

IS6025 DESIGN THINKING FOR BUSINESS ANALYTICS GROUP REPORT

A Design Thinking approach using digital solutions for aiding accessibility and inclusivity for wheelchair users in Ireland.

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1.0 Introduction

Physical mobility constraints continue to be an on-going issue faced by many wheelchair users, and the accessibility issues Ireland are no exception. Wheelchair users encounter problems navigating public roads and footpaths, public transportation, local stores, buildings, restaurants, and many other public amenities, limiting the landscape in which they can travel independently.

Through this report, an exploration from a user-centric approach is undertaken to understand the problems faced by wheelchair users and to identify opportunities to improve their accessibility concerns by utilizing the problem-solving and identification methodologies involved in Design Thinking.

2.0 Assessing wheelchair accessibility constraints through research.

2.1 Primary research sources

Primary research for this study was conducted using a questionnaire survey with 27 responses consisting of both qualitative and quantitative data. The survey received responses [6] from students at University College Cork, the University College Cork disability support group, and some from external sources.

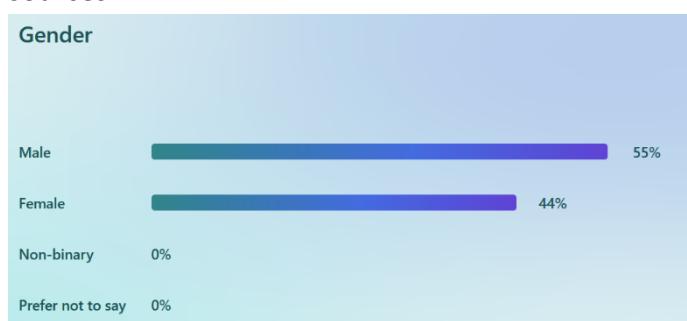


Figure 1: Gender demographics of the primary research survey consisting of non-wheelchair and wheelchair users.

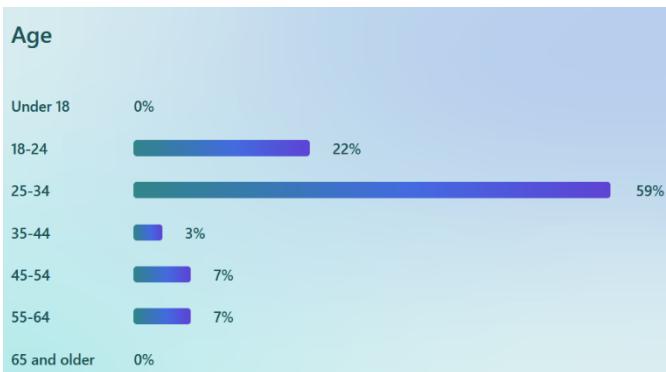


Figure 2: Age demographics of the primary research survey consisting of non-wheelchair and wheelchair users.

Figure 1 above displays the gender demographics of the respondents of the survey constitutes 55% male and 44% female respondents and Figure 2 below displays the age demographics where most of the respondents were of the age group 25-34 years, followed by those in the 18–24 years age group.



Figure 3: Gauging Direct impact of accessibility issues.

Figure 3 above indicates that 1 respondent was directly impacted by a disability, 11 respondents had friends or family who were impacted and 15 had no impact.



Figure 4: Categorical Ranking of accessibility limitations of public services and amenities.

In Figure 4, the respondents ranked the least accessible public services and amenities. Public transportation tops this list, followed by public infrastructure like accessibility to public buildings, roads, and road signs.



Figure 5: Public transportation accessibility rated from 1 – least accessible to 4 – most accessible.

In Figure 5, most respondents (59%) felt that accessibility for wheelchair users was good, indicated by 3, 25% felt it was fair and 7% felt it was poor.

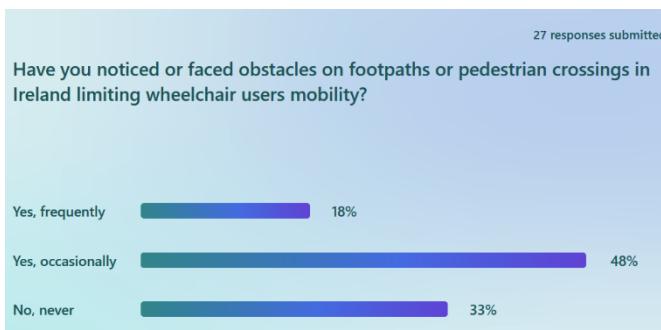


Figure 6: Assessing observed obstacles on footpaths and pedestrian crossings for wheelchair mobility.

