Economic and Technical Analysis of Universal Accessibility in Social and Private Housing in Chile

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Abstract. According to studies of accessibility in Chile show that the country is aging, by 2050 the population of the third age will increase to more than double where, in addition, the third of that group will develop some type of disability, with the physical type prevailing. Under this problem, Chile has modified its regulatory building body (OGUC) in 2016 establishing new design standards in order to have homes with basic characteristics of accessibility universal. But these modifications are not retroactive in housing policy. Because of this, the present study analyzes the incorporation of accessibility standards into social and private housing that are already built. Technically, it discusses basic solutions to comply with the regulatory approaches and then analyze the economic impact of the solutions, along with the modifications of non-structural elements for regulatory compliance without changing the useful surface of the housing. Showing to achieve accessibility in an existing private home the cost can increase by 0.08 UF/m² and for social housing by 0.05 UF/m². The study shows that with a good projection of the evolution of the people who will inhabit the houses, in conjunction with decisions from the design stage, they can have affordable housing at a low cost preventing the owner have to make large investments for adapt his house to any situation of disability that may be present throughout life.

1. National context of the accessibility in Chile
In Chile, according to the Second National Study of Disability conducted in 2015 [1] of the total population, 16.7% are in a situation of disability. This result was 3.8% higher than the First Study conducted in 2004 [2]. This increase is due, in part, to the constant aging of the population, a phenomenon that affects Chile. Thus, according to the National Institute of Statistics by the year 2050 the population of the 3rd age (specifically the population of 65 years and more), will represent 25% of the population, in addition, it’s expected that 34, 9% of this age group present some type of disability, mainly of physical type [3].

Different countries, including Chile, have begun to generate or modified his regulations and policy decisions to increase the quality of life of People living with Disabilities (PeSD). This term is used to refer to “those people who, in relation to their physical, psychic, intellectual, sensory or other health conditions, when they interact with various contextual, attitudinal and environmental barriers, present...
restrictions on their full and active participation in society”[1]. For this reason, countries are committed themselves through human rights pacts to eliminate or reduce these barriers that somehow limit the daily development of a person with a disability.

In this way, on March 4 of 2016, was published in the Official Journal the Supreme Decree No. 50 that modifies the General Ordinance of Urban Planning and Construction (OGUC), incorporating what is described in Law 20,422 about Equal Opportunities and Social Inclusion of Persons with Disability. This law indicates that all buildings of public use or that provide a service to the community must have a minimum degree of accessibility. In addition, those buildings that have been built since the year 1996 and after must make arrangements or modifications to enable compliance with this regulation. It’s emphasized that in the case of housing, this regulation will not be retroactive.

Accessible housing begins to be part of the real-estate market because of the regulatory requirements and the growing need of the population. First of all, it is important to recognize that it is in the house where people spend a significant amount of their time, so it is relevant that people with and without a disability can functioning as effectively as possible in their homes [4, 5, 6]. That is why both article 25.1 of the Universal Declaration of Human Rights and the article 11 of the International Covenant on Economic, Social and Cultural Rights, recognize that having decent and adequate housing is one of the fundamental rights for everyone. For this, the answer has been incorporate in housing and in different spaces of the city the universal accessibility criteria defined in the Supreme Decree No. 50 as: “the condition that must be met by the environments, processes, properties, products and services, as well as objects or instruments, tools and devices, to be understandable, usable and practicable by all people, in conditions of safety and comfort, in the most autonomous and natural way possible ”[7], understanding that spaces must be functional and accessible to all people.

2. Accessibility issues / needs of its occupants
At present, 34.6% of the homes have at least one person who is in a situation of disability [2]. This is important because as the number of people with disabilities increases, this situation becomes a problem associated with the offer in the real-estate market, as families will tend to move to another house or modify the structure of the house according to their needs. This cost is assumed by the families through different subsidies granted by the State.

For a home to be accessible, it is necessary that all people can access, move and function in the most autonomous and comfortable way possible in the interior, regardless if they are or not in a situation of disability. According to the Accessibility Guide [8] of the Supreme Decree No. 50, the basic requirements are that a bedroom, bathroom, hallways, living rooms and kitchen have a minimum degree of accessibility. These requirements are mentioned below:

- The minimum width of the access door should be of 80 cm.
- The minimum width of hallway should be of 90 cm.
- The bedroom must have a clear area of 1.50 m to allow the 360° rotation of a wheelchair.
- The bathroom should consider sink, toilet and shower with support bars. The design and specificities will have the following characteristics:
  a) In the inside of the bathroom should have a diameter of 1.50 m that allows the 360° rotation of a wheelchair without interruptions
  b) The access door will preferably open to the outside or in some cases a sliding door may be used.
  c) The shower will have a space for a seat of 0.45 m by 0.45 m, being able to be fixed, foldable or easily moved. It may consider lateral support arms.
  d) The shower can be telephone type and may not be installed higher than 1.20 m. The bathroom fittings of the shower and the sink will be pressure or lever type. And it must have a horizontal support bar installed at a height of between 0.75 m and a vertical bar between 0.80 m and 1.40 m, all measured from the finished floor level.
- The switches and plugs will be located in the accesses to the enclosures, at a minimum height of 0.40 m and a maximum of 1.20 m and cannot be located behind the doors.
The closing and opening mechanisms of doors and windows must be of pressure or lever and be located at a minimum height of 0.90 m and a maximum of 1.20 m.

To improve visual comfort, the balcony sill must not exceed 60 cm, a rail will be placed 95 cm high for safety.

In the Figure 1 it is possible to visualize how a person in a wheelchair is distributed in space. This figure is referential but can be useful to recognize the functionality of the solutions that are delivered and verify that they are in accordance with the requirements of its users.

![Figure 1. Person with reduced mobility in a wheelchair – Self elaboration from [5]](image)

Finally, it is important to note that the requirements for housing only focus on people with reduced mobility, so it is necessary to expand these criteria since the use that will be given to the house will depend on the type of disability and in turn, on the support that this person need.

### 3. Economic analysis of accessible housing

Currently, it is recognized that there is certain ignorance on the part of real estate companies about how to adapt a housing to be accessible to all people. In addition, there are different myths or beliefs regarding that an accessible house is much more expensive than the houses that are currently built because more surface space is needed to make it accessible. Then, a case study was developed to evaluate this situation in private and social housing.

Bellow, two cases are presented, the first is a private housing and the other is a social project. Both houses have a similar configuration of 3 bedrooms, living room, bathroom (in the case of private housing, it has 2 bathrooms, but only one will be modified) and a kitchen. First, an in depth analysis of the technical changes made to each accessible proposal will be presented. Second, an economic analysis in the cost of materials needed to modify was made. The technical modifications calculated were interior divisions (partition walls), wall covering, floor covering, doors and appliances and sanitary elements (tub, vanity and transfer and support bars). Finally, an economic comparison was carried out about the changes to remove barriers in a bedroom and a bathroom summarizes for the variations in surface area and costs for each case.

### 3.1. Analysis of constructive solutions

The proposals for accessibility housing were designed without altering the initial square meters, this is because the improvement solutions were made in existing homes, and therefore the structural envelope cannot be altered.

From the research of Montoya et al. [9], it is observed that due to the growing demand for housing in the Greater Santiago and therefore the shortage of land for building, to make the architectural program of the homes more attractive to buyers, the space that is most affected by the decrease of useful surface
is the bathroom. This makes it difficult and often makes it impossible for a person in a wheelchair to access or use it. On the other hand, it was observed that the hallways inside the house repetitively did not comply with the minimum width indicated in the OGUC (with less than 90 cm) as well as the interior door openings (with less than 80 cm).

The private house has 74.6 m². Then, in the common areas (kitchen, corridors, living room and dining room) there was surface enough for the turning radius of a wheelchair (at least 150 cm). The original housing is shown in Figure 2 and the proposed modifications are presented in Figure 3. Of these proposals, the most significant are the following:

1. It incorporated a sliding door in the bathroom and the bedroom. This measure can be replicated in the different enclosures because it allows an increase in the free usable surface.
2. Widening the door opening at 90 cm in the master bedroom for wheelchair access.
3. In the bathroom, support bars should be incorporated in the specified places to allow the person to move from his chair to the sanitary appliance without the help of another person.
4. In addition, sanitary appliances are relocated.
5. The partition wall is removed to increase the surface of the bathroom and the partition wall is created on axis 7 to close the enclosure.
6. Widening of the hallways at 90 cm. If the person had a visual impairment, the hallway should be 100 cm of width so that they could be accompanied by a guide. In addition, the hallway should not have elements or changes of direction that could hinder the movement.

On the other hand, from the research carried out by Narváez [10] the social housing chosen to make the accessibility proposals is one of the houses that can be acquired through the SENADIS (National
Disability Service), which offers two types of aid in case someone from the family group is in a situation of disability:

1) Housing application for people with disabilities: This subsidy can be apply to buy a new or used house of up to 950 UF with a subsidy between 314 to 794 UF. The supplementary allowance will be granted if a family member has accredited disability status, the base allowance will increase by up to 20 UF. On the other hand, if a family member has reduced mobility, the base of the subsidy will be increased up to 80 UF

2) Housing extension subsidy: With this subsidy an extension can be made in different areas of the home, such as: the bedroom, laundry-loggia, living-dining room and bathroom or kitchen

The social housing was chosen because of the similar configuration that it had to private housing. This house is made up of three bedrooms and a single bathroom (Figure 4), however, it has an area of 55.47 m². The changes that were made are similar to those of private housing, among which the following stand out (Figure 5):

1) Increase of interior doors opening from 80 to 90 cm.
2) Change of standard door to the sliding type in the bathroom. This solution could be applied to all rooms of the house.

The greater number of modifications, as in the previous case, were in the bathroom: (3) the partition wall of the kitchen’s wall was modified by 80 cm, to increase the bath area from 4.01 m² to 5.44 m². (4) As regards the sanitary appliances, there was a change from tub to shower with non-slip floor. On the other hand, (5) the position of the WC was changed parallel to the wall of loggia’s wall in front of the shower, this generate an area of 120x80 cm. (6) Support bar in the shower and folding seat were also added.

(7) The partition wall was displaced by 5 cm, to achieve an increase of width in hallways from 95 to 100 cm. Thinking in the case of a blind person.

(8) The width of the access door was increased from 85 to 90 cm.

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Figure 4. Original social housing

Figure 5. Proposed design of social housing
4. Results and discussion

As noted in the previous cases, the main modifications focus on having at least one bedroom and a bathroom with accessibility. In the common areas such as living room or dining room there are no significant modifications since they are the rooms with greater useful surface and with changes in the arrangement of furniture it is possible to achieve the turning radius that are required for a wheelchair.

Regarding the cost analysis, for the technical modifications the items evaluated were interior divisions (partition walls), wall covering, floor covering, doors and appliances and sanitary elements (tub, vanity and transfer and support bars). In each of the items, the elements that comprise it were determined. Then the material cost was quantified for the original case and for the proposed case. The analysis did not consider the workforce.

The distribution and variation of each one of these items in the dwellings can be observed in Figure 6.

For private housing, in partitions there is a decrease in costs of 4%, mainly due to the fact that it is required to reduce its surface area because it is necessary to increase the area of the door. Therefore the cost increases by 19% in the case of doors, where a traditional door is also changed for a sliding door. In the case of sanitary devices, there is a decrease of 15% because the tub is changed for a shower (to avoid problems in the transfer) and the latter is almost 50% cheaper than the first. In the floor and wall covering there is no modification since the surface that is removed in one enclosure is increased in the other. Finally, the amount of the items in the original home is $915,509 versus $1,079,066 of the proposed home.
For social housing, in the partition there is also a decrease in costs by 9%, for the same reason of the widening of the doors opening. And therefore the increase in the cost of the item of doors is 27%. In relation to sanitary devices, there is also a 17% decrease due to the change from tub to shower. Finally, there is a slight increase in floor covering (1%) and a slight decrease in wall lining (3%) mainly due to the interior division surface of the bay removal. In this case the amount of the items in the original dwelling was $751,969 versus $815,557 of the proposed dwelling.

Finally, after the technical modifications and their cost analysis, an economic analysis was carried out about the changes to remove barriers in a bedroom and a bathroom. Table 1 summarizes the variations in surface area and costs for each case.

| Space      | Private Housing (74.6 m²)       | Social Housing (55.47 m²)      |
|------------|---------------------------------|--------------------------------|
|            | Original                        | Proposal design                | Original                        | Proposal design                |
|            | m²     UF/m²                     | m²     UF/m²                     | m²     UF/m²                     | m²     UF/m²                     |
| Bathroom   | 3.05   7.02                      | 4.26   4.76                      | 4.01   3.57                      | 5.44   1.89                      |
| Bedroom    | 10.90  1.03                      | 9.68   1.89                      | 8.50   1.47                      | 8.50   2.21                      |
| Total      | ---    0.44                      | ----   0.52                      | 0.48   0.53                      |

As can be seen in Table 1 in relation to bathrooms, in both cases to meet accessibility, the useful area must be increased. In the case of private housing, the increase was 40% (1.21 m²) and in the social case the increase was of 36% (1.43 m²). This increase responds to compliance for the turning radius of the wheelchair and the minimum area required for a safe transfer. A decrease in the cost can also be observed. This is mainly due to the change of tub by shower, since as specified previously the first one is almost 50% more expensive than the shower.

In the bedrooms, the variation of surface is not a restrictive variable in the modifications, since by redistributing the furniture or arrangement of the bed the turning radius can be achieved, which is why it is possible to maintain the useful surface or even decrease it. The increase in costs responds mainly to...
the modification of the openings to meet the required door width. As in both cases an 80 cm door was changed to a 90 cm sliding type, the cost of the modification is increased, but it is gain in free area (there is no discount for the thickness of the door, neither the loss of surface area due to opening of the door).

In conclusion, it is obtained that to achieve accessibility in an existing private home the cost can increase by 0.08 UF/m² and for social housing by 0.05 UF/m², which is consistent with the results of Orrigoni et al [11] where he presented an analysis made to the design of 15 homes that have the Housing Solidarity Fund 1. In the analysis the variation in the unit price of square meter (UF / m²) was between -0.50 UF/m² to an increase of 0.25 UF/m² of the value per square meter to build. But it stands out that the trend of the results was that in 6 of the 15 homes there is a moderate increase in the cost, between the range of 0.01 UF/m² (0.25%) and 0.25 UF/m² (5.08%).

The difference in the study Orrigoni et al [11] was that the surface of the house could be modified to make it accessible. The variations in footage between existing and modified homes were from -0.58m² to 3.55m² of the pre-existing area. In this case, the study realized that the greater the surface area of the dwelling, the lower the need to increase the surface area to obtain accessibility standards.

Finally, in Europe it was recognized that in order to implement accessibility regulations, the support of private companies was essential and to obtain it was important to recognize the benefits of removing barriers in a home. Therefore, López [12] identified for the first time what were the costs and benefits of removing barriers in homes, concluding that the benefits are not only for the user but also for real estate companies because people are willing to pay more for a barrier-free house versus construction cost that increase below the benefits. This can be seen in the following quotation:

“When comparing two similar dwellings, with the only difference being their accessibility conditions, the 1,007 randomly chosen households that answered the direct survey would pay, on average 12.5 % more for being barrier-free. Different studies consulted estimate the cost for the elimination of barriers in 5% more that the initial cost for a standard house.”

5. Conclusions

The spaces analyzed to make the proposals for modifications are those that generally require more privacy, such as the bedroom and bathroom, where it is expected that a person can move and perform their activities autonomously, with adequate space for it. It is recommended that in the future a more detailed study of the kitchen will be developed, since it is a space that can present mobility difficulties due to its size and the obstacles presented by the furniture. Or a more specific analysis for the needs of older adults. The results obtained in the economic analysis of the modifications are within the ranges obtained by other studies and in general could be assumed by the families through the subsidies that are available for these purposes.

Despite this, it is important to consider that if these analyzes are performed when the project is designed, greater savings could been achieved, as a result of a better technical analysis of the value of the project. Within these analyzes the redistribution of the spaces must be incorporated to the design to have more flexibility for adaptation to the changes that can occurred as a result of the passage of time. Related to this, the State could save in terms of subsidies, since the new buildings would not require so many modifications.

In this sense, it is important to consider that in the near future there will be many more people who require houses with accessibility standards because the rate of older adults is increasing. Therefore, it is relevant that both the state and real estate companies incorporate these concepts since they begin to study the feasibility of carrying out a project or even delivering the option of minor modifications at the time of acquiring a home, changing the currently established paradigms and generating a new standard that allows people to be more self-sufficient in a more egalitarian environment.

On the other hand, it is also relevant that the industrial sector can promote innovations for accessibility, because as the increase in the offer of accessible houses, the prices, for example of sanitary appliances or others, it becomes more accessible.
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