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Elderly people and fall hazards in the historical centre of Santiago de Chile. Assessment and barrier-removal proposals for a better quality of life

Safety

This article identifies fall hazards for elderly people in the public space of the historical centre of Santiago de Chile. It does so by defining barriers and surveying their presence in the selected public spaces and streets. It also records the perception of elderly people who use this space or have ceased to do so due to the risks they have to run. The results will serve as the basis for a proposal of measures for overcoming these barriers, thus raising the quality of life for this age group and all users of the city.

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Two trends that characterise the C21st society are an ageing population and their general tendency to live in cities. Within this demographic trend, cities and the proportion of the population aged 60 and over are both set to grow at unprecedented rates, as part of an inevitable and irreversible process. Both factors pose huge problems in terms of providing safe environments conducive to autonomy, independence, active ageing and integration of elderly people into society, ensuring a suitable quality of life for this age group.

In line with the above trend, today's urban population now accounts for 80 of the population in Latin America and will continue growing until reaching 89 percent by 2050, (UN -Habitat 2012). This includes elderly people, who are more socially, economically and culturally vulnerable to the perils of this urban living and tend to live in environments that are not really suited to their needs.

According to the reference studies (*Fundación MAPFRE, Spain, 2011*) elderly people's out-of-the-home accident rate is an important problem that needs to be dealt with. The commonest accident is falls (81 percent) due to damaged or uneven pavement, affecting one third of elderly people. This has devastating effects for the health system and families, increasing the A&E load and the need for surgical operations and rehabilitation treatment. According to the abovementioned population estimates, all these problems are bound to increase, (Gonzalez, 2001), (Cartier, 2002), (Gac, 2003). The solution does not lie in increasing hospital facilities but rather in preventive action. Most of these accidents, after all, are avoidable by dint of a proper analysis of the causes and then acting accordingly

Two trends that characterise the C21st society are an ageing population and their general tendency to live in cities. These factors call for a proper study of the problem and the provision of safe environments

Our study centres on the following factors: the population's ageing and urban living as an important problem; the intrinsic and extrinsic conditions affecting elderly people; the need of a suitable quality of life on the basis of a favourable environment; identification of mobility-affecting and fall-inducing risks and barriers that limit access to urban spaces and public buildings, hindering the social inclusion of elderly people. We generate a hazard counting and surveying method and a rule for identifying types of barriers in the historical centre of the city of Santiago de Chile, to propose general lines of action and measures to overcome these hazards.

Working hypotheses and objectives

The working hypothesis of our study is that elderly people's degree of autonomy and independence in moving around the city and the presence of barriers and risk hazards are directly related to the design characteristics of the architecture and the urban spaces they move and live in. The degree of mobility of elderly people, therefore, is not only tied in with strictly physiological and anthropometric aspects but is also determined by the spatial and formal characteristics of the environment. A suitable diagnosis would make it possible to identify barriers and hazards, pinpoint necessary adaptations and lay down general lines of action. This would be based on an analysis of the types of hazards posed, in the interests of improving the situation and creating a people-friendly, risk-free city not only for elderly people but for everyone else too.

The general objective of this project is to survey and identify the types of barriers present and fall hazards for elderly people in the historical centre of Santiago de Chile, doing so on the basis of an examination of the urban space and important public buildings. An instrumental guideline was drawn up to evaluate the mobility-accessibility relation and potential fall risks in the study area. These were brought into relation with architectural and urban-facility factors to propose necessary adaptations and lines of action to improve the situation. This objective assumes that the autonomy and independence of elderly people arises from the relation between their anthropometric-functional characteristics and the formal-dimensional features of urban spaces and public buildings.

This overarching objective can be broken down into the following specific goals:

- Identify, describe, survey and categorise by type the mobility-limiting situations and barrier-associated fall risks in direct relationship with aspects of architecture and design. This also involves observing the way elderly people move around the urban space and important public buildings of the historical centre of Santiago de Chile.
- Systematise the findings in tables to serve as a basis for generating adaptation proposals according to the types of barriers and risks detected and suggestions for formalising these proposals in legislation and standards.
- Crosscheck detected fall hazards against objective data (on the basis of the assessment and interpretation of the research team), subjective data (of the users themselves) and referential data (from legislation and standards in Chile and other countries).
- Assess the applicability in Chile of tried-and-tested urban-space adaptation and barrier-removal experiences for elderly people, as carried out abroad, e.g. Spain

The historical centre of Santiago; definition of the sample

The chosen sampling area is the historical centre of Santiago, not only due to its civic and cultural value but also because it is still a place where many administrative, cultural and commercial activities of great importance to its citizens are carried out. The study area is delimited by the following vertices:

- North: the southern pavement of Costanera Andrés Bello, bordering on the River Mapocho, as an important threshold in terms of defining the historical centre of Santiago.
- Sur: northern pavement of Alameda Bernardo O'Higgins, as the natural limit too of the historical centre, generated as a thoroughfare after starting out as a branch of River Mapocho.
- East: western sidewalk of Calle Ismael Valdés Vergara, to the foot of the hill called Cerro Santa Lucía. This hill was the

site of the first Spanish settlers and as such the seed of the city and today's historical centre

- West: the least defined border, historically speaking, but we established as an eyeline for the border of our study the western pavement of Calle Teatinos. This includes two important buildings: Mapocho train station and the Palacio de Gobierno (Government Hall)

Within the abovementioned limits the study area was then broken down into the four following items:

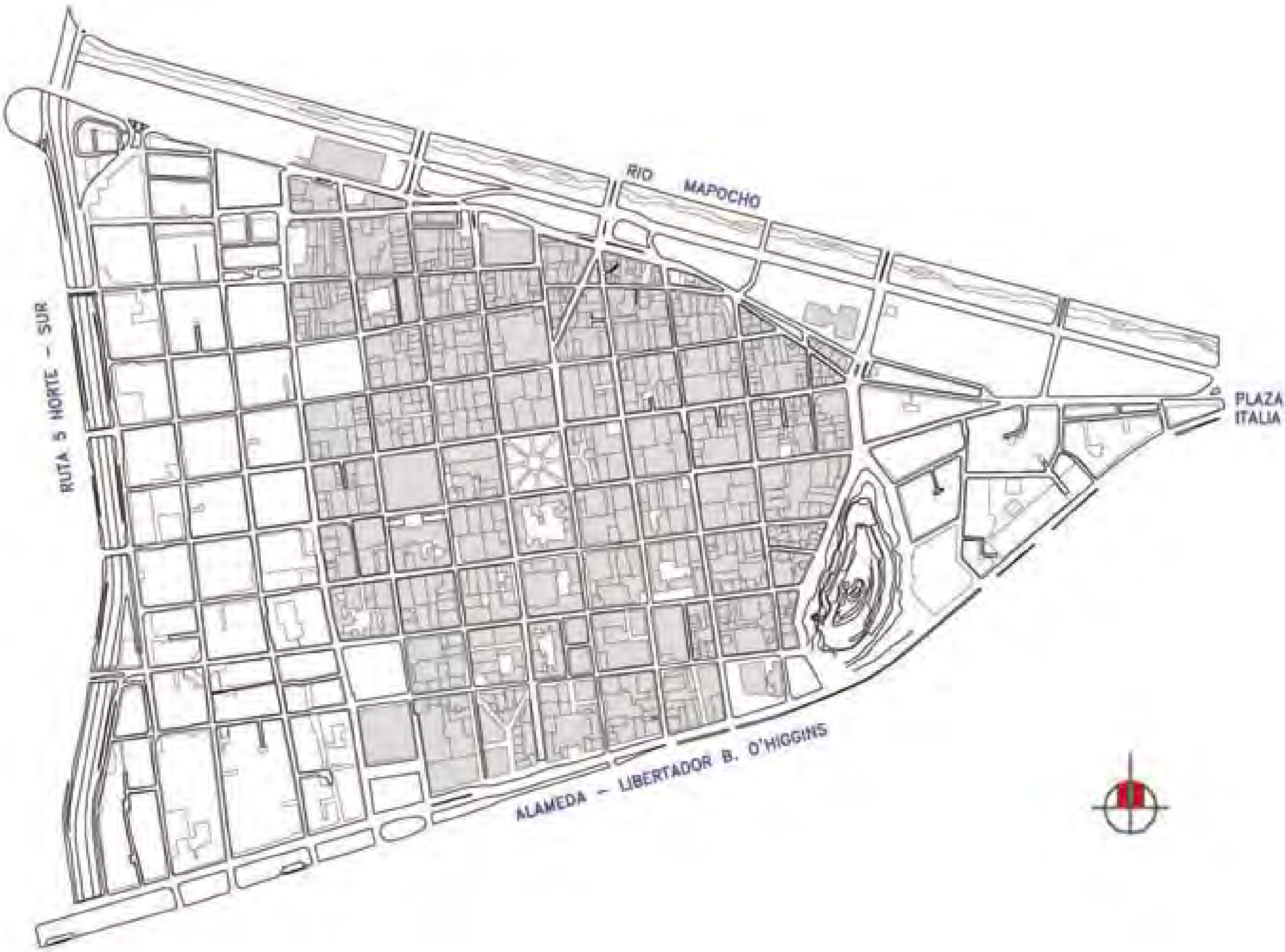

Figure 1. Study area in the historical area of Santiago.

Thoroughfares, public spaces, buildings and metro stations

Thoroughfares

A selection was made of cases representing the different types existing in the study area: city-connecting trunkroad, pedestrian street and mixed thoroughfare for pedestrians and vehicles, including public transport. For each of these types the following cases were selected as the most representative

- City-connecting trunkroad: Alameda Bernardo O´Higgins, northern pavement, the main east-west city spoke. It comprises the main transport pathways including the Metro (underground train), and is the main access thoroughfare to the city centre; as such it is always busy.
- Pedestrian street: of those existing in the study area the following was selected: *Paseo Peatonal Huérfanos*, running east-west from Cerro Santa Lucía to Teatinos.
- Mixed pedestrian-vehicle thoroughfare including pubic transport: the selected streets were *Calle Bandera* and *Calle San Antonio*, both important routes of communication between the north and south of the city.

Public Spaces

The chosen public squares were *Plaza de Armas*, the main square of the original city, *Plaza de la Constitución* and *Plaza de la Ciudadanía*, due to their symbolic character and crowd-attracting potential, and the *Parque Forestal* in the area surrounding the Museum of Fine Arts and Museum of Contemporary Art, due to their cultural attraction and large daily crowds (Fig. 2).

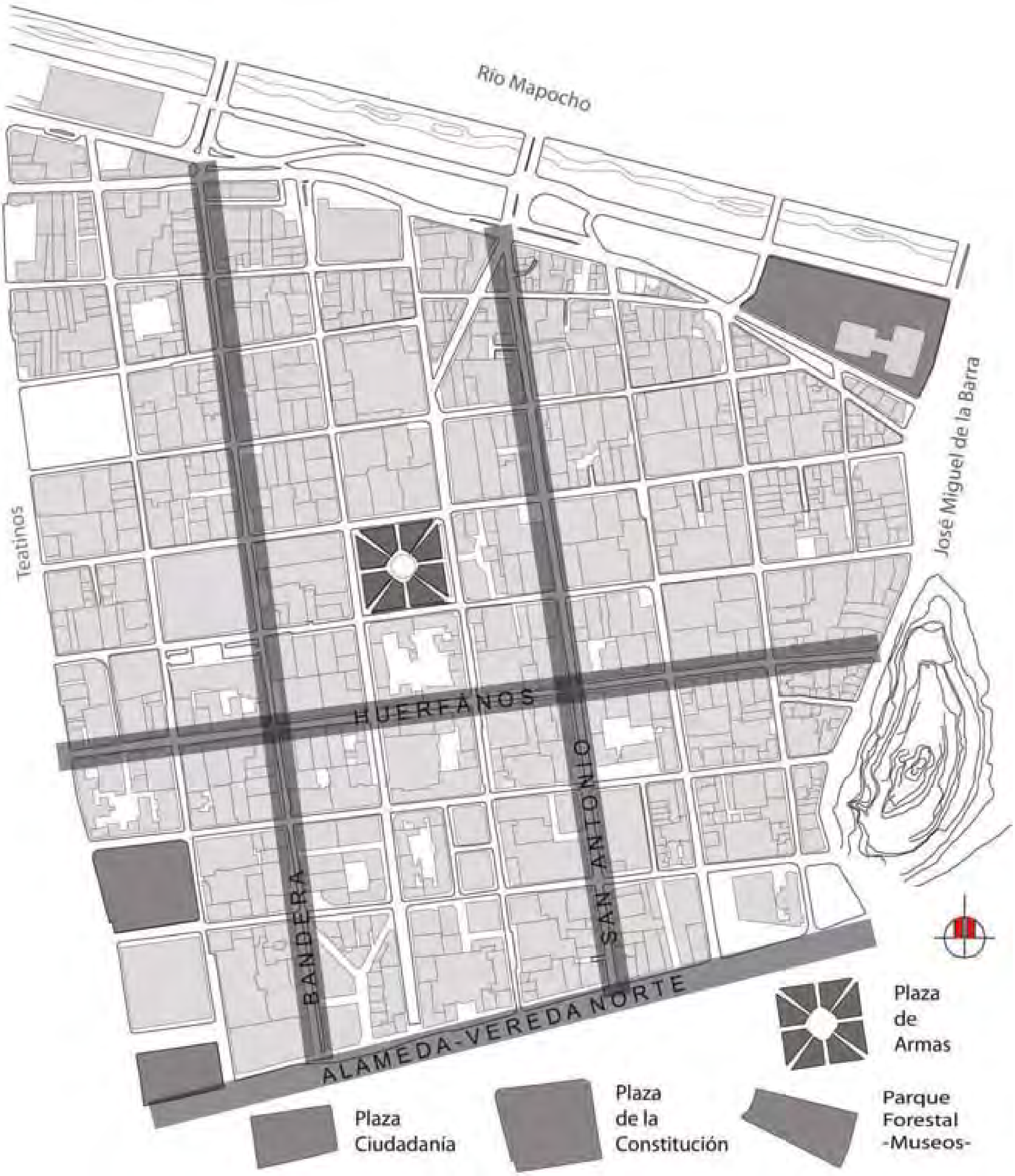

Figure 2. Location of thoroughfares and public spaces.

Important Buildings

A total sample of 26 buildings was chosen; 24 of them are historical sights set in the study area, with a big impact on the surrounding area and a large crowd-attracting potential (taken from the official record of the Local Byelaw of the Municipality of Santiago), then tagging on the head offices of two major banks *Banco del Estado* and *Banco de Chile*, both housed in listed buildings (Fig. 3).

Figure 3. Location of important buildings.

Metro Stations

It was considered important for the study to take into account accessibility into the six Metro stations falling within the study area. This means of transport is a very important mobility factor for elderly adults, to access the historical centre from different sectors of the city. Lines 1 (red) 2 (yellow) and 5 (green) run through the sector (Fig. 4).

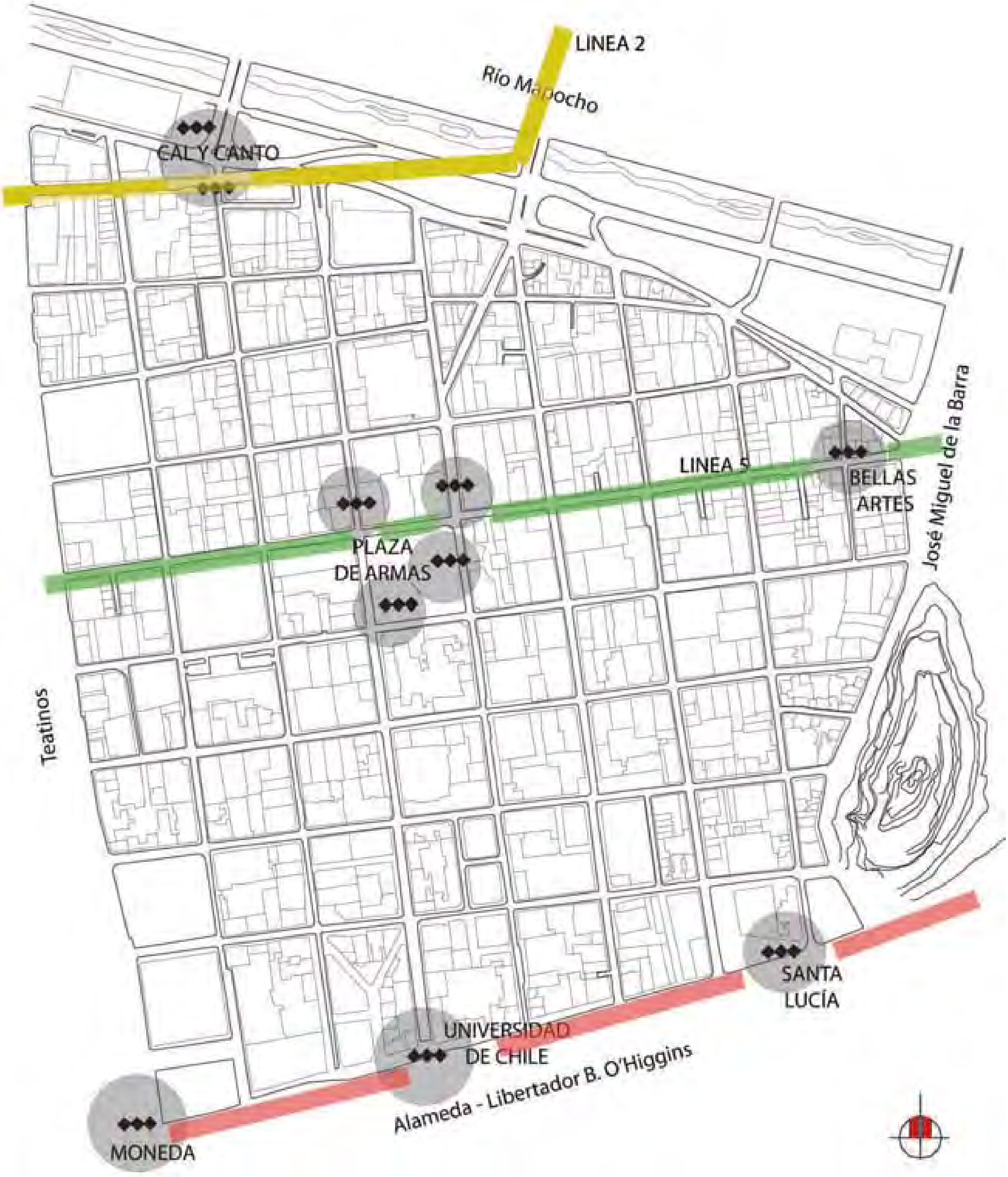

Figura 4. Location of metro station entrances.

Risk Assessment

The study is mixed in character with some quantitative aspects but mainly qualitative aspects of a descriptive, explanatory and cross-sectional nature. Its purpose is to assess the mobility and movements of able-bodied elderly people in the historical centre of Santiago de Chile, ascertaining the fall hazards and possible improvements.

The descriptive character of the study involves the following factors: characterisation of the risk factors and dimensions of the physical environment and its components plus the anthropometric and functional characteristics of the use of these spaces; its explanatory character is accounted for by comprehensive and relational argumentation in the form of user comments. The cross-sectional character is expressed by a combination of town-planning, architectural and physiological outlooks.

Data validation was conducted by means of the expert team's analysis of important information, giving an objective opinion on the presence of fall hazards in the historical centre of the city and the experience of the elderly people, assessed by means of a focus group, inputting the subjective opinion of risks present

The assessment was conducted in the following stages:

- Definition of observation parameters.
- Design of field recording instruments .
- Focus group.

Definition of observation parameters

Our definition of the parameters to be observed was based on references of international accessibility experts, Enrique Rovira-Beleta (2003) and Fernando Alonso (2002) of Acceplan, both Spanish. To be able to systematise the information, a conceptual definition was made of the barriers to be identified. To do so the urban space of the thoroughfares was broken down into three categories:

Obstacle-free zone

This is generally the part of a pedestrian street running adjacent to buildings that is ostensibly kept free of any protuberances, street furniture or any other obstacle that might hinder the free passage of pedestrians

Changes of level:

Any area involving steps, ramps or changes of level within the pedestrian area should be duly indicated with a warning of the height.

Crossings

This refers to the intersection of two thoroughfares, whether pedestrian or vehicular. The remit here is to remove all barriers on pedestrian routes to ensure they are accessible for the whole population. They should be designed to be as close as possible to each intersection of the street.

Within each of these categories a definition was also made of the various components or elements, each with diverse characteristics, that might potentially pose a risk to free circulation of people if badly sited or designed.

In the obstacle-free zone the following was observed:

Dimensions. these have to be at least 1.5 m wide and with a clearance of at least 2.1 m. As for pavements, the curb height should never be more than 12 cm. At pedestrian crossings and street corners they have to lowered to the same level (level 0). No urban elements fixed to building facades should protrude by more than 15 cm in the obstacle-free zone.

Street furniture. For our purposes this concept includes seats, handrails, litter bins, bollards and other such elements. As objects of public use all these items must be user friendly and, above all, they must be fitted in such a way as never to pose a barrier or obstacle. In particular they must never be allowed to reduce the width of the obstacle-free zone; they must be properly distributed and safe to use without any potentially harmful burs, edges or corners.

Trees. Tree protecting elements and grid-covered tree wells on pedestrian walkways might be made of various materials, regardless of which they must always be firmly fixed, flush with the surrounding pavement and nonslip.

Pavement. Urban pavements should be hard, nonslip and continuous, without any joints or openings that might hinder pedestrian passage, especially of the elderly. Cobbled-type pavements are especially troublesome and are impossible to walk on for many. In the case of wooden-board or ventilation-grid pavements, the joint between the elements has to be less than 1.5 cm, and the joints should always run in the walking direction, never across, to reduce the chances of trapped walking sticks, crutches, wheelchair- or pram-wheels. All pavements have to be firmly fixed to the support element without any missing or lose parts. Due consideration should be given to the fact that polished or enamelled pavements might be dazzling.

At any changes of level in any of the spaces under study herein, due consideration was given to the following:

Steps or staircases. strictly speaking these do not tally with concepts of accessibility but there are certain factors that make them easier to use for elderly adults, namely:

- Stair treads have to be at least 28 cm. and the riser at most 18 cm. Stairs with open risers are not recommendable since elderly adults tend to use the back of the tread to feel their way. There should also be no overhang of the tread over the riser as this might trip up anyone climbing the stairs.
- Accessible staircases will have a maximum of 8 steps per flight; if ever this amount is exceeded there should be resting places measuring at least 150 cm. There will be handrails on both sides. Pavements at the top and bottom of the stairs will be nonslip, with texture in relief and contrasting colour with the steps, measuring at least 60 cm. along the width of the stairs.
- In the shaded areas underneath the stairs there should be a clearance of at least 2.1 m. to ensure visually impaired persons do not bang their heads.

Ramps. A ramp is the accessible solution for spanning different levels. In pedestrian walkways the maximum ramp slope should ideally be 10 percent. The minimum width of the ramp has to be 90 cm. Throughout their whole length there should be a handrail with side protection edges of at least 10 cm. to avoid slipping. The pavement should be nonslip and firmly fixed.

Factors to be taken into account at crossings are the following:

Level drops. These should be designed to sit as close as possible to each crossing of the street or walkway. The two levels will be joined by an inclined plane with a maximum lengthwise slope of 10 percent and maximum sideways slope of 2 percent. The level drop should have a minimum width of 1.2 m., in which there should be no item of equipment such as bollards or the like. The level drop shall end at level zero, i.e., at the level of the pavement or roadway. The texture of the crossing pavement shall stand out from the rest of the pavement. The texture will be in relief or other standardised surface that complies with pedestrian crossing alert legislation.

Pedestrian crosswalk traffic lights. Pedestrian crosswalk traffic lights should be placed as close as possible to the vehicle stop line, in the same field of vision and at a maximum height of 2.1 m. The crossing time has to be sufficient to guarantee safe crossing of elderly adults, bearing in mind their reduced mobility. If the crosswalk lights have a pushbutton, this should be placed at a height of between 90-120 cm. There should be an audible sign to inform pedestrians of the crossing period.

Opposite curb ramps at crosswalks. Curb ramps at crosswalks will be so designed as to lie opposite each other ensuring a crossing direction at right angles to the roadway.

Design of field recording instruments

The following 2 types of data recording forms were designed to systematise field recording procedures:

Form for studying building blocks, crossings and public spaces

A form was designed to show a plan view of the block, crossing or public space under study together with a general plan view of the whole thoroughfare with the block or crossing in question greyed in. This form was used for recording any elements representing a barrier or fall risk according to the objective observation of the researchers.

For this purpose the following symbols were used: (Fig. 5).

Figure 5. Barrier symbols.

The barriers found in the thoroughfares under study were catalogued as building blocks and crossings. Crossings were taken to be the intersection of the thoroughfare under study with those that cross it, as confined within the projection of the building line of each construction making up the corner. As for public spaces, the whole block containing them was studied. (Fig. 6) (Fig. 7) (Fig. 8).

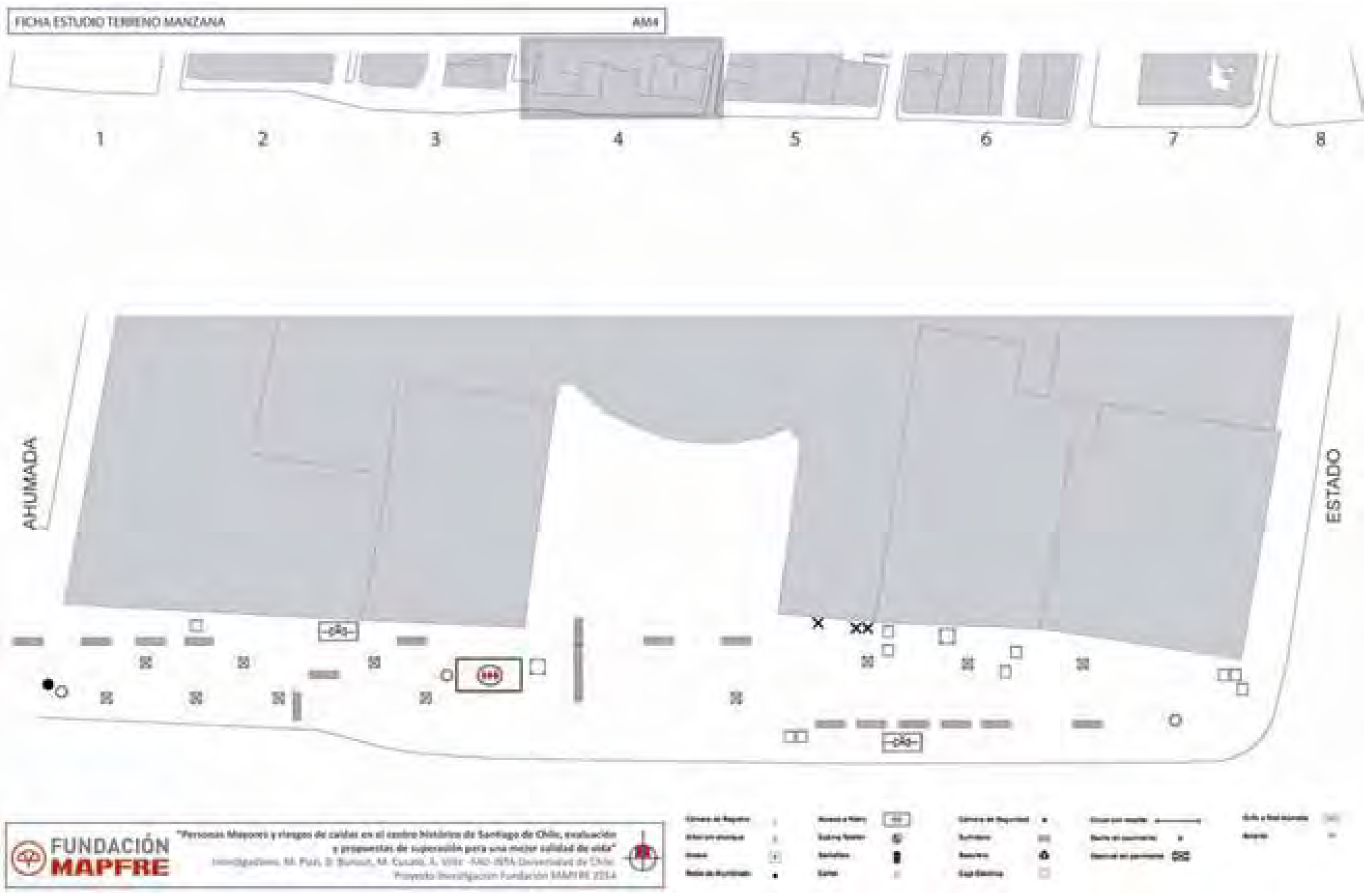

Figure 6. Block study form.

Important building and metro entrance study form

A form was designed for field recording, showing the elevation of the main entrance to the building or metro and the state of the pavement of the block where it stands. The form therefore consists of a plan view with the corresponding part of the block, recording the barriers using the same symbols as for the study of thoroughfares; smaller scale location plan, photographs and a binary recording chart of the problem found.

The following parameters were established to systematise the recording of barriers or risks:

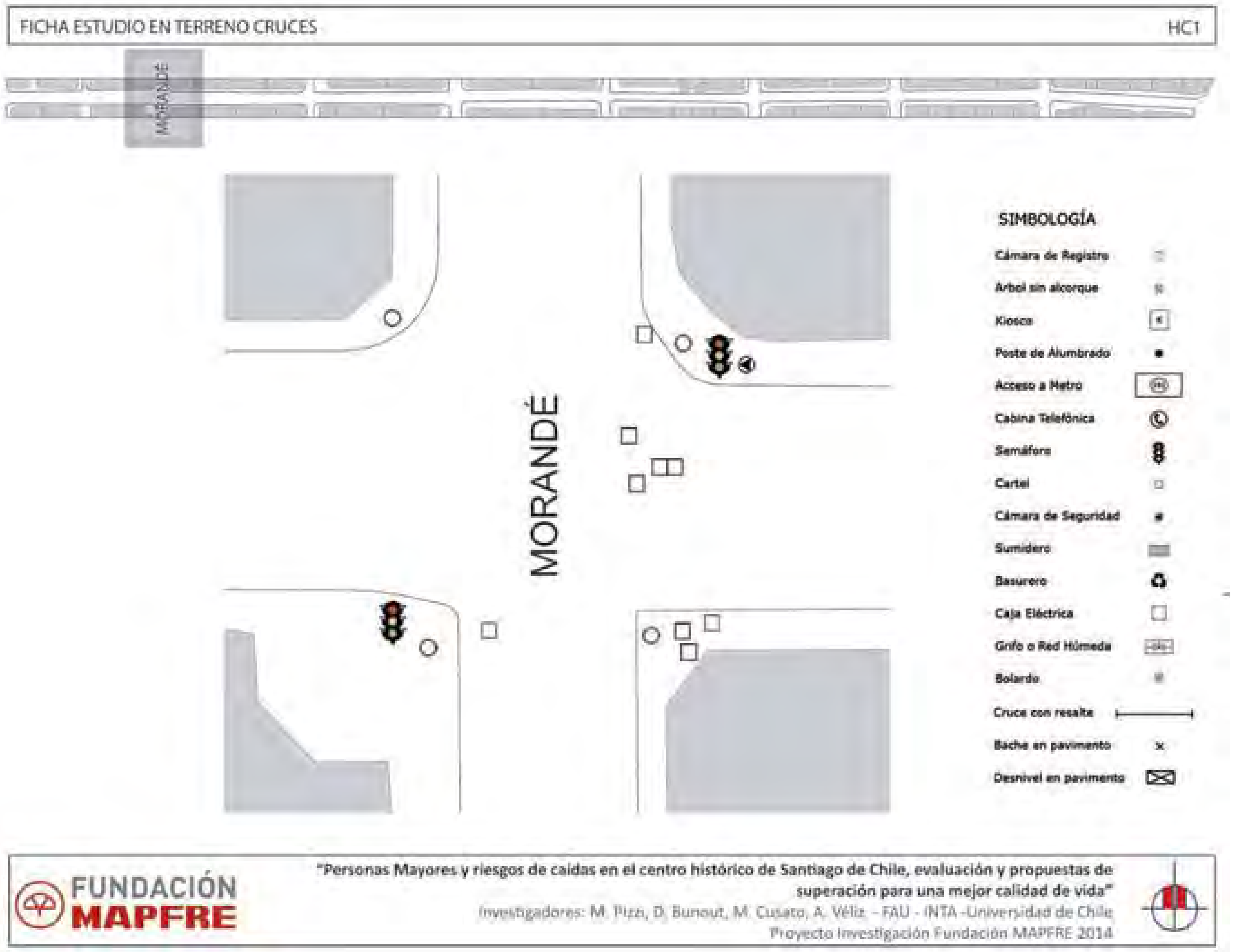

Figure 7. Crossing study form.

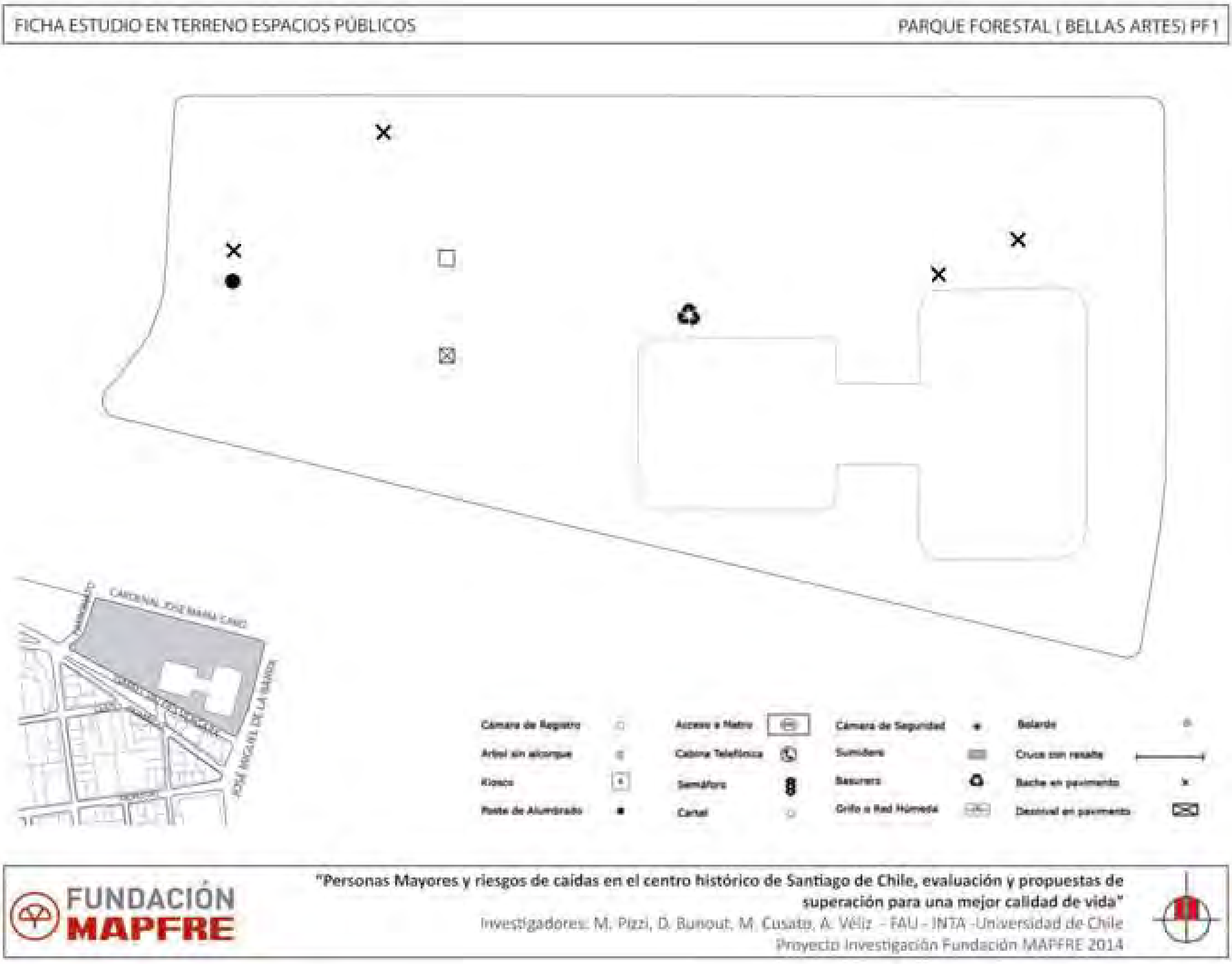

Figure 8. Public spaces study form.

A suitable diagnosis would make it possible to identify barriers and risk situations in the interests of improving the situation and creating a people-friendly, risk-free city not only for elderly people but also for everyone else

Dimensions (width): assessment of the access width both of the threshold and entrance door. This must allow unfettered entrance and the necessary manoeuvres for safe and comfortable circulation.

Level jumps (height): assessment of the height of stairs or level jumps that have to be spanned to reach the main building entrance. These must have a maximum height of 18 cm.

Handrail. At least one handrail will be necessary in the presence of any stairs or level jump. This handrail will be 85-90 cm high from pavement level; it has to be continuous up to the first landing and it must be smooth and easy to grab with the whole hand. Non-existence thereof is considered to be a risk or barrier.

Landing. assessment of the length of the landing whether on the staircase itself or before the entrance door, to ensure the door-opening operation is safe and easy.

Door (opening). assessment of the opening mechanism; this must be simple, easy to operate for users of all types in a safe and autonomous way.

Ramp. If there is any change of level at the building entrance there must be a ramp that can be autonomously used by all people. An assessment will be made of the existence, upkeep and state of the ramp.

A table was therefore drawn up with the abovementioned parameters, involving a binary analysis of 0 when there is no risk or problems and 1 when there is at least one problem. (Fig. 9) (Fig. 10)

Figura 9. Important building study form.

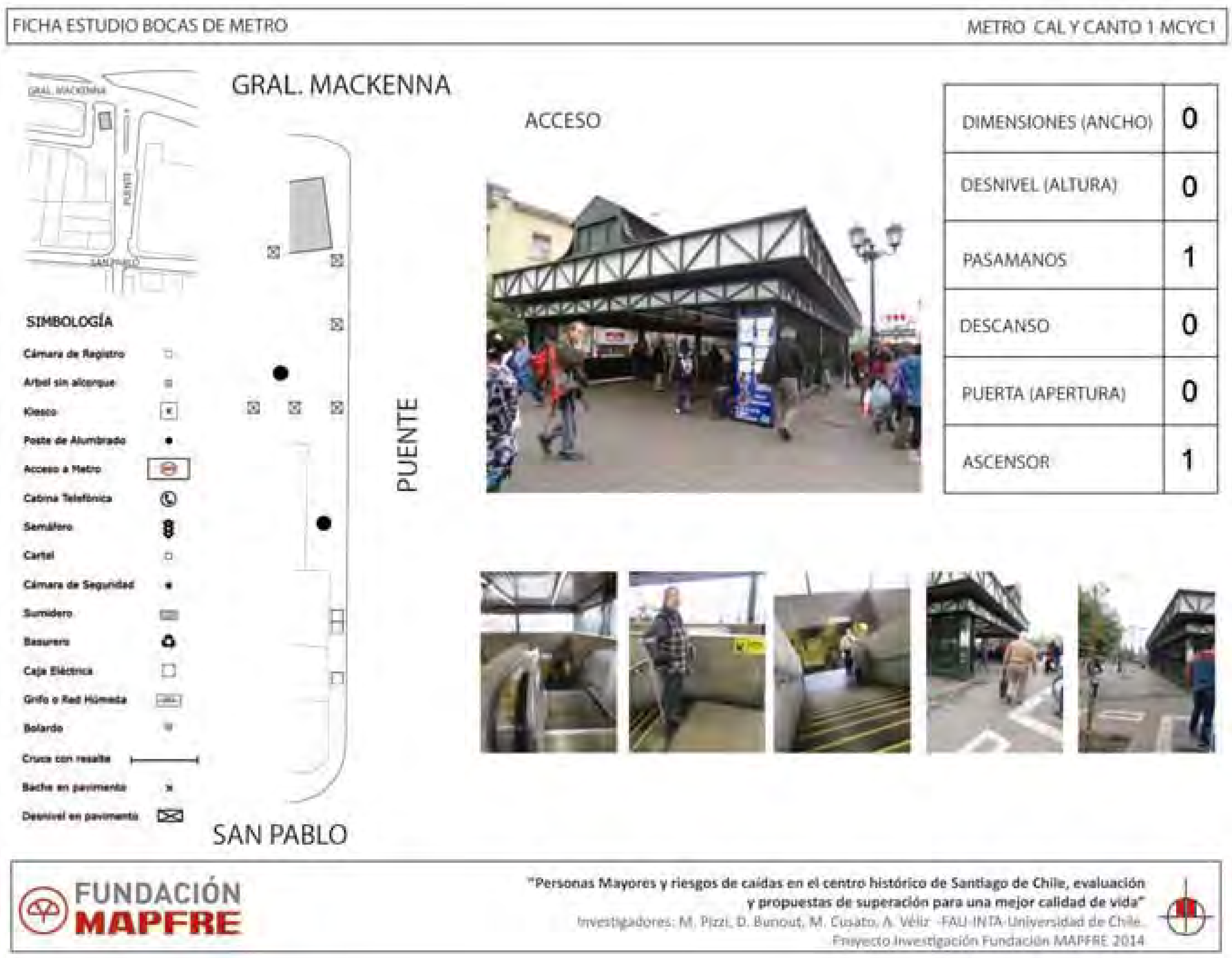

Figura 10. Metro entrance study file.

Focus group

A focus group with 21 elderly people was held to validate the findings. This group comprised 4 men and seventeen women aged 70 to 94. All of them were assiduous participants in activities, workshops and exercises run by the Food Technology and Nutrition Institute (*Instituto de Nutrición and Tecnología en Alimentos*: INTA) of the Universidad de Chile. They were therefore able-bodied elderly people with a strong motivation to take part in social activity, even though some of them showed obvious mobility difficulties or visual impairments

The idea of the focus group, given the sheer size of the study sample, was to talk about the perceived risks and difficulties in the most representative areas of our study, such as the streets Calle Alameda and Calle Huérfanos, the churches Iglesia de Santo Domingo and Iglesia de las Agustinas, the head offices of the Banco del Estado and Correos de Chile, Plaza de la Constitución and the entrance to the Metro station Plaza de Armas.

All respondents are familiar with, remember and visit the study sites. To ensure trustworthiness at a technical level, current photographs were shown of each site.

The elderly people perceive specific difficulties in the flagship sites and streets shown in the images and also perceive other factors besides those studied and assessed herein. Even so, they also express nostalgia for spaces and lifestyles they remember of the city centre. They have typical third-age motor, visual and hearing difficulties and they consider that these difficulties should be taken into account in public policies for the design and upkeep of streets, buildings and transport.

Although the interviewees generally consider the historic centre of Santiago to be a highly attractive site, most shun it due to the perceived difficulties of getting about.

Results

Once the barriers had been recorded in all the public spaces included in the study sample, the results were then tabulated and quantified in accordance with the aforementioned categories, i.e.,: road and path crossings, important buildings, metro station entrances and public spaces.

Thoroughfares (tabla 1)

A first global analysis of results in the building blocks of the surveyed thoroughfares shows that nearly all the recorded barriers (69.3 percent) correspond to manholes (43 percent), and trees without grid-covered tree-wells (26.3 percent); close behind come potholes (14.1 percent and poorly kept drains (8.3 percent). Proportions under 3 percent are considered to be insignificant.

Table 1. Amount and percentages of barriers in the building blocks of the four thoroughfares surveyed

Block record	Alameda		Huérfanos		San Antonio		Bandera		Total	
Manholes	50	9.1%	200	36.6%	132	24.1%	165	30.2%	547	43.0%
Tree without tree-well	54	16.1%	105	31.3%	96	28.7%	80	23.9%	335	26.3%
Kiosk	4	100%	0	0.0%	0	0.0%	0	0.0%	4	0.3%
Lamp post	6	85.7%	0	0.0%	0	0.0%	1	14.3%	7	0.5%
Metro entrance	3	100%	0	0.0%	0	0.0%	0	0.0%	3	0.2%
Telephone cabin	0	0%	11	91.7%	0	0.0%	1	8.3%	12	0.9%
Crosswalk light	3	100%	0	0.0%	0	0.0%	0	0.0%	3	0.2%
Hoarding	12	80.0%	1	6.7%	1	6.7%	1	6.7%	15	1.2%
Security CCTV	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
Drain	31	29.2%	51	48.1%	18	17.0%	6	5.7%	106	8.3%
Litter bin	6	50.0%	6	50.0%	0	0%	0	0%	12	0.9%
Electrical box	11	35.5%	1	3.2%	16	51.6%	3	9.7%	31	2.4%
Pothole	15	8.4%	46	25.7%	84	46.9%	34	19.0%	179	14.1%
Hydrant	4	22.2%	4	22.2%	7	38.9%	3	16.7%	18	1.4%
Total									1,273	

Within the four abovementioned categories, we find that, of the thoroughfares studied, Alameda has the lowest number of manholes while Huérfanos is the most affected in all categories except potholes; this is striking given its pedestrian character. (Table 2).

Table 2. Amount and percentages of barriers in the crossings of the four thoroughfares surveyed

Block record	Alameda	Huérfanos	San Antonio	Bandera	Total

Block record		Alameda		Huérfanos		San Antonio		Bandera		Total	
Manhole		18	45.0%	40	50.0%	80	89.9%	63	76.8%	201	69.1%
Tree without tree-well		4	10.0%	0	0.0%	0	0.0%	2	2.4%	6	2.1%
Kiosk	K	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lamp post		1	2.5%	1	1.3%	0	0.0%	2	2.4%	4	1.4%
Metro entrance		0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Telephone cabin		0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Crosswalk light		1	2.5%	9	11.3%	1	1.1%	8	9.8%	19	6.5%
Hoarding		6	15.0%	21	26.3%	3	3.4%	5	6.1%	35	12.0%
Security CCTV		1	2.5%	6	7.5%	0	0.0%	1	1.2%	8	2.7%
Drain		7	17.5%	1	1.3%	2	2.2%	0	0.0%	10	3.4%
Litter bin		0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Electrical box		0	0.0%	0	0.0%	1	1.1%	0	0.0%	1	0.3%
Pothole	X	1	2.5%	1	1.3%	1	1.1%	0	0.0%	3	1.0%
Hydrant		1	2.5%	1	1.3%	1	1.1%	1	1.2%	4	1.4%
Total		40	13.7%	80	27.5%	89	30.6%	82	28.2%	291	

Analysis of the recorded data shows that manholes pose the greatest fall hazard at crossings, accounting for 69.1 percent of cases. Hoardings in crossing zones account for 12 percent of problems surveyed. The siting of crosswalk lights weighs in with 12 percent and drains with 6.5 percent. Only in Vía Alameda do manholes represent less than 50 percent, peaking in Vía San Antonio at 89.9 percent, nearly the sum total of barriers founds in this road's crossings. As for which thoroughfare presents the highest number of barriers in its crossings, we see that Huérfanos, San Antonio and Bandera show similar percentages of 27.5, 30.6 and 28.2 percent, with a lower number of barriers in Alameda at 13.7 percent.