In Figure 6, 18% of the respondents felt that they frequently faced obstacles on footpaths or pedestrian crossings and 48% occasionally felt the same, limiting wheelchair mobility. These numbers display that the number of obstacles faced are high, limiting wheelchair accessibility.



Figure 7: Categorical Ranking of accessibility limitations of public services and amenities.

In Figure 7, 29% of respondents were definite about experiencing or noticing accessibility limitations for wheelchair users in stores and buildings, while 55% felt that this was experienced to some extent.



Figure 8: Understanding from respondents' impact of a digital solution to improve wheelchair accessibility concerns.

In Figure 8, 91% of the respondents agreed that a digital solution providing accessibility routes, crowd-sourced ratings for accessibility in stores, and accessible parking reservations would enhance accessibility for individuals using wheelchairs, while 7% were not sure of its impact.

If you could improve one aspect to enhance accessibility for those in wheelchairs, what would it be?

"Online mobile application which suggests areas for them to access which are disabled friendly. Also regular feedback and monitoring to avoid mishaps while using the application."

Figure 9: A respondent's input about an aspect to enhance wheelchair accessibility.

If you could improve one aspect to enhance accessibility for those in wheelchairs, what would it be?

"alternate access points where no wheelchair ramps available"

Figure 10: A respondent's input about an aspect to enhance wheelchair accessibility.

If you could improve one aspect to enhance accessibility for those in wheelchairs, what would it be?

"Improving ramp accessibility at public spaces and transportation hubs would significantly enhance mobility for individuals in wheelchairs in Dublin."

Figure 11: A respondent's input about an aspect to enhance wheelchair accessibility.

In Figures 9, 10 and 11, respondents provided their inputs about what they think could improve accessibility constraints for wheelchair users which provides insights on viable solutions that can be applied.

The primary research survey provides insights emphasizing the need for a digital solution and an acknowledgement by the respondents about accessibility issues for wheelchair users.

2.2 Secondary research sources

To gauge the level of wheelchair accessibility issues in Ireland, statistical information from various secondary sources like research articles and papers sheds light on the problems.

Access Survey 2019

Q: How often are the following barriers encountered in accessing public buildings?

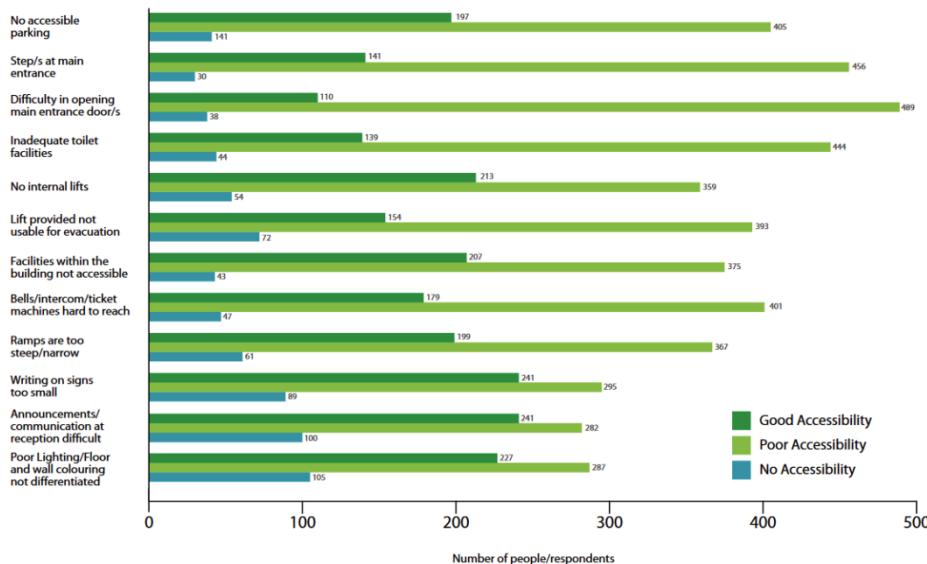


Figure 12: Accessibility survey 2019 by Irish Wheelchair Association showing poor accessibility responses for parking, lifts, toilets, ramps, and other issues.

Based on a survey from 1,000 people, the Irish Wheelchair Association (IWA) states that 77% of disabled wheelchair users have limited access to public spaces and amenities like footpaths, disability parking and pedestrian crossings, making the need for accessible routes a useful requirement, 68% of them had limited access to lifts and 63% had poor access to disability parking. Figure 12 displays accessibility issues in Ireland in greater detail [1][5]

According to the National Disability Survey 2006, around 184,000 people face challenges walking longer than 15 minutes, 31,400 people rely on wheelchairs with about 83,300 people utilize walking aids [2]. This number has now increased to 40,000 people relying on wheelchairs [3]. In addition to the wheelchair mobility concerns, there is just one wheelchair space available on Bus Eireann, requiring wheelchair users to contact them several hours in advance for a reservation, making immediate travel plans difficult. [4]

The information derived from the secondary research in addition to the primary research strengthens the narrative that underlying problems exist in wheelchair accessibility for public spaces and transportation services.

3.0 Design Thinking approaches for solving accessibility problems.

This study will examine the wheelchair stakeholders' experiences, feelings, thoughts, and customer journey phases to determine opportunities and problems by observing various touchpoints that they interact with. Once these are identified, the study will progress to define existing problems with a problem statement and generate multiple solutions through the ideation phase of design thinking and transform them into tangible prototypes. Followed by this, usability tests will be performed to improve the overall experience of the proposed digital solution for the wheelchair users to utilize the digital solutions to enhance their inclusivity and accessibility independence.

3.1 Empathizing to understand wheelchair user's challenges.

3.1.1 Observing service experience with Service Safari

By observing the wheelchair users in their daily lives, the services they use, and the physical stores that they visit the types of services, stakeholders involved, the activities that the users were performing, the products being used and identifying at the touchpoints what went well and did not go well for the end user, a service safari was created with various inputs. The safari service is accessible on a Miro board [here](#).

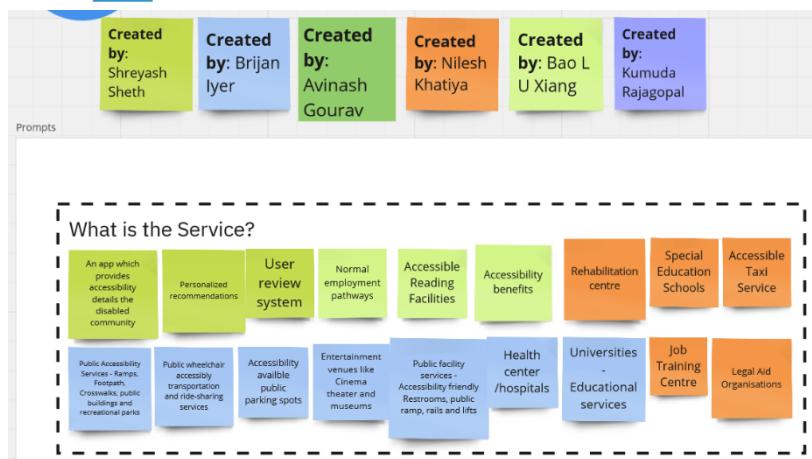


Figure 13: Service Safari – observing services used by wheelchair users.

As Described in Figure 13, Observing wheelchair users gives a deeper understanding in to what services are being accessed by them. From the initial observation it can be inferred that they were particularly interested in the service related to mobility, accessibility services, healthcare facilities etc. It was also observed that certain users were also interested in services related to academics and entertainment and were looking for accessible options related to it.

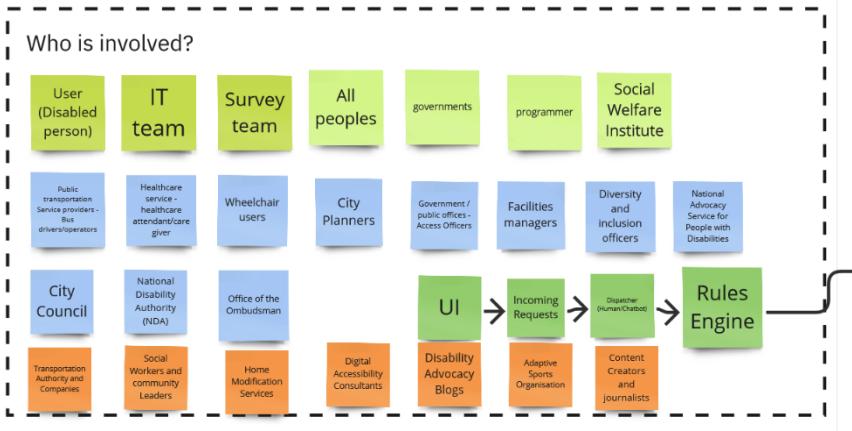


Figure 14: Service Safari – observing stakeholders involved with service interaction.

As Described in Figure 14, Observing the wheelchair user helped to capture intricate web of interactions between customers, service providers, and the physical environment within a service context. It not only delineates customer journey but also helps identify key touchpoints where a user may have interacted with service stakeholder. By understanding the role and involvement of stakeholders involved with the service interaction the Service safari map opens a roadmap for identifying opportunities and pain points.

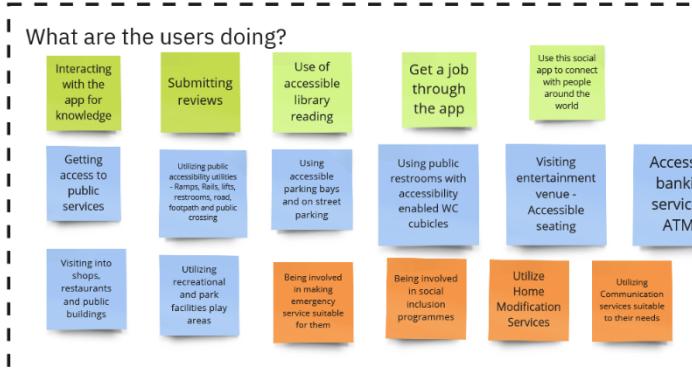


Figure 15: Service Safari – observing what the users are doing at the service location.

As described In Figure 15, observing the wheelchair users gives an understanding of what users are doing at various stages of their interaction with the services. It was observed that the users were exploring a digital interface, seeking information, making a transaction, or interacting with service providers. This clarified the actual behavior and needs of the user.



Figure 16: Service Safari – observing the interaction space at the service location by wheelchair user.

As described in Figure 16, Observing the interaction space through wheelchair user's perspective gave a unique viewpoint and the emphasis of physical spaces offering accessibility options. The Service Safari painstakingly records the wheelchair user's experience, noting all potential impediments or barriers that may impede easy travel, from access points and doorways to routes and facilities. This has helped identify mobility challenges and barriers the user faces daily.

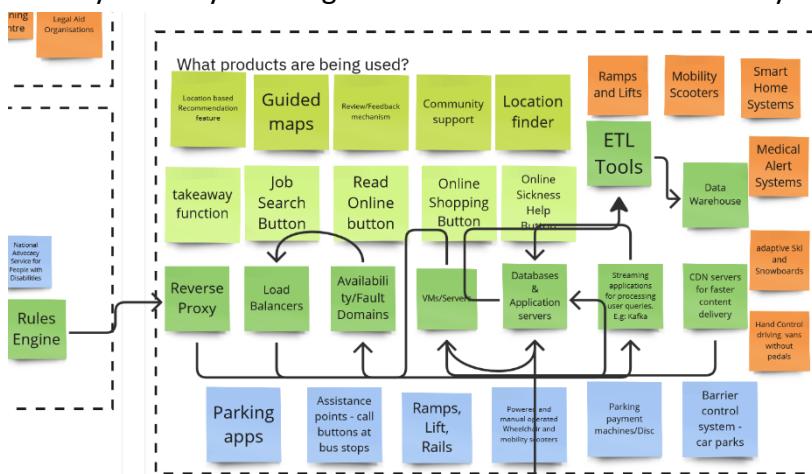


Figure 17: Service Safari – observing products being used by wheelchair users.

As described in Figure 17, observing the products being used by wheelchair users gave a key insight of the durability, adaptability, and overall effectiveness of the products in real world scenarios. This observational strategy gave valuable information of the user's firsthand experience of engagement, noting moments of difficulty or convenience. This also helps create a product which is more user-centric in design and convenient for the user to use daily.

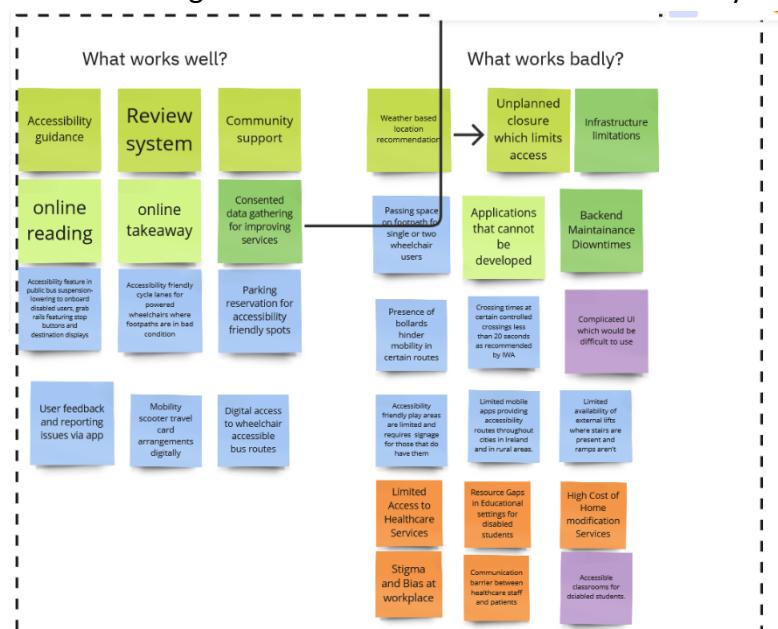


Figure 18: Service Safari – determination of service features that work well and those that do not.

In Figure 18, Using an immersive technique and by observing users' interactions with service components in real time both positive and potentially negative aspects of the user experience can be understood. Through meticulous documentation of users' interactions with a range of features, including both digital and physical environments, the Service Safari proves to be an invaluable instrument in assessing the effectiveness of distinct service components. It gives an insight while creating a service as to which features could help ease the problems faced by the users and which could complicate them.

3.1.2 Knowing impacted stakeholders with Stakeholder maps.

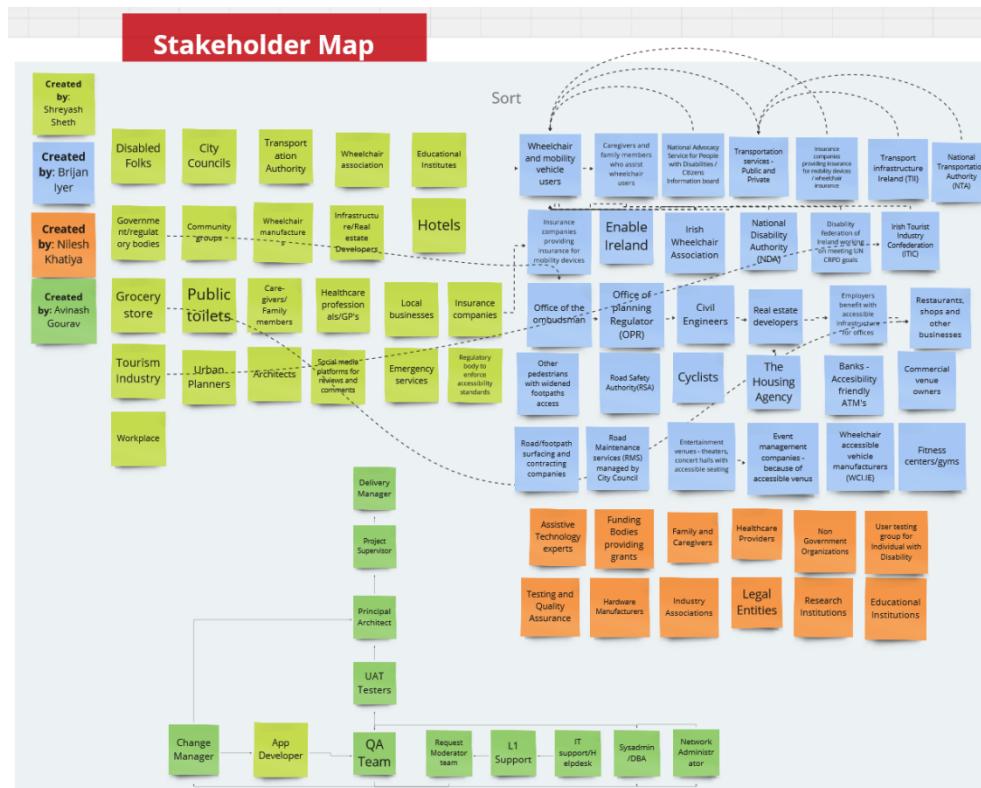


Figure 19: Identified stakeholder relationships with wheelchair users at service locations.

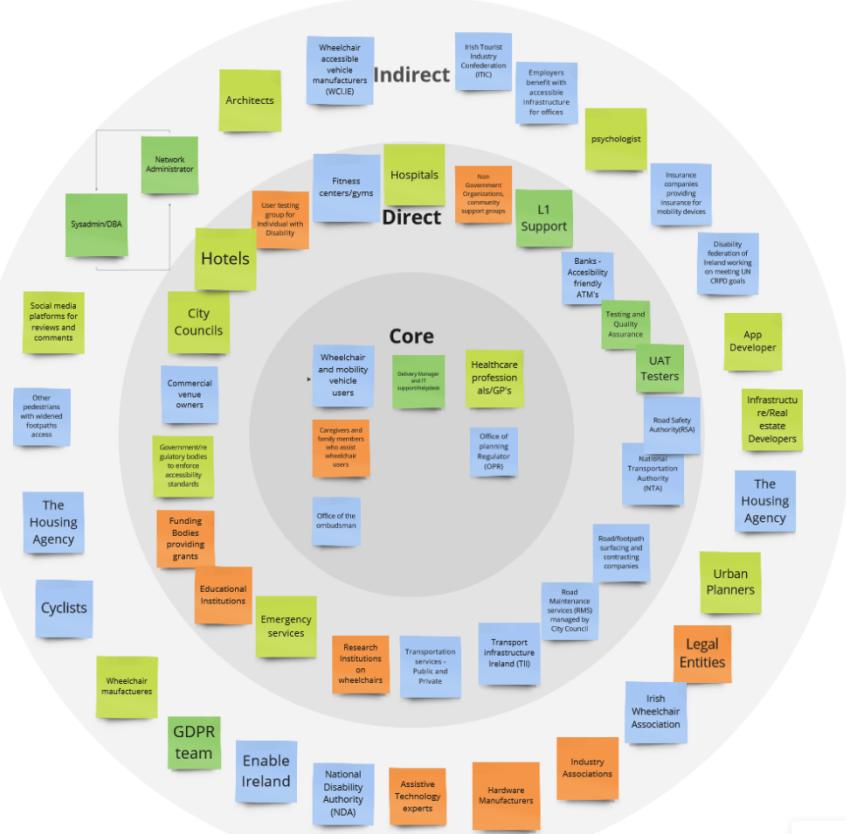


Figure 20: Identified stakeholder relationships with wheelchair users at service locations.

The stakeholder map with inputs is accessible on a Miro board [here](#).

As described in Figures 19 and 20, to create an inclusive and accessible environment, it is essential to comprehend the connections that stakeholders have with wheelchair users at service sites. It helps to further develop relationships and connections between different stakeholders and provides a key understanding of how the actions or opinion of one stakeholder may affect others. It gives a clear idea of who core stakeholders, direct stakeholders, and indirect stakeholders are going to be. Stakeholder maps also help to prioritize efforts and research based on the significance of each stakeholder.

3.1.3 Understanding affected stakeholder goals, opportunities, and pain points with Personas.

From the stakeholder map three core stakeholders affected by the wheelchair accessibility problem were identified. Personas were created in a Miro board [here](#) for these three stakeholders to understand and represent information such as their goals, pain points and opportunities. This enabled us to empathize with the personas, identify problems and opportunities to be used in further stages of designing a solution. The persona profile images were generated using Adobe Firefly [16] to ensure user privacy.

Name and Occupation:
Give your persona a name

Created by:
Brijan Iyer

Personas



Biography
Provide some details about the persona your product or service aims to solve for

Gender: Female
Age: 19

Lives in South Dublin suburb, is a student and uses a wheelchair due to Cerebral Palsy. Her friend assists her as she navigates around the city using public transportation. She enjoys spending time at cafe's and charity shops selling vintage items.

Goals

- Improve occupancy rate of wheelchairs on buses - Only one wheelchair space available and most times driver is forced to turn her away as it is occupied.
- Check availability of wheelchair bus space. