perceived in most cases. However, when someone looks in the direction of a surface when moving, he or she might not perceive the problems that are possible to encounter. The reason for not perceiving changes in the area at which we move might be color, texture, weak lighting, flash, etc.

Another characteristic is that pedestrians will move to a specific destination in most cases opt for the path whose overcoming spends the least energy. These paths are the shortest and have at least an oscillation in height. Due to their own nature, pedestrians tend to cross the street at the most appropriate place instead of the one where there is a pedestrian crossing.

According to research conducted by AASHTO² during 2001, pedestrians do not cross the distance of more than 1600m (1 mile) to their job, or 800m (0.5 mile) to the transportation stop. The survey also showed that 80% of the length of pedestrian movement is less than 800m (0.5 mile).

During the process of design of an effective pedestrian environment, we must follow the principle that adjusts various users. However, reality shows large differences among individuals in relation to the speed of motion, endurance limits, physical strength, physical performance, capacity assessment, which challenges the long accepted concept of "the average pedestrian".

The definition of abilities would be that: they are individual characteristics that make someone perform certain actions and they can be divided into four groups: physical, psychomotor, sensory and cognitive abilities.

Physical abilities are those individual skills that include strength, endurance, flexibility, balance and coordination.

Psychomotor abilities are skills that affect the ability to manipulate and control objects.

Sensory abilities are abilities that affect the visual, sound and speech perception.

Cognitive abilities are the abilities that affect the acquisition and use of knowledge during solving certain problems.

Walking, crossing the street and involvement in traffic are complex processes that require adequate functioning and performance, so any impairment of cognitive or executive functions can be difficult due to poor walking, spotting incoming vehicles and the difficulties in crossing the street fast enough. (Oxley, Charlton, & Fildes, 2005) These factors increase the risk of traffic accidents.

According to their abilities, pedestrians differ widely. The difference in children's height and cognitive abilities is equally important to be considered as well as decrease in the speed of reflexes, and hearing and visual quality of the elderly. Ability can also vary during a pedestrian travel, if we take into account that the pedestrian becomes tired or interfered with other actions carried out during the movement (if someone is accompanied by children, carrying luggage, and consumption of food, beverages or cigarettes during the movement, use of mobile phone, etc.).

Characteristics of pedestrians include the individual characteristics that are necessary to perform certain actions that involve pedestrian movement and influence each other's distinction.

² American Association of State Highway and Transportation Officials

Bearing in mind the specific characteristics and abilities of humans we can identify different groups of pedestrians. Different groups of pedestrians are identified based on those characteristics that are necessary for the performance of pedestrian movement, according to the established definition of a pedestrian. The table shows the characteristics and abilities of pedestrians that influence pedestrian movement, and segments and elements of pedestrian traffic and infrastructure on which it can be reflected.

Based on abilities and characteristic, we will describe individual groups of pedestrians that can be found, and their general characteristics and subgroups that can be recognised within isolated groups.

Children

Children have reduced ability compared to adults due to their developmental immaturity and lack of experience. These differences are not only physical, but also include some characteristics that are acquired through the developmental process of growing up.

General characteristics that can be seen for children compared to adults are:

- Small height
- Diminished peripheral vision
- Reduced attention and cognitive abilities
- Reduced ability to estimate speed and distance
- Difficulties in the direction of providing sound localization
- Unpredictable and impulsive reactions
- Lack of transport schemes and expectations
- Lack of understanding of complex situations

These features differ, depending on the age of a child, and thus can be separated in following groups:

Infants and Toddlers (ages 0 to 5)

At this age, walking skills are just being developed and the children require constant parental supervision. Infants and toddlers have very limited abilities, and feature the following characteristics:

- They are learning to walk.
- They are developing peripheral vision and depth perception.
- They are impulsive and unpredictable.