Important Buildings

After recording the elevation of the 26 buildings under study, a table was drawn up to quantify the number of barriers present; this allows us to calculate the percentage of problems found in each category for each building and for the sum total.

The buildings were thus broken down as follows:

- 0 percent = the building presents no problems in any of the parameters studied.
- 17 percent = the building presents problems only in one of the parameters under study.

- 33 percent = a third of the observed parameters pose problems
- 50 percent = half of the observed parameters pose problems.
- 67 percent = two thirds of the parameters pose some type of risk.

The overall result is shown in Table 3.

Table 3. Amount and overall percentages of barriers surveyed in building entrances

Percentage of barriers in each building	% of the total number of buildings	buildings surveyed
0%	2	8%
17%	4	15%
33%	7	27%
50%	9	35%
67%	4	15%

This shows that half (15 percent +35 percent) of buildings studied present 50 percent or more of problems in the studied parameters, while 27 percent of the sample show problems in one third of the 6 risk factors studied. Only a lower proportion of 23 percent have 1 or fewer problems in their entrances.

The percentage of barriers in the buildings studied break down as follows:

- 67 percent: Iglesia Santo Domingo (MH4), Precolombian Museum (MH7), National Congress Building (MH20), Head office of the Banco del Estado (CH1)
- 50 percent: National History Museum (MH8), Municipal Theatre (MH18), Justice Courts (MH20), National Museum of Fine Arts (MH23), Central Post Office of Chile (MH26), City Hall (MH27), Iglesia de la Merced (MH28) Iglesia San Agustín (MH33), Club de La Unión (MH35).
- 33 percent: El Sagrario (MH19), National Library (MH22), Mapocho Station (MH24), Intendencia de Santiago (MH25), Stockmarket Building (MH36), National Archive (MH54), Head Office of the Banco de Chile (CH2).
- 17 percent: Museo Casa Colorada (MH5), Palacio Arzobispal (MH18), Iglesia de las Agustinas (MH30), Central Market (MH44).
- 0 percent: National mint (MH1), Santiago Cathedral (MH2).

Two of the buildings showing the highest number of entrance hazards are heavily frequented by the public, especially the elderly, namely Iglesia de Santo Domingo and the Head Office of the Banco del Estado. The biggest problem in the former is the non-existence of ramps and handrails; this problem represents overall the highest percentage of cases (Table 5), while the Precolombian Museum presents problems despite having been recently remodelled (Table 4).

Table 4. Amount and percentages of types of barriers in building entrances

Barrier	Overall amount surveyed	% of the total of barriers
Dimensions (width)	1	1.6%
Change of level (height)	14	23.0%
Handrail	20	32.8%
Landing	1	1.6%
Door (opening)	4	6.6%
Ramp	21	34.4%
Total	61	

Table 5. Amount and overall percentages of barriers surveyed in Metro entrances

Percentage of barriers in each metro entrance	Nº. of metro entrances	% of the total of metro entrances surveyed

Percentage of barriers in each metro entrance	Nº. of metro entrances	% of the total of metro entrances surveyed
0%	1	10%
17%	4	40%
33%	3	30%
50%	2	20%
67%	0	0%

Another finding is that the problem is concentrated in ramps and handrails, accounting for 34.4 and 32.8 percent respectively, normally due to the lack thereof. Changes of level of more than 18 cm, or those of less than 10 cm, which are difficult to discern, account for 23 percent of cases. Changes of height therefore represent a barrier, whether due to the size of the drop or rise or because they lack the necessary support to negotiate them safely. As for the other parameters (dimensions, door opening and landing) they have less of an incidence than the previous factors.

Metro Entrances

Two of the Metro entrances chosen for survey, corresponding to the station *Plaza de Armas*, could not be surveyed in the end due to an overrun of remodelling work in the *Plaza de Armas* itself. After recording of the elevation of the 10 metro entrances under study, the same tabulation criterion as for the buildings was then used:

- 0 percent = the access presents no problems in any of the parameters studied.
- 17 percent = the access presents problems only in one of the parameters under study.
- 33 percent = a third of the observed parameters pose problems
- 50 percent = half of the observed parameters pose problems.
- 67 percent = two thirds of the parameters pose some type of risk.

The overall result is shown in Table 5.

Overall, we find that none of the studied entrances showed problems in over 50 percent of the parameters but the whole sample showed at least one category with problems. Seventy percent (40+30 percent) of the surveyed metro entrances breach one or two of the proposed parameters, breaking down as follows:

- 33 percent: *Metro Universidad de Chile* 1 (eastern exit), *Metro Cal y Canto* 1 (central market exit), *Metro Cal y Canto* 2 (eastern exit Calle Bandera).
- 17 percent: *Metro Universidad de Chile* (western exit), *Metro Moneda*, *Metro Plaza de Armas* 1 (21 de Mayo exit) and *Metro Plaza de Armas* 2 (Calle Puente exit)
- 50 percent: *Metro Santa Lucía* and *Metro Cal y Canto* 3 (Calle Bandera Poniente exit)

Access to the Metro Bellas Artes station was found to present no barriers. (Table 6).

Table 6. Amount and percentages of types of barriers in Metro entrances

Barrier	Overall amount surveyed	% of the total of barriers
Dimensions (width)	11	6.3%
Change of level (height)	1	6.3%
Handrail	4	25.0%
Landing	1	6.3%
Door (opening)	1	6.3%
Lift	8	50.0%
Total	16	

The highest percentage of barriers is accounted for by potholes (43.8 percent). Trees with no protected tree well and poorly sited bollards and public fountains all account for the same rate of 18.8 percent

Lifts account for 50 percent of surveyed problems, mainly the lack of any lift. One quarter (25 percent) of the barriers are related to handrails, which often stop before the end of the landing.

Public spaces (table 7)

In general the surveyed public spaces show few fall hazards. This is mainly because the two important Santiago squares known as *Plaza de la Constitución* and *Plaza de la Ciudadanía* both lie next to the National Mint so the upkeep is good. The biggest percentage of barriers, however, is represented by pavement potholes (43.8 percent). Trees without protected tree wells, badly sited bollards and hydrants all account for 18.8 percent of cases.

Although the *Plaza de Armas* was opened to the public only a few weeks before this report after a long refit, it also presents problems, such as the height of the bollards, lower than 40 cm, some potholes and poorly sited hydrants and litter bins.

Table 7. Amount and percentages of barriers surveyed in public spaces

Public space record	*Parque Forestal*	*Plaza Constitución*	*Plaza Ciudadanía*	*Plaza de Armas*	Total	
Manhole	1	1			2	12.5%
Tree without tree-well	1	1	1		3	18.8%
Kiosk					0	0.0%
Lamp post	1				1	6.3%
Metro entrance					0	0.0%
Telephone cabin					0	0.0%
Crosswalk light					0	0.0%
Hoarding					0	0.0%
Security CCTV					0	0.0%
Drain					0	0.0%
Litter bin	1				1	6.3%
Electrical box					0	0.0%
Pothole	4	3			7	43.8%
Hydrant			2		2	12.5%
Total	8	5	3		16	

Focus Group

Two main findings arose from the focus group: firstly, those related to aspects under study herein, i.e., public spaces, buildings and metros; secondly, other fall risks flagged by elderly people.

Some of the most frequently cited hazards in the historical centre of Santiago were poorly upkept streets, pavements and curbs; loose and slippery slabs; ground orifices of diverse sizes and functions; weight and height of entrance doors; long, steep flights of stairs with narrow treads and no landing, handrails or ramps; trees; tree wells; bollards and other items in the ostensibly obstacle-free zone. These findings chime in with the observations made by the team of architects so they help to bear out the survey findings.

Final Conclusions

As seen throughout, this study of fall hazards in the historical centre of Santiago has confined itself to the physical dimension and anthropometric aspects of the relationship between human beings and their space, to determine the risks in their microsystem, leaving for later studies the social and psychological aspects.

The study looked at autonomous elderly people, whereby future studies should look at dependent elderly people or those with varying degrees of disability, to factor in the development over time of the aforementioned initial condition of autonomy.

We conclude that the concept of accessibility should be used as a tool to improve the quality of life of users, to ensure equal terms for all citizens. It should be applied as a measure to ensure that each elderly person and all city residents can participate autonomously in all aspects of society without having to depend on special solutions and specific measures.

The main accessibility problems, looked at in their various categories, are posed by the city's structural shortfalls. This is mainly due to failure to take the problem onboard, design features that do not consider all potential users and breaches of local and national legislation.

As for the examination of the legislation and existing recommendations, the risk analysis conducted in this sample shows that these recommendations need to be more clearly specified and defined, to the direct benefit of elderly people and the whole society.

The diagnosis and assessment process allowed us to pinpoint the main difficulties or barriers to be faced when moving around the historical centre of Santiago and using its facilities. The accessibility diagnosis method used herein was based on mobility requirements deriving from legislation considering the whole set of needs of people with reduced mobility, such as elderly people.

This study identified the commonest barriers that then pose the main fall hazards for elderly people. From the architectural point of view, due consideration needs to be given to the material and dimensions of the elements. From the point of view of the design and street furniture, consideration has to be given to the handling and dimensioning needs of elderly people.

Elderly people perceive the historical centre of Santiago as an area where they are highly vulnerable, pointing to a series of hazards that expose them to the risk of falls and other accidents

The barriers posing the biggest difficulty and ipso facto the biggest fall risk, particularly for elderly people, are assessed in terms of mobility in 4 thoroughfares and their corresponding crossings studied herein. We can hence conclude that the main problems are posed by pavement conditions. These pavements are often in a bad state, uneven and poorly maintained with protuberant manhole covers and trees without protecting tree wells. The overall analysis of the barriers impinging on the fall risk of elderly people in the thoroughfares under study shows that nearly all (91.7 percent) correspond to a combination of manholes (43 percent), trees without protecting tree wells (26.3 percent), and, to a lesser but still influential degree, potholes (14.1 percent) and drains in a poor state (8.3 percent).

An analysis of the various city spaces dedicated to public use in our study shows that their maintenance and management does not always meet basic accessibility requirements and conditions. In general the pavements have parts missing, with resulting holes that might cause falls or injuries or protruding elements or manholes of the supply companies, which may also trip up passers-by. Shortfalls also came to light in the maintenance of street trees and the repair of potholes and drains, all of them posing significant obstacles to mobility.

These objective findings were vetted against the subjective opinions of the elderly people as expressed in a focus group, who expressed their satisfaction and hopefulness upon seeing their opinions, perceptions, problems and experiences being taking into account to improve the future design of city spaces in light of their life-stage needs.

They unanimously perceive the historical centre of Santiago as an area where they are highly vulnerable, pointing to a series of hazards that expose them to the risk of falls and other accidents. These hazards include poor street upkeep; poor state of pavements and curbs; misplaced or slippery paving slabs; ground orifices of diverse sizes and functions; the weight and height of entrance doors; steep, long flights of stairs with narrow treads, without any landings or ramps; trees; tree wells; bollards and other obstacles in the ostensibly obstacle-free zone; kiosks and street sellers; crosswalk lights with short crossing times; poor signage; parking of vehicles on pavements and cyclist use of pedestrian areas. These findings tallied with the observations made by the team of architects and thereby serve to bear out the study results.

Proposals

One of the main needs is the drawing up of a thoroughgoing maintenance plan by responsible state authorities, to head off deterioration of pavements and manholes, which represent between them one of the main hazards in our study. There is also a need for daily cleaning of pavements to remove the rubbish and organic waste that tends to build-up in the least frequented areas. This would involve an awareness-raising programme among dog owners and the provision of public baths.

As regards pavements and walkways, it is recommendable to remove all protuberances that might trip up passers-by, not only elderly people or other people with reduced capacities but also all users. The obstacle-free zones have to be 1.5 m. wide and 2.1 m. high. There is therefore a need of a municipal tree-pruning plan to prevent branches from invading this area. They should also be kept free of temporary obstacles such as street sellers, with reserved zones being marked out on the pavement for the latter to use.

In general podotactile pavement in the centre of Santiago lacks continuity and does not meet international standards, posing a risk for blind people and for all pedestrians. Often there are protruding parts that might trip up other users and cause confusion among those with impaired vision such as elderly people.

As regards communication and information on obstacles and the constructed environment in general, there must be sufficient lighting, duly reinforced in stopping areas for safety reasons.

There should also be a dedicated strip for installing street furniture, signs, fire hydrants, lighting and shading elements to ensure the obstacle-free zone is kept clear, guaranteeing fluid circulation.

It is recommended that both vehicle entrances and ramps spanning any change of level should have a different colour to stand out from the surrounding pavement, making them more discernible for anyone with impaired vision.

It came out in our study that an important safety factor for elderly people is the crossing time of crosswalk lights, which are always regulated to favour vehicle flow without considering the time needed to cross unhurriedly. This is therefore considered to be a non-constructional fall risk, since pedestrians are forced to rush across the street with the consequent risk of tripping up. In this context it is also important to check the suitable size and protection of raised median islands when these are deemed necessary.

In sum, we can conclude that the elimination of fall hazards can be achieved not only by means of specific modifications to the built environment but also implementation of maintenance and awareness-raising plans to ensure due respect for public spaces.

In Chile the problem of population ageing and the quality of life of elderly people has not yet been properly taken onboard by society. Neither does it feature on the agenda of the state’s public policies, especially in relation to housing and public spaces. To date there have not yet been sufficient studies in the country to look at the accident rate of elderly people, particularly in terms of the conditions of the built environment that favour them. Even fewer studies have tackled the identification of barriers, the possible adaptations to be brought in and the drawing up of legislation to prevent new errors in the future and correct existing ones. This is now a pressing need and constitutes a moral responsibility we need to assume vis-à-vis our elderly fellow citizens of today and tomorrow.

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References

1. Alonso López, F.; (2002), Libro Verde, La Accesibilidad en España: Diagnóstico y bases para un plan integral de supresión de barreras.
2. Cartier, Luis, Caídas y alteraciones de la marcha en los adultos mayores, Revista Médica de Chile v. 130 n.3, Santiago mar. (2002) http://dx.doi.org/10.4067/S0034-98872002000300014 Acceso 28/03/2014.
3. Fundación Mapfre (2011) Estudio accidentabilidad de las personas mayores fuera del hogar. http://www.mapfre.com/documentacion/publico/i18n/catalogo_imagenes/grupo.cmd?path=1063027.
4. Gac, Homero; Caídas en el Adulto Mayor. (2000), Boletin de la Escuela de Medicina, Pontificia U. Católica, 29:71-4.
5. Gac, Homero; Marín, Pedro Paulo; Castro, Sergio; Hoyl, Trinidad; Valenzuela, Eduardo (2003).
6. González, Gisela; Marín, Pedro Paulo; Pereira, Gloria, Características de las caídas en el adulto mayor que vive en la comunidad, Revista Médica de Chile v.129 n.9, Santiago set. (2001) http://dx.doi.org/10.4067/S0034-98872001000900007 Acceso 25/03/2014.

7. ONU-HABITAT (2012) Estado de las ciudades de Latino América y el Caribe.

8. Rovira-Beleta Cuyás, E; (2003), Libro Blanco de la Accesibilidad, Ediciones UPC, Barcelona, España.