


Definition of Needs and Requirements for an Accessible Cabin on Regional Aviation

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ABSTRACT

The global increase in the number of passengers with disabilities in the aviation market raises the need for airlines to offer an inclusive service to these groups, which can represent a differentiation in the market. This paper is part 1 of a two-part series where it was proposed to apply a methodology inspired on Design Thinking, with tools such as persona mapping and user's journey to define requirements and propose a concept for an accessible cabin. In this part, bibliographic research, with study of other papers that investigated the aviation market and mapped the complaints and needs of users with disabilities were initially carried out. The result of these researches served as the basis for the application of the methodology and definition of needs and requirements for an accessible cabin concept. It was concluded with this work that it is crucial to consider the needs of all stakeholders involved in the system for the good definition of the needs, that is, users, manufacturers, and airlines, since modifications to the cabin can affect important parameters such as cost and weight, and must be made to address points that can really improve the user experience. It was noted that research is limited for passengers with sensory impairments making it harder to clearly define their needs. Passengers with mobility restrictions, on the other hand, are better represented in research. Finally, the proposed list of needs demonstrates the potential to enhance the flight experience for passengers with special needs, potentially increasing their market share and overall satisfaction.


Keywords: Aircraft interiors; Human factors engineering; Systems engineering.

INTRODUCTION

The article 13 of the Universal Declaration of Human Rights asserts freedom of movement, and, as such, tourism and travel as a universal right. In April 2010, the European Union (EU) declared that one's ability to travel and the way people spend their holidays is a great indicator of quality of life (THE TIMES 2010). However, as presented on "Traveling with a disability: more than an access issue" (Yau *et al.* 2004), people with disabilities sacrifice their right to travel as they feel there are too many challenges that need to be overcome.

As new rules and standards are established for commercial aviation, safety and comfort for the passengers has been put in high regard for legislators. Along with the establishment of these rules, passengers with disabilities have been demanding that the industry adequate itself to their needs, allowing them to fulfill their universal right for tourism and travel. The number of people who have some kind of special need is quite representative. For example, in 2014, 85.3 million people had some type of disability

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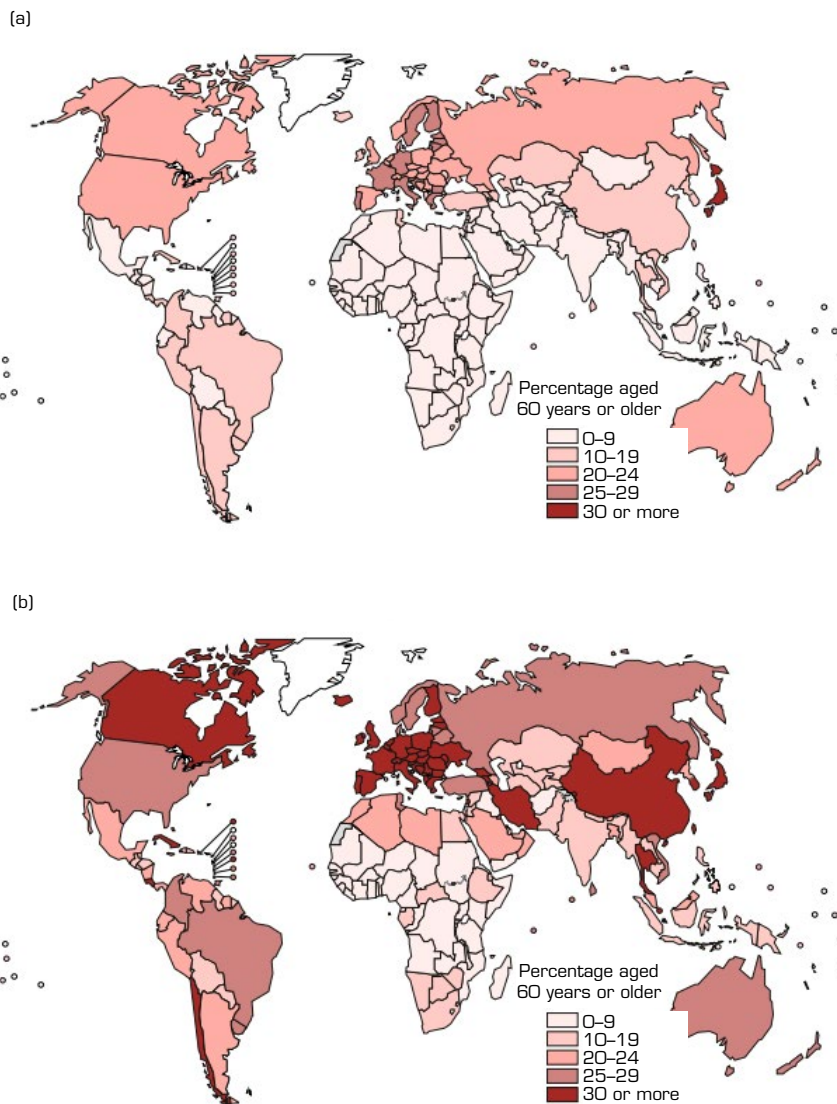
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in the United States, accounting for 27.2% of the total population (Taylor 2018). This represents a 56% increase over 2005, when 18.70% of the American population had some type of disability (Castro 2010).

Due to improved medical technology, increased life expectancy averages, and reduced infant mortality, there is a trend toward increasing numbers of people with disabilities. In the United States, for example, this number tends to increase, reaching the 100 million mark by the year 2030. Counting the families and friends of this population, there is a significant market that is often overlooked by the industry and the airlines (McKercher *et al.* 2003; Ray and Ryder 2003; Yau *et al.* 2004).

In 2019, there were 703 million people aged 65 and over in the world, equivalent to 9.12% of the population. Over the next 3 decades, this number is expected to more than double, reaching 1.5 billion people by 2050 (WHO 2019). The largest growth in the older adults population is expected to occur in the Southeast and East Asian region. Wealthier regions such as the European Union and North America also have a strong aging population trend, as shown in Fig. 1 (WHO 2015).

One of the main reasons that discourages people with disabilities from traveling is simply the physical inaccessibility of facilities used by passengers, such as airports and aircraft (Avis *et al.* 2005).



Source: Retrieved from WHO (2015).

Figure 1. Proportion of people over 60 by country in 2015 (a) and projection for 2050 (b).

When it comes to the facilities to be used by passengers with special needs, there are usually fewer services offered in the aircraft environment than in airports. Today, most aircraft have seats with movable armrests to facilitate the transfer of a passenger to and from the wheelchair. Transporting passengers to the lavatory is done with an on-board wheelchair, but most lavatories are not accessible. Depending on the airline, services such as braille safety instructions, trunk restraint belts, and stretchers are offered for passengers who need these (Vega 2016).

According to the literature, current legislation in several countries defines few or no criteria that aircraft must meet to ensure the accessibility of their facilities. Most aircraft are equipped to comply with Part 382 of the U.S. legislation; however, even meeting these stipulations still does not seem to be enough to leave passengers with special needs on an equal footing with able-bodied passengers (Vega 2016).

The existing legislation aims at ensuring equal treatment for passengers with special needs, but is not sufficient to ensure their satisfaction with the services offered by air transport. Several studies have been reviewed and have shown that, for the most part, passengers with reduced mobility or sensory disabilities have less than ideal satisfaction with these services.

Amid the ongoing transformation in aviation, there is a discernible trend towards the modernization of airplane cabins through the integration of smart devices (Silva *et al.* 2023a; b). This ongoing transformation seeks to enhance the overall passenger experience by introducing innovative technologies and amenities. Notably, this trend is not only revolutionizing the way passengers interact with the cabin environment, but also holds the potential to bring about significant benefits for individuals with disabilities. By leveraging these smart technologies, airlines can tailor services to better meet the diverse needs of passengers, including those with reduced mobility or sensory disabilities. These aspects will also be considered in this study.

This article aims to present a list of user needs and requirements for an accessible cabin concept for regional aviation, aimed at people with disabilities, and high-level requirements derived from these needs. To accomplish that, a literature review was performed, aiming to better understand the profile of those passengers. Design Thinking tools, such as persona mapping and user's journey were also used for this end.

With this study, a list of requirements related to the needs of passengers with disabilities was created. Thus, this study is capable of showing that, to better fulfill their roles as providers of traveling and tourism services, aircraft manufacturers are able to design passenger cabins that properly meet the needs of passengers with disabilities, using insight provided by user research.

Theoretical reference

Legislation regarding accessibility on air travel

There are varieties of approaches to handling the rights of passengers that requiring special treatments worldwide, and much of the legislation is relatively new. As of 2020, some major markets were still in the process of drafting new legislation regarding these passengers and relied on international regulations to address the issue (Budd and Ison 2020). For this reason, some of the research studied in the literature review still did not consider these newer regulations.

The United States and the European Union, two of the few regions with specific legislation regarding passengers with disabilities, were chosen as the main study subjects for this thesis because they are two of the biggest international aviation markets (Eriksson and Steenhuis 2015) and their legislation is used as a reference for airline operations internationally. Canada was also chosen as an object of study because its legislation, although recent, is one of the most demanding for airlines.

United States

Code of Federal Regulations (CFR) - Part 382

Chapter 14 of the Code of Federal Regulations (CFR), a set of general regulations published by the United States' Federal Government, deals with matters regarding aeronautics and space. Part 382 deals with operational requirements whose objective is to enforce the Air Carrier Access Act (ACAA) of 1986, which guarantees the non-discrimination of any individual with disabilities regarding the provision of air transport services (United States of America 2008). Subparts D, E, and F of this Part list requirements related to aircraft and airport installations.

Regarding requirements for aircraft, Subpart F specifically deals with seating accommodations on aircraft. It states that the carrier must provide seating accommodations for passengers who self-identify as having a disability specified in Part 382 upon request, if the type of seating accommodation in question exists on the particular aircraft.

Once the passenger self-identifies to the carrier, they must ensure that the information is recorded properly and transmitted to personnel responsible for providing the accommodation (United States of America 2008). The following seating accommodations must be provided by the carrier under these circumstances:

- For a passenger who uses an aisle chair to access the aircraft and who cannot readily transfer over a fixed aisle armrest, you must provide a seat in a row with a movable aisle armrest. You must ensure that your personnel are trained in the location and proper use of movable aisle armrests, including appropriate transfer techniques. You must ensure that aisle seats with movable armrests are clearly identifiable.
- You must provide an adjoining seat for a person assisting a passenger with a disability in the following circumstances:
 - When a passenger with a disability is traveling with a personal care attendant who will be performing a function for the individual during the flight that airline personnel are not required to perform (e.g., assistance with eating);
 - When a passenger with a vision impairment is traveling with a reader/assistant who will be performing functions for the individual during the flight;
 - When a passenger with a hearing impairment is traveling with an interpreter who will be performing functions for the individual during the flight; or
 - When you require a passenger to travel with a safety assistant (see § 382.29).
- For a passenger with a disability traveling with a service animal, you must provide, as the passenger requests, either a bulkhead seat or a seat other than a bulkhead seat.
- For a passenger with a fused or immobilized leg, you must provide a bulkhead seat or another seat that provides greater legroom than other seats on the side of an aisle that better accommodates the individual's disability (United States of America 2008).

The regulation also requires the carrier to provide seats with movable armrests on every aircraft with more than 30 seats, and states that, under circumstances where the safety of the aircraft would not be compromised, the airline cannot deny the transportation of service animals or assistive equipment to passengers with disabilities. The airline must also provide adequate space for the service animal and stowage for assistive equipment.

Moreover, Part 382 requires that on aircraft with more than one aisle, there must be at least one accessible lavatory, and it has requirements related to onboard wheelchair features and presence. It requires that aircraft with more than 60 seats and that have an accessible lavatory (regardless of whether this lavatory is mandatory) must have an onboard wheelchair. On any aircraft with a capacity of more than 60 passengers, the airline must be able to provide an onboard wheelchair if a passenger requests one. It also defines the characteristics of such a wheelchair.

It also requires that airlines give priority to carrying assistive equipment in the aircraft baggage compartment, and that instructional videos have accessibility options for the visually or hearing impaired. The regulation requires aircraft to place braille placards, identifying seat locations and bathroom facilities in the airplane. Lastly, it requires that aircraft with 100 or more passenger seats have priority space for storage of wheelchairs.

Europe

European Commission Regulation (EC) – n° 1107/2006

To ensure the rights of passengers with special needs, the European Commission published the EC Regulation number 1107 of 2006, which has been effect since July 2008. This regulation forbids airlines to refuse to provide service to any passengers due to their reduced mobility or any disabilities. The document also guarantees that those passengers shall receive adequate assistance without any further charges, in order to allow them to use air transportation as equals to other passengers (European Union 2006).

This act says that there may be exceptions for airlines in cases where the transport of a passenger may compromise established safety requirements or when the dimensions of the aircraft make the embarking or transport of said passenger physically impossible.

In those cases, however, the airline must make reasonable efforts to provide alternatives to the passenger and inform him correctly in case the flight is not possible and the airline must justify its denial of service appropriately. People who

have their service denied for these reasons have a right to reimbursement, according to EC Regulation number 261 of 2004 (European Union 2006).

Canada

Accessible Transportation for Persons with Disabilities Regulations – SOR/2019-244

In Canada, SOR/2019-244 deals with determinations to ensure accessibility in transportation for people with disabilities. This standard provides operational requirements for various modes of transportation. For the purposes of this paper, a summary will be made of the requirements affecting the construction and operation of commercial aircraft.

The section of the document that contains requirements relating to these operators is Part 3, Division 1 – Air Carriers. The requirements of this section, unless otherwise stated, apply to Canadian air carriers, whether domestic or international. Exceptions to this requirement are aircraft with a seating capacity of up to 29 passengers and aircraft manufactured before May 13, 2009. Some sections of this division have other restrictions, such as not being determinations for single-aisle aircraft (Canada 2019).

The Canadian operational standard, of those reviewed in this paper, is the most detailed in terms of aircraft requirements. It requires operators to ensure the following elements are present on aircraft with more than 29 passengers.

Lifts – Lifts to be used by people with disabilities, including those who require mobility aids, to board or disembark from the aircraft must have

- Handrails located on both sides of the lift; and
- Slip-resistant surface and be capable of supporting a minimum weight of 363 kg (Canada 2019).

Ramps – Ramps to be used to assist people with disabilities, including those who require mobility aids to board or disembark from an aircraft must

- Have a contrasting color strip that runs the full width of its bottom edge;
- Have raised edges to prevent a mobility aid from rolling off the edge of the ramp;
- Have a slip-resistant surface; and
- Be capable of supporting a minimum weight of 363 kg (Canada 2019).

Stairs – Any stairs that are to be used to board or disembark from an aircraft and any interior stairs on an aircraft must

- Meet the requirements set out in clauses 5.4.1 and 5.4.2 of CSA B651-18, a Canadian Standard for accessible construction;
- Have handrails located on both sides of the stairs, at a uniform height of 860 mm to 920 mm, measured vertically from the leading edge of the tread, and meet the requirements set out in clause 5.3.1 of CSA B651-18; and
- Have tactile attention indicator surfaces that meet the requirements set out in clauses 4.3.5.2(a) and (b), 4.3.5.3.1, and 4.3.5.3.4 of CSA B651-18 are located at the top of the stairs, and commence one tread length before the top of the stairs, extend the full width of the stairs and measure from 600 mm to 650 mm in length (Canada 2019).

The standard also states that at least one onboard wheelchair must be available on aircraft that have an accessible toilet, similar to the Part 382 recommendation. In addition, there is a requirement that at least 50 percent of the seats provide movable armrests, and that these seats are evenly distributed throughout the aircraft. It also requires aircraft to have crew call buttons that are tactilely discernible and operable with minimal force, as well as tactile seat row markers, with raised characters and Braille, permanently or temporarily installed above the armrests and to the sides of the seats or adjacent to the overhead bin opening mechanism (Canada 2019).

Regarding safety information, aircraft must have at least five information leaflets in large font and at least five in Braille, or an electronic device that provides safety information in aural and visual format and allows a person with a disability to adjust the audio volume and font size. The standard also requires an in-flight entertainment system equipped to assist people with disabilities by offering captioned and/or audio description content that is the same or comparable to that offered to other passengers (Canada 2019).

In addition, the standard requires airline operators to demonstrate “reasonable efforts” to ensure that a person with a disability who uses a folding wheelchair or walker can store it on board the aircraft or bus. The standard has requirements for toilets, but these are only applicable to aircraft with more than one aisle (Canada 2019).

Future trends

In September 2019, the Department of Transportation of the United States of America announced the formation of the ACAA Advisory Committee and also as announced the 19 members for this group, whose main goal is to act as counsel for

the Secretary of Transportation regarding problems related to the needs of passengers with special needs in air transportation (U.S. Department of Transportation 2019).

The responsibilities of this committee that were considered relevant for the scope of this thesis are:

- Advise the Secretary of Transportation regarding the implementation of the ACAA;
- Review current regulations regarding practices related to the passenger's routine when traveling, such as choosing seats, priority access, and stowage of technical devices;
- Identify and combat existing and emerging barriers to access for passengers with disabilities;
- Describe improvements regarding the passenger experience in air transport for passengers with disabilities;
- Recommend actions deemed appropriate to improve the experience in air transportation for passengers with disabilities.

Since its inception in 2019, this committee has published a number of reports and presentations aiming to better understand the needs of passengers with disabilities and to improve the current legislation, which is mostly lacking and, according to the ACAA Advisory Committee, is insufficient for most passengers with disabilities or reduced mobility.

In March 2022, for example, this committee has published a regulation proposal aiming to demand single-aisle aircraft with over 125 passengers to also include an accessible lavatory (U.S. Department of Transportation 2019).

This committee is representative of a rising effort to adapt current regulations to the needs of passengers with disabilities, as well as to better educate the general public, airlines, and original equipment manufacturer (OEM). Other major needs that were discussed by this committee, which are also not well addressed by existing legislation in the United States, are the storage of wheelchairs and other equipment, as well as accessibility rules for the airlines' websites.

In April 2023, the Federal Aviation Administration (FAA) released Advisory Circular (AC) 120-32A, titled "Safety considerations in the air transportation of persons with disabilities". This AC provides information to crewmembers and aircraft operators regarding the safe transport and handling of passengers with disabilities. Despite not imposing any other requirements regarding aircraft construction, this shows progress toward stricter regulation regarding this theme.

The experience of passengers with disabilities

Aiming to better identify solutions and layouts that could be important to improve the experience of passengers with disabilities and those who require special treatment, a study of other scientific studies that deal with this public was conducted, aiming to map their main needs. This material will be utilized in the future as a basis for defining the passengers' needs.

There is a relatively small number of studies that aim to describe and understand the experiences of passengers with disabilities in the service and consumer goods industries, especially those related to the air travel industry. The interactions of these users with the ambiance of the tourism industry is a not well-explored field, especially when it comes to users with sensory disabilities.

Moreover, since the needs of the passengers are strictly related to the type of disability or special need they possess, as well as its severity, it is important to consider multiple perspectives on the handling of reports of those experiences (Silva 2016). This was one of the main challenges for defining requirements.

The main complaint of passengers with reduced mobility was related to the usage of the bathroom, which was described by these participants as a painful and humiliating experience. Many participants related problems moving to the lavatory, as well as in its usage, due to the limited room to move inside the bathroom. Especially for aircraft without accessible bathrooms, wheelchair users have to be carried by the cabin crew or their companion to the toilet. Because of this, many of those passengers avoid using the lavatory during the trip, subjecting themselves to painful and uncomfortable situations, such as prolonged fasts or the use of diapers during the flight (Poria *et al.* 2009).

Aiming to assess accessibility in air travel Souza (2014) conducted a study on both the regulatory scenario and the needs of the passengers that request special assistance. The research interviewed passengers with physical disabilities (wheelchair users and non-users), hearing and visual disabilities, passengers with multiple disabilities, as well as older adults and obese passengers.

The paper lists all complaints the passengers mentioned during the interviews, as well as details how many times each of these complaints were mentioned. For passengers with physical disabilities that were also wheelchair users, 96 interviews were conducted, and the most frequent complaints were, in descending order: accessibility and inadequate space in washing closets (54 times), being carried by cabin crew (49 times), lack of adequate equipment for boarding (40 times), and deplaning (38 times).

Other frequent complaints were delays, narrow aisles, unavailability of adequate seating, and damage to personal wheelchairs or other assistive equipment.

For passengers with physical disabilities that were not wheelchair users, 61 interviews were conducted, and the most frequent complaints were, in descending order: long distances in the airport (28 times), lack of adequate equipment for boarding (17 times), restricted legroom (14 times), and accessibility and inadequate space in washing closet (11 times). Other complaints were unavailability of adequate seating and lack of space to store assistive equipment (Souza 2014).

The author also interviewed passengers with hearing and visual disabilities and recorded the most frequent complaints. For passengers with hearing disabilities, 21 interviews were recorded, and the most frequent complaints were inadequate signaling, lack of crew fluent in sign language, and understanding of aural information during the flight.

For passengers with visual disabilities, 23 interviews were made, and the most frequent complaints were lack of means to understand information on panels (small fonts, low contrast), inadequate relay of safety and evacuation guidelines, and difficulty using the washing closet.

Overall, the most frequent complaint for passengers with reduced mobility is the cabin layout and user accessibility, being mentioned in all the literature that was used as the basis of this study. Another frequent concern is the boarding process and the use of the onboard chairs, which are often described as inadequate and uncomfortable. The process of moving between this chair and the seat is also the subject of frequent complaints, being described as painful and dangerous to the passengers' physical well-being. Other complaints also include the proper dispatch and receipt of passengers' personal wheelchairs.

As for passengers with sensory disabilities, in particular visual and hearing impairments, the main complaints concern the proper understanding and receipt of evacuation and safety guidelines. Although less frequent, other needs mapped out from passengers with visual impairment were the accessibility of in-flight entertainment devices and difficulties in finding their seats.

In summary, the literature and research that has identified the main needs of passengers with disabilities provide an overview of the main problems faced by these passengers when traveling by air, despite their main focus on users with reduced mobility and physical disabilities.

METHODOLOGY

The methodology used in this paper is loosely based on some of the steps described in the books "Change by design: how design thinking transforms organizations and inspires innovation", by Tim Brown (2009) and "The field guide to human-centered design: design kit" (IDEO 2005).

This approach was chosen because it allows for the clear definition of the main users' needs and requirements, in this case, the passengers. This process enables the creation of solutions centered on the desires and perceptions of the customers, which tend to be more effective from a service and business point of view. A similar methodology was applied in the study by Silva *et al.* (2023a; b), wherein Design Thinking was employed for the development of smart cabin design in regional aviation.

The first step in defining the needs of the accessible cabin users is to develop personas based on the key users of the cabin, namely, the passengers. A persona is an accurate, hypothetical description of a user and what he or she wants when interacting with a product or system. This tool aims to help those responsible for developing or defining the requirements of a system by paying attention to aspects of designs and forms of use that other methodologies do not allow (Blomquist and Arvola 2002). The main inputs for defining which personas will be developed are the stakeholder studies and the literature review. In this study, an analysis of the personas to be represented was performed, using as its main basis the literature review of the works that analyze the experience of these passengers.

The user's journey tool, on the other hand, uses the personas and the stakeholder study to create fictitious and illustrative journeys for the developed personas that allow visualizing their main difficulties and gains when interacting with the product. The tool consists of analyzing the steps of the interaction of the user with the product and assigning a satisfaction level for each

of the activities he has to undertake. For each of these steps, it is possible to identify his feelings, his needs, and opportunities for improvement.

Needs definition

In this chapter, the results of the user analysis will be presented. The needs of the users were defined by creating personas and user's journey. These tools were then used to find the needs of the different profiles of passengers on different stages of the flight.

Personas and user's journey

In a study of the "passenger" stakeholder, it is possible to find several profiles, or personas, that represent this group. For the work at hand, one may find, for example, passengers with reduced mobility, passengers with hearing disabilities, passengers with visual disabilities, or passengers without disabilities.

In this study, the characteristics of each persona, or each archetype, will be organized in Tables with keywords, to give a better view of each of the individual personas. The characteristics of each user were defined based on bibliographic research and on the reports of passengers found in interviews, travel blogs, YouTube videos, and other media. Research used to base the personas and user's journey was made on the websites wheelchairtravel.org, FlyerTalk's accessibility forum, [accessibleGo](http://accessibleGo.com), [ABLEize](http://ABLEize.com), and accesstravel.com, as well as YouTube channels, [@wheelchairkev](https://twitter.com/wheelchairkev), and [@wheelsnoheels](https://twitter.com/wheelsnoheels).

It was possible to divide passengers according to the type of disability they have and into non-disabled passengers. It is also relevant to study the interests of the latter, since it may be possible to implement some technology that meets the needs of both these users and users with disabilities. It would also be possible to stratify these passengers into economy and business class passengers, for example, but since the focus of the present study is accessibility solutions, this division may not be so relevant.

Therefore, the main types of passenger persona for this study were:

- Passenger with reduced mobility: passengers with limited mobility, older adult travelers, or passengers with physical disabilities. May be wheelchair or walking aids users. May require assistance for locomotion.
- Passenger with visual disability: blind or low sight passengers. May require assistance for finding seating inside the airplane. May require special assistance during the relay of safety information. May require the ability to travel with a guide dog. May require customized entertainment systems.
- Passenger with hearing disability: deaf or passengers with hearing loss. May require special assistance during the relay of safety information. May require customized entertainment systems.
- Passenger without disabilities: usually does not require special assistance. May have a desire for more comfort and space. Sometimes they accompany and assist passengers with disabilities.


An example of a persona can be seen in Fig. 2. Each persona consists of a user's name, occupation, age, and background, and also provides characteristics that may influence in their journey. This is summarized by a group of keywords. With the personas selected, the user's journey methodology was applied, and the needs of the passengers were defined. These needs will be presented in the next section.

User needs

First, the main phases and activities for each persona were defined in the user's journey. The full user's journey for each persona accounted for any possible differences between specific users' activities and for the persona's context. These activities were described according to the example found in Fig. 3, which contains a portion of a persona's user's journey. With the proper description of the activity and the persona's feelings and satisfaction, their needs were mapped.

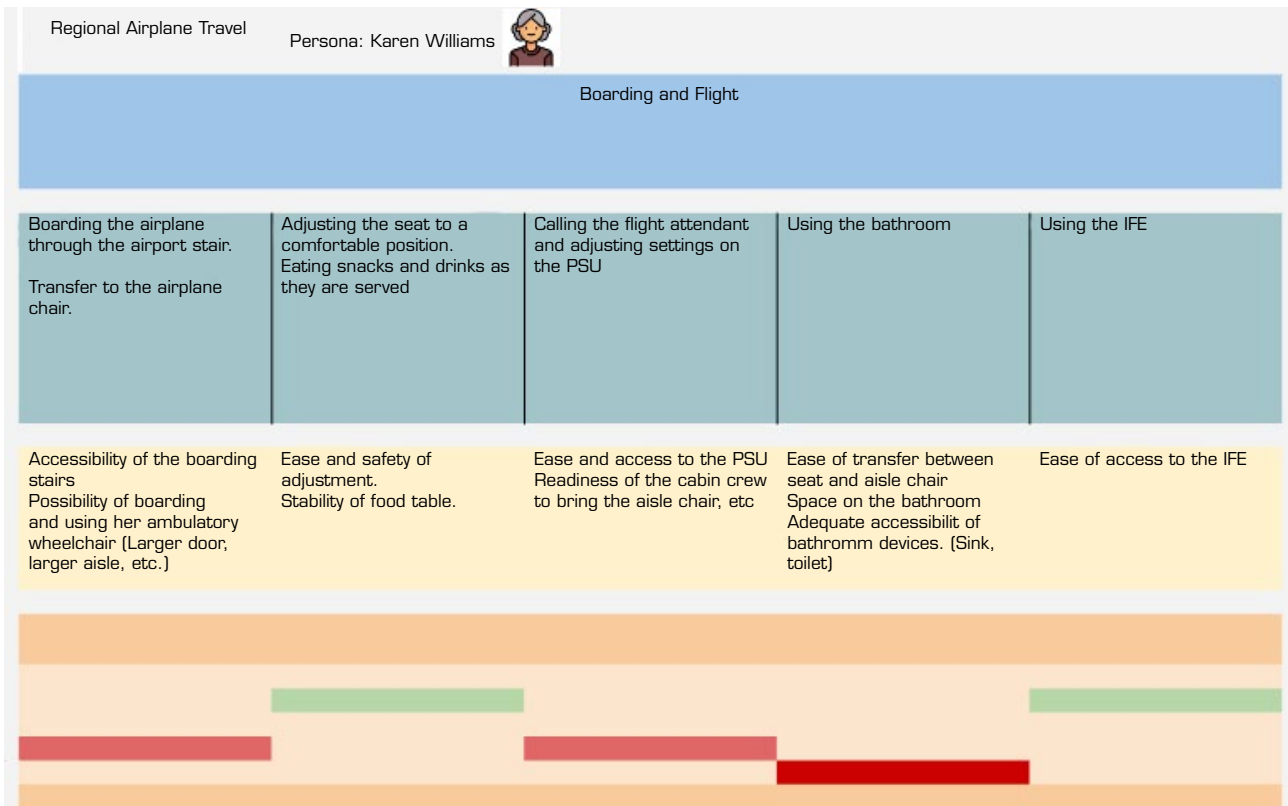
Based on the results from the user's journey and the literature review, to delimit present solutions in the market that add value, as well as to propose new relevant solutions, this chapter was created to compile the needs pointed out by the user's journey. Here, the focus is on comments that can be addressed with modifications to the aircraft and systems, although there are many needs that relate to the improvement of the service in general.

The information is organized in Table 1, according to the aircraft system or flight stage related to the identified need. The solutions that will be proposed by this study will not necessarily address all the needs listed here.

	<p style="text-align: center;">Data</p> <p style="text-align: center;">Name: Karen Williams Occupation: Retired Teacher Age: 62</p>
	<p style="text-align: center;">Background</p> <p style="text-align: center;">Karen is friendly and outgoing, and enjoys traveling and experiencing new cultures. She is a retired teacher that has mobility issues and uses an ambulatory wheelchair</p>
<p style="text-align: center;">Keywords:</p> <ul style="list-style-type: none"> Reduce Mobility; Hesitant in demanding rights; Cost-driven; Comfort and accessibility. 	<p style="text-align: center;">Characteristics:</p> <ul style="list-style-type: none"> Enjoys being able to do things on her own; Not well-informed on her rights as a passenger with reduced mobility; Is hesitant to ask for assistance and doesn't like to draw attention to herself; Pays attention to price when booking flights, but prefers a more accessible service if possible

Source: Elaborated by the author.

Figure 2. Persona of an older adult passenger with reduced mobility.



Source: Elaborated by the author.

Figure 3. User's journey of an older adult passenger with reduced mobility.

Table 1. Needs of passengers with disabilities.

Needs	Recommendations
Access to the aircraft	A.1 The steps of the access should be modified to improve accessibility
	A.2 The access stair handrail's height should be modified to improve accessibility
	A.3 The corridor should be larger to make it possible to circulate with a standard wheelchair
	A.4 The aircraft's door should be widened to allow access on a standard wheelchair
Access to the seat and seat usage	S.1 The seats should be larger to improve comfort of passengers with disabilities or reduced mobility
	S.2 The use of chairs with fixed armrests should be avoided, mainly on the first rows
	S.3 There should be a way for passengers with reduced mobility sat on the window seat to access the corridor
	S.4 Means for passengers with visual disabilities to locate their seats should be provided
	S.5 The seat controls location should be of easy access and the use should be secure
	S.6 Seat controls should be easier and safer to use through the use of levers for example
	S.7 More seat recline should be provided when possible for better comfort of passengers with mobility issues
	S.8 Optional seat cushions should be provided, or passengers should be allowed to use their own cushions to prevent pressure sores/ulcers
	S.9 Improve drink support for better stability for passengers with mobility issues
	S.10 Instead of floatable cushions, life vests should be provided for passengers with reduced mobility
Passenger control unit (PCU)	P.1 The PCU and PSU controls should be accessible to all seated passengers
	P.2 Avoid placing seat and PCU controls in areas of difficult access
Luggage and assistive equipment stowage	L.1 A stowage compartment in an accessible location should be provided (preferentially inside the aircraft cabin)
	L.2 The luggage stowage must be made so that it prevents damage to wheelchairs
	L.3 An individual compartment to stow hand luggage should be provided
Crew announcements and cabin information	C.1 Subtitles for crew announcements on the IFE screen should be provided
	C.2 A better communication system should be provided for passengers with sensorial disabilities
	C.3 An aural indication should be combined with luminous signs (such as "fasten seat belts" "do not smoke" etc.) to facilitate recognition
	C.4 Improve contrast and size of visual signs
	C.5 Provide an aural indication for oxygen masks presence, as well as an audio description of how to use them
	C.6 Cabin audio description should be provided
	C.7 A briefing card with safety information with braille should be provided
	C.8 The "call flight attendant" button should be identified with braille or high relief
Passenger circulation and cabin space	Cl.1 An appropriate and secure onboard wheelchair should be provided, or the use of conventional wheelchairs should be made possible
	Cl.2 Aural and visual signs about lavatory occupation should be provided
	Cl.3 A minimum space for guide dog accommodation should be provided
	Cl.4 A solution that allows guide dog retention should be provided

Continue...

Table 1. Continuation.

Needs	Recommendations
Lavatory	LA.1 A secure and appropriate wheelchair for lavatory access and use should be provided, or the use of conventional wheelchairs should be made possible
	LA.2 Adequate space and conditions for the passenger to transfer between the onboard wheelchair and the toilet should be provided
	LA.3 Adequate space and conditions for passengers with reduced mobility to use the sink and other lavatory features should be provided
	LA.4 Adequate space and conditions for passengers to use the lavatory with a companion should be provided, if necessary
	LA.5 A door with adequate space for access with an onboard wheelchair should be provided
	LA.6 Toilet dimensions should be reassessed to improve accessibility
	LA.7 Means for passengers with visual disabilities to identify the location of the facilities of the lavatory, such as braille or high relief, should be provided
In-flight entertainment	IFE.1 Subtitles (closed-caption) should be provided in the IFE for crew announcements
	IFE.2 Flight information and entertainment content should be provided in sign language
	IFE.3 Voice software and high contrast layout should be available on the IFE device

Source: Elaborated by the author.

CONCLUSION

The disabled population has been growing and is becoming more and more present in the air travel market. With this research, it was possible to observe that many studies are underway in order to improve the experience of these passengers in air travel, especially on their experience in airports, aiming to better understand their needs.

Despite that, it was also possible to observe that the current regional aviation market still has a lot of room for improvement and research in this field. Despite the efforts of some groups, research that clearly maps the needs and pains of passengers with disabilities during the “flight” stage of air travel is still scarce, and would be a valuable tool for offering services that meet the customers’ actual necessities.

This is especially true for passengers with sensory disabilities. This group represents important market segments and also very heterogeneous groups, whose requirements and needs are difficult to properly assess due to the lack of substantial research when related to the aircraft cabin.

Design Thinking tools, as they were used in the present study, may be a good way to adequately assess the needs of passengers with disabilities, and is a valuable tool for finding user needs and requirements. Although time constraints did not allow for the full use of this methodology, which should usually include contact that is more direct with the users being studied, they provided interesting insights for the research of solutions and proposal of an accessible cabin concept.

It is important to note that the process of deriving system/cabin requirements from the captured user needs could benefit from other analyses and validations that would require a more direct user input. These analyses may include the “Importance-Satisfaction Matrix”, for example, which involves surveying potential users to evaluate which of the captured needs should be more urgently addressed. Requirement validation with the help of both users and experts in the adequate fields is also another methodology that was considered.

Finally, with the needs presented in this work, it is possible to better understand and meet the actual necessities of passengers with disabilities in regional aviation, in order to make flights more accessible and satisfactory for these groups and potentially increasing their participation in this market, elevating the product’s value for the OEMs and airlines and customer satisfaction.

CONFLICT OF INTEREST

Nothing to declare.

AUTHORS' CONTRIBUTION

Conceptualization: Souza JBG; **Methodology:** Nascimento Filho SRO; **Validation:** Moraes AO, Souza JBG; **Formal analysis:** Nascimento Filho SRO; **Investigation:** Nascimento Filho SRO; **Writing - Original Draft:** Nascimento Filho SRO; **Writing - Review & Editing:** Nascimento Filho SRO, Moraes AO, Souza JBG; **Supervision:** Moraes AO, Souza JBG; **Final approval:** Nascimento Filho SRO.

DATA AVAILABILITY STATEMENT

The data will be available upon request.

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