Young Children (ages 5 to 7)

At a young age, children have unique abilities and needs. Since children at this age vary greatly in ability, it is important for parents to supervise them and make decisions on whether their child is ready for a new independent activity. Children in this age range tend to be:

- Impulsive and unpredictable,
- Limited in their peripheral vision (a sound source is not easily located),
- Limited in training/lacking in experience,
- Thrilled or excited by close calls,
- Short and therefore hard to be seen by drivers,
- Susceptible to darting or dashing out into the intersection,
- Likely to copy the behaviour of adults;

Preteens (ages 8 to 12)

By middle school years, children do have many of their physical abilities developed but still lack experience and training. Now there is greater desire to take risk. Preteens generally:

- Lack experience,

- Walk and ride a bicycle more often than before and at different times (which increases the possibility of crashing),
- Ride more frequently under risky conditions (high traffic),
- Lack positive role models,
- Cross the street at riskier locations,
- Get involved in more conflict situations with other traffic participants,
- Have a sense of invulnerability that makes them more willing to take chances

Teens (ages 13 to 17)

By high school and college, exposure changes and new risks can occur. Many walk and ride bicycles under conditions of low light. Other characteristics of this age group are that they:

- Are very active, can go long distances, and visit new places,
- Feel invincible,
- Lack experience and training,
- Are capable of travelling at higher speeds,
- Will overestimate their abilities on hills, curves, etc,
- Attempt to use bicycles, in-line skates, etc., based on practices carried over from youth.
- Are willing to experiment with alcohol and drugs

Consequences of limitations and functional impairments of children

Considering the principles of making decisions at three abstract levels, children as a separate group of pedestrians show a specific behavior. This behavior largely depends on factors related to the physical requirements for the movement of children of different ages, but also on their needs, related to a specific age.

Strategic level of decision making with children is determined by several criteria. According to a research conducted and published by the London Department for Transport (Department for Transport, 2007), the reason why children travel varies depending on their age. Young children are accompanied (usually by their parents or someone older than they are) more than half of their total outdoor and public movement. Most of the other reasons for travel are shopping, personal affairs or entertainment. From their second year of life, a decline in travelling as an escort occurs, while the number of travels whose purpose is education increases.

Starting from 5 to 15 years, the movement with a purpose of education represents 35-40% of the total number of children's trips (Figure 6). From 15 years of age, children usually move with the purpose of working. The difference between boys and girls who are teenagers, the number of movements whose purpose is shopping is in favor of the girls.

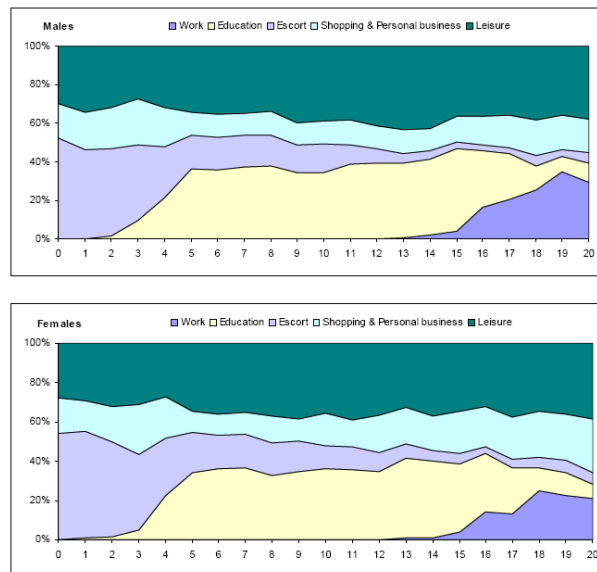


Figure 1: Travel by purpose, age (0-20) and gender (London Department for Transport, 2007)

From a previous research, we conclude that the most common purpose of travel for children and young people (up to 20 years) is education and entertainment. Other travel purposes, which are listed in the previous study, appear on a much smaller scale for children who are accompanying the adults while they perform their activities or are related to young people of 15 years of age. On a tactical level of decision making for children, their independence is an important criterion. According to a research conducted and published by the London Department for Transport, 79% of children aged 7 to 10 years are accompanied by the adults, contrary to 23% of children aged 11 to 13 years. (Department for Transport, 2007) The reasons why their parents behave like this either are the risks of other forms of transport (58%) or fear of attacks and abuse of their children (45%). As reasons for escorting the older children, parents entice the greater distance from school (32%), the risk of other forms of transport (30%) and fear of attacks and abuse (26%).

In addition to this, the survey included the question in which age do parents allow children to cross the street alone. The results are shown in the Figure 7.

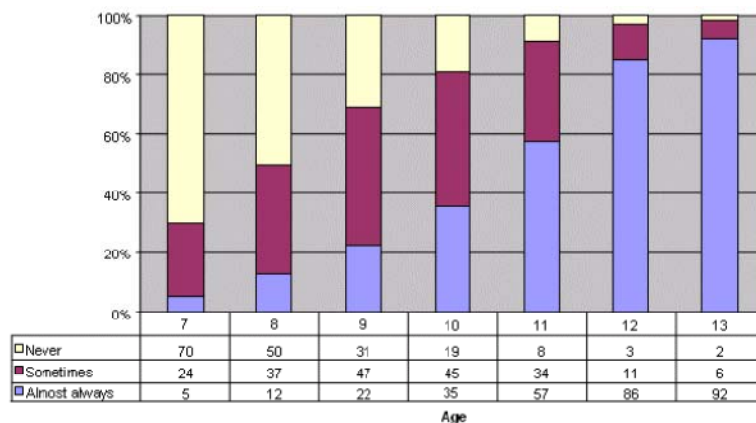


Figure 2: Children crossing roads alone (London Department for Transport, 2007)

Operational level of decision-making really depends on developmental age of the child or of its physical, psychomotor, sensory and cognitive abilities. Development of these abilities is linked to aging and health of the child. As previously shown in a number of cases, the parents make decisions on their child's movement, and this largely depends on their subjective assessment in related to the ability of the child.

According to the specific characteristics of children as identified group of pedestrians we can specify the main reasons and barriers for walking of children. They are presented in the following Table 3.

Table 1: Reasons and barriers for walking of children

Mode of transport	Psychological/emotional	Practical/functional	Economic
Walking (+)	Purpose Entertainment	Local trips for purpose	No cost
Walking (-)	Independence Fear of crime	Age Poor weather Parental accompany	

Also, we identified the factors that influence strategic, tactical and operational level of decision making of children, which are presented in Table 4.

Table 2: Factors that will influence different levels of decision

Mode of transport	Strategic	Tactical	Operational
Walking	Purpose Entertainment No cost Local trips Limited distances	Age Independence Fear of crime	Age Health conditions Poor weather

Adults

If we look at this group of pedestrians, concerning the characteristics and abilities of pedestrians, we might consider that this group fully performs traffic movement, with minor oscillations. Oscillations in abilities mainly differ between men and women, while among the members of the same sex may vary in relation to the physical characteristics and physical fitness.

Adult pedestrians are persons aged 19 to 65 years. Within this category, according to the age, two groups are distinguished with certain differences in characteristics and abilities (U.S. Department of Transport, 2009):

Adults (19 to 40)

These adults are highly competent in traffic and capable of perceiving and dealing with risk in most circumstances. Some use bicycles for commuting and utilitarian trips, while others use bicycles primarily for recreation. This group is generally:

- Active and fully aware of the traffic environment,
- Comprises only 1–4 percent of bicycling population in most communities,
- Tend to be very vocal and interested in improving traffic conditions.

Middle-Aged Adults (41 to 65)

During this stage of life, many pedestrians experience slower reflexes necessary to observe, assess, and respond to traffic conditions.

Besides these characteristics, the behavior of this group of pedestrians will generally depend on other factors such as interest, professional orientation, employment status, income, etc. Considering the previously mentioned factors of these adults, as the singled-out group of pedestrians, three dominant groups can be noticed (allocated by some authors) among which

there are some differences in concerning: income, ethnicity and religious affiliation (belonging to minorities) and a place of living (depending on whether they live in urban or rural areas).

Consequences of limitations and functional impairments of adults

If you observe abstract levels of decision-making in terms of walking, adults are a category of pedestrians who have all the preconditions for normal motion, concerning the physical, psychomotor, sensory and mental abilities. Their decisions will be affected by other factors, such as the purpose of travel, their income, ethnic and religious affiliation (if they belong to minorities), place of residence (depending on whether they live in urban or rural areas), etc.

The main reasons for travelling adults are classified into four broad categories whose purposes are their job, as a "suite" (such as tracking children to school), shopping and conducting personal business and entertainment. If you observe the results of a research on the purpose of pedestrian movement (Figure 8), regular travels and shopping are distinguished for a group of pedestrians ageing from 16 to 69 years (which is slightly greater than the interval discussed in this paper).

	Percentage of trips						
	0-15 years	16-25 years	26-54 years	55-69 years	70+ years	All 16+ years	All ages
Commuting	-	23	23	13	1	19	15
Business	-	3	6	4	-	4	4
Education	27	11	-	-	-	2	6
Escort/education	5	2	7	1	1	4	5
Shopping	9	15	19	29	39	22	20
Other escort	15	5	10	7	4	9	9
Other personal business	8	7	9	14	10	11	10
Visit friends at private home	17	16	9	10	13	11	12
Visit friends elsewhere	3	7	4	5	5	5	4
Sport/entertainment	6	7	5	7	9	6	7
Holiday/day trip	4	3	3	5	5	4	4
Other including just walk	3	2	4	5	5	4	4
All purposes	100	100	100	100	100	100	100
Base (unweighted)	1,150	2,128	7,871	3,106	2,170	15,761	10,004

Figure 3: Proportion of walking trips per person, per year, by purpose (London Department of Transport, 2007)

Small differences in frequency are seen in walking, between men and women, but there are differences related to age. According to a research published by the London Department of Transport, only 3% of people aged 16 to 44 years walk at least 10 minutes a day, but this percentage increases to 9%, according to the increase of age. (London Department for Transport, 2003)

There are differences in the frequency of walking conditioned by place of residence. According to the same survey, 92% of respondents that live in urban areas walk 10 more minutes at least once a week, in contrast to 86% of respondents who live in rural areas.

As mentioned earlier, most adults consider walking an alternative kind of movement (transport) and choose this form of transport only for short distances. Shorter distances mean walking to other forms of transport, such as a private car, the public transport stations, etc. or movement in their immediate environment in order to perform everyday purchases and personal affairs.

At the tactical level of decision-making, continuity of movement will be affected by distance and characteristics of physical and social environment. The influences of these characteristics differ from the subcategories of the working population, based on income, place of residence and ethnic and religious affiliation.

At the crossroads, and for safety when crossing the streets, adults have all the preconditions to perform all the actions without any great difficulties. On the other hand, speed of adults will depend on the characteristics of the terrain, distance, movement and depending on whether they move independently or accompanied by one or more persons. Depending on who they are moving with (the child in the wheelchair, the elderly, persons with disabilities), the adults will, in most cases, adjust their speed and gait according to the person (persons) that are moving with. These facts can affect the tactical level of decision making when choosing walking as a form of movement.

Adults have all the advantages that enable them to make decisions easily on an operational level because, in most cases, they are very much able to perform the action of walking. However, the operational level of decision-making in adults, similar to the tactical level, may depend on the cases when they move with other people. Depending on the characteristics and state of other people or creatures that move with the adults, (children, elderly, people with disabilities, dogs, etc.) the method and the characteristics of movement will be adjusted to the person accompanying them.

In relation to the specific characteristic of the adults as identified group of pedestrians we identified the reasons and barriers for walking of adults. Those results are presented in the following Table 5.

Table 3: Reasons and barriers for walking of adults

Mode of transport	Psychological/emotional	Practical/functional	Economic
Walking (+)	Purpose Recreation Relaxation Entertainment	Short distance trips for recreation and relaxation Well mentioned environment	No cost
Walking (-)	Fear of crime Fear of attacks and problems Belonging to the different ethnical, religious and racial groups	Distance Inadequate pedestrian environment Place of living Material status Accompany Poor weather	

Also, we identified the factors that influence strategic, tactical and operational level of decision making of adults, which are presented in Table 6.

Table 4: Factors that will influence different levels of decision

Mode of transport	Strategic	Tactical	Operational
Walking	Purpose Place of residence Adequate pedestrian environment	Fear of crime Fear of attacks and problems Belonging to the different ethnical, religious and racial groups Material status	Adequate pedestrian environment Accompany Poor weather

Elderly

In PQN³, ageing is defined as the demographic process in which the proportion of the elderly increases. The elderly are usually defined as people of 65 years and older. With regard to walking elderly people of 80 years and older is a much more functional definition⁴.

³ Pedestrian Quality Needs Glossary

⁴ The generation between 65 and 80 do not have serious troubles walking, except when they have one or more handicaps. One has to bear in mind that among the 80+ there are many that are in excellent physical condition, are able to walk quite fast and do not have any serious handicap when walking. They are however more fragile than younger generations.

Based on characteristics and abilities of pedestrians in this category, we can recognize certain variations. They are a consequence of the gradual decline of physical and cognitive functions, which are quite visible after 75 years of life. Bearing in mind that these changes could affect any or several categories of abilities (physical, psychomotor, sensory or cognitive); older pedestrians generally exhibit the following characteristics and behaviors (U.S. Department of Transport, 2009):

- Walk more in older years, especially for exercise/independence,
- May have reduced income and therefore, no car,
- All experience some reduction in vision, agility, balance, speed, and strength,
- May have further problems with hearing, extreme visual problems, and concentration,
- Have the tendency to focus on only one object at a time,
- Have difficulty hearing vehicles approaching from behind,
- All have greatly reduced abilities under low light/night conditions,
- May overestimate their abilities,
- Have a higher fatality rate than other pedestrians do, when involved in collisions with motor vehicles (Table 7)

The Critical Review of the Literature about Older Pedestrians⁵ considers the effect of ageing on older people’s vision, hearing, physical mobility, and cognitive processes. Although the changes experienced are well established, there has been little direct research linking functional decline to older pedestrian accidents. There were identified the principal changes most likely to affect pedestrian skills, which are listed below. They conclude that the age at which difficulty is experienced, and the extent of impairment, varies greatly between individuals.

Consequences of limitations and functional impairments of elderly

According to a research conducted by the London Department for Transport, published in the “*Understanding the travel needs the behavior and aspirations of people in later life*”, three basic categories are found related to the purpose of movement of elderly people: social and recreational, and everyday personal and business. (London Department of Transport, 2007) Social and recreational activities for people in an older age include activities such as going to lunch, socializing with friends, visiting a local club, or doing hobbies. Daily and personal activities include shopping, going to the doctor, dentist or a hairdresser. Business activities include work, or doing certain activities that are related to their job (this study included the part of the random population aged above 50 years). In our case, activities considered bind to the population aged over 65 years, majority of them unemployed, so travelling with the purpose of performing work is excluded.

To fulfill their needs, older people must navigate to specific destinations, which are mentioned in the survey: the nearby city centre or a larger city, the local environment, periphery or going to another city, the site located at the other end of the country, abroad, etc. (London Department of Transport, 2007) Featured destinations are mainly related to the purpose of movement. As the main advantages and barriers to walking as a mode of movement, the old people say (Table 8):

Table 5: Reasons and barriers for walking of elderly people

Mode of transport	Psychological/emotional	Practical/functional	Economic
Walking (+)	Leisure activity	Quick local trips	No cost

There is some empirical evidence that there is a ‘fear factor’ from speed of cars by people of over 65, which might be explained by uneasiness facing the acceleration of life in general. As a perceived risk, it needs to be addressed.

⁵ Dunbar, G., Holland, C. A., & Maylor, E. A. (2004). *Older Pedestrians: A Critical Review of Literature*. London: Department of Transport. pp. 11-12

		Maintaining health and mobility
Walking (-)	Fear of crime	Poor weather Limited distances Health conditions

The main factors related to a destination where the planned activity will be performed are the quality of local infrastructure, health conditions of an individual and costs. In addition to this, we can see that people tend to combine several activities in one trip. They usually travel during the day by choice, and tend to avoid walking in the evenings, during rush hours, or at times when children are returning from school.

Tactical level of decision making related to pedestrian movement depends on the health and abilities of an individual and the level of assessment of the physical environment and provided equipment that meets the needs of older persons. By this, we consider the existence of places to rest on an adequate distance, because the seniors quickly get tired, and adaptation to the intersection with other forms of traffic for safe moving of old people, obvious and well-adjusted signals, pavement quality, etc.

At the operational level of decision-making, the important factor will be the health condition of the individual in terms of walking abilities, or a condition in which the individual is while performing an action, or after performing the desired action. The number of elderly people was tested in the research of the Department of Transport pleaded to feel pain when walking, or after performing this action. However, the interesting thing is that old people usually understand the importance that walking has on their health, so even when they feel the difficulties and inconvenience, they still decide to walk.

Factors that influence different levels of decisions are shown in next table (Table 9).

Table 6: Factors that will influence different levels of decision making

Mode of transport	Strategic	Tactical	Operational
Walking	Leisure activity No cost Quick local trips Maintaining health and mobility Limited distances	Fear of crime Fear from other traffic users Health conditions	Maintains health and mobility Health conditions Poor weather

People with handicap

People with disabilities are also more likely to be a part of the pedestrian group, since some physical limitations can make driving difficult. According to FHWA publication on providing access (1999), disabilities can be divided into three categories: mobility, sensory, and cognitive disabilities.

People with mobility impairments include those who use wheelchairs, crutches, canes, walkers, orthotics, and prosthetic limbs. However, many people with mobility impairments do not use assistive devices. Characteristics common to people with mobility limitations include substantially altered space requirements to accommodate assistive device use, difficulty in passing over soft surfaces, and difficulty in passing over surfaces that are not leveled.

Although people with sensory disabilities are more commonly thought of as totally blind or deaf, partial hearing or vision loss is much more common. Other types of sensory disabilities can

affect touch, balance, or the ability to detect the position of one's own body in space. Color blindness is considered a sensory defect.

Cognition is an ability to perceive, recognize, understand, interpret, and respond to information. It relies on complex processes such as talking, memory, learning, and recognition. Cognitive disabilities can hinder the ability to think, learn, respond, and perform coordinated motor skills. Such individuals might have difficulty navigating through complex environments, like streets, and might become lost more easily than other people might.

For those of us fortunate to live to an older age, 85 percent will have a permanent disability that limits our range of mobility. Disabilities are common through all ages, and the permanently disabled people make at least 15 percent of our population. Those with permanent physical disabilities, often kept away from society in the past, are now walking and bicycling regularly. Many others have temporary conditions, including pregnancy, and broken or sprained limbs that may restrict their mobility.

According to type of handicap, we can identify four main groups of pedestrians: mobility-impaired pedestrians, sensory-impaired pedestrians, pedestrians in wheelchairs and mentally impaired pedestrians.

Mobility-impaired pedestrians

Mobility-impaired pedestrians are commonly thought of as using devices to help them to walk, ranging from canes, sticks and crutches to wheelchairs, walkers and prosthetic limbs. However, a significant proportion of those with mobility impairments do not use any visually identifiable device.

Sensory-impaired pedestrians

Sensory impairment is often mistaken as being a complete loss of at least one sense, but a partial loss is far more common. Vision impairment mainly affects pedestrians' abilities, although to some extent hearing and proprioception (the ability to sense the location of parts of the body) can also have an effect

Wheeled pedestrians

Wheelchair and mobility scooter users can legitimately use the pedestrian network, but in many ways, their characteristics are very different from those of pedestrians who walk. This means that the network has to function differently when considering these users.

From the previous observation, we can conclude that people who are classified in this subcategory have limitations in three categories of abilities physical, sensory and psychomotor. Because of these restrictions, the width required for the movement should be increased, providing fewer possibilities for balance loss, neutralisation of lower observing height level, and reduced speed when moving uphill and increased speed when moving on flat surfaces or downhill.

Mentally impaired pedestrians

Category of persons with disabilities includes people with mental disorders. These people have restrictions in all categories of skills, but the most of them are related to the psychomotor and cognitive abilities. These damages may result in poor orientation in space, the impossibility of understanding the signals and information, the inability of fast reactions, inadequate assessment of traffic, etc.

Consequences of limitations and functional impairments of people with handicap

People with disabilities belong to all the previously mentioned age groups, have different levels of education, religious and racial affiliation and can live in different places. According to the facts

mentioned the reasons why people with disabilities travel may be different and can vary significantly depending on the subcategory that you are analyzing in a particular situation.

The main reasons of travel can be travel for business or education, travel for social and entertainment activities, travel to perform tasks related to household income and travel for the health services. (Penford, Cleghorn, Creegan, Neil, & Webster, 2008)

Similar to the old people, for fulfilling their needs, persons with disabilities must navigate to a specific destination such as a nearby city centre or a larger city, the local environment, periphery or going to another city, the site located at the other end of the country or abroad. However, according to the type of disability and the destination for which the purpose is associated with, the travel planning is an important part of the process and requires possession of a large number of information. Decisive factors that affect planning of persons with disabilities are the level of spontaneity and flexibility in planning trips and the travel, the provision of accessible information, and the level of confidence when travelling.

Walking, as a mode of transport among destinations is determined by distance and as a key factor will be the level of equipment and arranging the physical environment that provides safe and affordable movement of people with disabilities. They consider trips in which we use other transport modes, and include certain distance that is necessary to acquire walking.

The main reasons and barriers for walking of people with handicap are presented in Table 13.

Table 7: Reasons and barriers for walking of people with handicap

Mode of transport	Psychological/emotional	Practical/functional	Economic
Walking (+)	Purpose Lesure activity Socialisation	Quick local trips	No cost
Walking (-)	Low confidence Fear of crime Fear of injury	Poor weather Limited distances Health conditions Low income	

Tactical level of decision-making is determined by factors related to continuity of movement, the possibility of safe street and intersection crossing, as well as safe movement. This level is mostly determined by the characteristics of the environment, such as the topography, the existence of size-adjusted footpaths, and availability of the equipment adjusted to persons with disabilities. It is necessary that the information and signals are available, which serve people with different types of disability (people with sensory disabilities, persons with mental disabilities, etc.).

At the operational level, the decisive factors for the decisions in movement are the specifics of persons related to different types of disabilities. This level of decision-making is related to the specific characteristics of movement (walking, standing, stepping, etc.) and the level of possible damage will be the decisive factor for the selection of pedestrian movement as well as of the forms of transport. In addition, if a person uses a tool in movement, the level of available equipment in the environment will be another important factor in making this decision. When it comes to travelling in situations that are more complex, and since they require changing different forms of transport, the decision will be made according to the possibilities of entering and exiting the other transportation means, and the possibility of waiting undisturbed in places where the changes of transport are carried out. The possibility to communicate with staff who manages transportation means, and the level of assistance that they can provide when people with disabilities are involved in different forms of traffic are also important.

Factors that influence different levels of decisions are shown in following Table 14.

Table 8: Factors that will influence different levels of decision making

Mode of transport	Strategic	Tactical	Operational
Walking	Leisure activity No cost Quick local trips Distances Equipment and arranging the physical environment	Fear of crime Fear from other traffic users Health conditions Characteristic of the environment	Characteristics of movement Health conditions Poor weather

Other groups

Other groups can be extracted from some other groups of pedestrians, but their size and characteristics are not extensive enough to be separated. Possible parameters vary regarding the professional commitment, habits, place of origin and living, etc. However, their differentiation would overlap mentioned groups, so that some of their characteristics can be represented.

Instead of physic, psychomotor, sensory and cognitive abilities, we can analyze the action performed during walking by some studies done in USA. (NYC Department of City Planning, 2006) From this, we can distinguish smokers, pet owners, people who consume food in motion, people who listen to music or talk on a mobile phone while moving. Given the kind of action performed during the walk, some of the abilities may be limited (less attention when talking on a phone, limited hearing when listening to music, reduced speed of walking during the consumption of food, etc.).

In this study, these pedestrians will not be singled out as a distinct group. However, it is recommended that some of the future researches consider the characteristics of those pedestrians who perform another action while walking.

Conclusion

This paper presents the main results and conclusions related to the research of functional abilities of humans and identifications of specific groups of pedestrians. The abilities are individual characteristics that make someone perform certain actions and they can be divided into four groups: physical, psychomotor, sensory and cognitive abilities. *Physical abilities* are those individual skills that include strength, endurance, flexibility, balance and coordination. *Psychomotor abilities* are skills that affect the ability to manipulate and control objects. *Sensory abilities* are abilities that affect the visual, sound and speech perception. *Cognitive abilities* are the abilities that affect the acquisition and use of knowledge during solving certain problems. Having in mind the identified groups of abilities, there were analyzed the characteristics and abilities of pedestrians that influence pedestrian movement, and segments and elements of pedestrian traffic and infrastructure on which it can be reflected.

Following noticing the abilities that are necessary for walking, there is considered physical environment, social environment and transportation access, as preconditions for the safe mobility of pedestrians. Those preconditions affect the decisions on all three strategic levels (operational, tactical and strategic) regarding the movement of a pedestrian. In addition, listed preconditions do not act independently, but as a system.

Base on abilities and characteristics, there are described individual groups of pedestrians that can be found (children, adults, elderly and persons with disabilities) and their general characteristics and subgroups that can be recognized within isolated groups.

The consequences of limitations and functional impairments of different groups of pedestrians are explored on the basis of established three strategic levels of decision making (operational, tactical and strategic). Having in mind that identified groups show a specific behavior regarding on their abilities they will act differently in relation to strategic levels of decision-making. Related to this we conclude that it is necessary to ensure barrier free environment (physical, social, transportation, etc.) in which people can behave freely and independently in accordance with its abilities.

At the end of the subsections there are recognized the main reasons and barriers for walking of people who belong to different groups that were identified. Also there are stated the factors that will influence different levels of decision making (strategic, tactical and operational).

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