

# Door's design for people with mobility impairments and service dogs

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**ABSTRACT:** A door can be an obstacle when it does not meet the needs of its users. The purpose of the work was to determine the dimensional and functional requirements of the use of internal doors in public buildings by people with mobility impairments and with service dogs. This paper addresses three subjects: (i) human and canine functioning, (ii) accessibility standards, and (iii) comparison between personal and environmental components. As a result proposals for the improvement of the Portuguese accessibility standard are presented.

## 1 INTRODUCTION

Accessibility is characterized by a set of environmental conditions allowing its users to "reach, understand or approach something or somebody" (WHO & WB 2011). The accessibility standards set out good practices and, when compulsory, regulate the minimum requirements to be met.

Inclusive design is "The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible (...) without the need for special adaptation or specialised design" (BSI 2005). The partnership of designers with extreme users (users with a severe disability or multiple disabilities) is one of many different approaches to inclusive design. By meeting the needs of extreme users, inclusive design can create mainstream design solutions that are accessible, usable and enjoyable by a broad range of users.

## 2 CONCEPTUALIZATION

### 2.1 *Doors in public spaces*

In buildings doors are the boundary element between two spaces enabling or conditioning the passage. Nowadays, many exterior doors in public buildings are automated. The investment to install and maintain these systems, decrease their viability in internal doors, mainly due to their greater quantity. Despite the advantages for accessibility, automated systems also have detection, timing and power cuts problems.

### 2.2 *Portuguese accessibility standard*

The Portuguese accessibility standard is mandatory and enforced by the Decree-law 163/2006. The standard sets minimum criteria to be met in public spaces, community facilities, public buildings and residential buildings. Requirements for doors accessibility are set in the standard. The standard reportedly focuses mainly on people with reduced mobility, namely wheelchair users.

### 2.3 *Target subjects*

It was estimated that there are 171,255 individuals living in Portugal with motor impairments (INE 2001), representing almost 1,7% of the total population.

The service dog (SD), like the guide dog, belongs to the assistance dog category and their function is to assist people with motor impairments in overcoming challenges in autonomous activities of life, e.g. picking up objects, switching lights and operating doors. In Portugal, the use of service dogs is regulated by the Decree-law 74/2007, which grants people the right to be accompanied by their service dog to locations, transports and facilities of public access. Presently there are four service dogs in action in Portugal and they are exclusively Labrador's Retriever breed.

### 2.4 *Problem statement and goal*

People with mobility impairments (PMI) are more likely to have more difficulties using the doors. Their structural and functional anthropometric dif-

ferences give rise to gaps in the interaction with doors.

Although many PMI depend on their canine partner for door operation, dogs are not usually considered in doors design. A rope attached to the door handle is an improvised solution often adopted for doors operation by SD, but is not viable in public spaces.

The Portuguese accessibility standard focuses on wheelchair users. This approach does not necessarily address the needs of the remaining PMI or the SD.

The objectives of the work were to i) determine the dimensional and functional requirements for the use of internal doors in public buildings by PMI and SD, and ii) make proposals to improve the requirements regarding doors set by the Portuguese accessibility standard.

### 3 RESEARCH DESIGN

#### 3.1 General approach

The implementation of accessibility principles may be compromised by the lack of theoretical fundamentals in at least one of the three levels of knowledge (Iwarsson & Stahl 2002): standards (environmental component), human functioning (personal component), and compatibility between personal and environmental components. This study addresses the three components.

#### 3.2 Environmental component

A comparative analysis of accessibility standards from Portugal (DL 163/2006), Australia (AS 1428.2-1992 and AS 1428.1-2009), United Kingdom (BS8300: 2009) and United States of America (ICC/ANSI A117.1-1998) was carried out. Portuguese and Australian standards are mandatory. The remaining two standards are recommendatory. Accessibility standards set the rules that shape the environment where PMI and SD have to operate.

#### 3.3 Users component

For human functioning, anthropometric studies involving direct consultation of PMI (a total of 690 individuals) were analyzed to obtain live data.

A questionnaire was applied to determine the constraints and preferences in doors use by PMI in the Portuguese context. A sample of persons with heterogeneous mobility impairments was selected. The questionnaire collected data on how the performance was influenced by the type of door (hinged and sliding), handles and mechanical closing devices. A set of 28 questions using a Likert scale (never, rarely, sometimes, usually, always) was used and the collected data were treated statistically, using descriptive statistics.

The research about Labrador as a service dog using doors was limited mainly due to the sparse literature on the subject. Three sources of data were collected: the breed standard, an interview with a service dog educator and a study on SD opening hinged doors using the rope's method (Coppinger et al. 1998).

#### 3.4 Compatibility between personal and environmental components

Proposals to improve the Portuguese accessibility standard were based on the comparative analysis of accessibility standards and the constraints and preferences in doors use by PMI and SD.

## 4 RESULTS

### 4.1 Comparative analysis on accessibility standards

Portuguese minimum clear width is the smallest of the four standards (from 770 mm till 850 mm). In the PT, AU and US standards the clear width of a hinged door is measured between the jamb and the door leaf open at 90 degrees. The UK measurement method allows different amplitudes in door opening and discounts the projection of door hardware (Fig. 1).

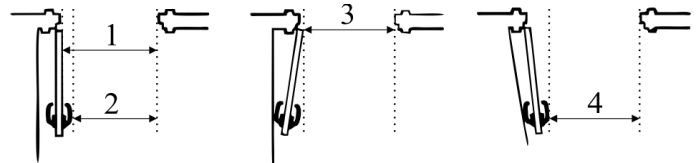


Figure 1. Measuring methods for clear width in PT, AU, US (1) and UK (2, 3, 4) accessibility standards.

The maximum force for door opening is similar between the four standards, varying from 20 N to 22.5 N. The US and UK standards set that the maximum strength for door hardware operation should be less than those agreed for door use. The US standard does not specify any values. The UK standard sets "the torque force required to operate keys and cylinder turns should not exceed 0.5 Nm". PT and AU standards establish a unique maximum force for all door operations.

All four standards indicate that door hardware shall allow the door to be unlocked and opened with one hand and without prehension need. The dimensional constraints for doors hardware location are presented in Table 1.

Table 1. Parameters for locating doors hardware

|    | (1)      | (2)      | (3) | (4) |
|----|----------|----------|-----|-----|
| AU | 900-1100 | 900-1200 | 60  | 50  |
| UK | 800-1050 | 700-1300 | 54  | 72  |
| US | 865-1220 | (*)      | (*) | (*) |
| PT | 800-1200 | (*)      | 50  | (*) |

(\*) Unspecified.

(1) Lower-upper limits for door hardware (mm).

(2) Lower-upper limits - pull handles (mm).

(3) Minimum distance from door free edge (mm).

(4) Minimum distance between devices (mm).

#### 4.2 Anthropometric studies on population with motor impairments

The two studies analyzed included various anthropometric parameters from PMI and tested hinged doors use (Steinfeld et al. 1979, 2010). The following three main recommendations were collected from these studies.

Wider doors are better for accessibility and there is no need to set a maximum width of doors in regulations, although doors wider than 1040 mm could pose some problems (Steinfeld et al. 2010).

Grip precision is inversely proportional to device contact area. Maximum force for small devices is not expected to exceed 9 N. For operation of larger devices the desirable upper limit is 22 N. Knowing that many users have very limited or no grasping ability, whenever possible, design should promote solutions for device operation without the need for prehension (Steinfeld et al. 2010).

The upper limit of 1220 mm in lateral reach of the American standard is adapted to the majority of wheeled mobility devices (WMD) users and it could rise even higher, "but this may result in limitations for people of small stature". In turn, the 380 mm lower limit of the same standard needs to be updated to 700 mm, since lower ranges have proven unsafe for WMD users (Steinfeld et al. 2010).

#### 4.3 Labrador's anatomy and functioning

Taking into account the ideal posture for Labrador in door operation (all four paws on the floor), the dog is hardly capable of grasping the handle at 800 mm high with its teeth in a forced extension of the neck (Fig. 2).

The snout use is not just a canine natural preference for doors operation but also a way to avoid doors deterioration caused by the use of paws (Castro Lemos 2012).

Strength demands for Labrador opening doors with a rope increases with the height differences between dog's mouth and door handle. Even without maximum force quantification, it can be said that Labrador can exert forces higher than 22 N (Coppinger et al. 1998).

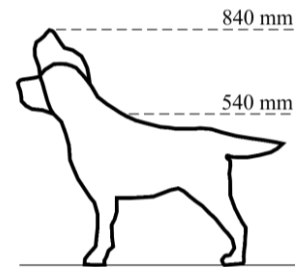


Figure 2. Minimum height (540 mm) of Labrador Retriever standard and maximum estimated height range (840 mm).

#### 4.4 Constraints and preferences in doors use by PMI in the Portuguese context

The most relevant results from the 41 respondents to the questionnaire are presented below.

The problems in reaching door handle are considerable, since half of the sample experiences "sometimes" or "usually" difficulties in reaching the handle. Moreover almost half of the sample states the use of handles for body support, at least in some situations (Table 2).

Table 2. Questionnaire results

|                                      | MEAN* | STDDEV |
|--------------------------------------|-------|--------|
| I cannot reach door handles.         | 2.46  | 1.142  |
| I use the door handle to support me. | 2.41  | 1.161  |

\*1 (Never), 2 (Rarely), 3 (Sometimes), 4 (Usually), 5 (Always)

Preferred height for doors hardware is not consensus among respondents: 44% prefer a lower handle, 25% a higher handle and 24% a "well located". These differences are most likely related to reach capabilities, often constrained by mobility limitations or changes in body structures functioning such as the ones in upper and lower limbs, trunk or stature, or even the limitations imposed by their own assistive devices for mobility.

#### 4.5 Proposals to improve the Portuguese standard

The location of door hardware between 800 mm and 1100 mm in the Portuguese standard constitutes a reach problem for Labrador since only in forced extension of the neck the dog is only able to reach the 800 mm height with its snout. Many human users also stated their preferences on lowering door hardware to resolve their own reaching problems. Mean-time, other users have needs for higher devices. Therefore door hardware should present as many different height options as possible for more users benefit, i.e. multi-point solutions, and the heights range should be reduced from 800 mm to at least 700 mm

in their lower limit. Ideally this improvement may extent to a full height solution.

The use of the UK measurement system for clear width, would contribute to conflict regulation between the projection of door hardware and effective width for passage. This would not only beneficiate users but would also benefit the designing of spaces, expanding project options with variations in door opening angle.

Operating doors using only the snout contact is a condition for service dog that meets the prehension need for human users when handling door hardware. Therefore, design development of door hardware solutions that exonerate prehension needs will benefit human and canine use. Following this specification, clearance considerations are required around door hardware to facilitate its use with a closed hand, a dog's snout or similar. In this matter, at least two considerations for Portuguese standard improvement can be made: (i) increasing the minimum distance from door free edge and (ii) establishing the same value for the minimum distance between devices. Preferably, this value should be 72 mm as set by the UK standard (Fig. 3).

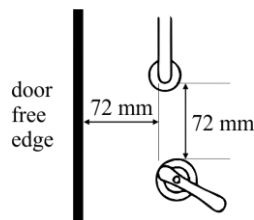


Figure 3. Distances in door hardware (example).

## 5 CONCLUSIONS

It was concluded that SD, as an extreme user, have requirements for door design which can also benefit human users.

The suggestions to improve the minimum requirements for doors design set by the Portuguese accessibility standard would enable more inclusive practices.

The main suggestions are the following: reduce the lower limit of door hardware, change the measurement system of door clear width, set minimum clearance criteria around door devices and promote door hardware solutions with no need for grasping.

This study has some limitations. The results are adapted to the Portuguese context and based on a small sample of the population with mobility impairments.

To increase reliability of the results, the study should proceed. Further research should be based on observation, experimentation and participation of a more representative sample of the target population.

## 6 ACKNOWLEDGEMENTS

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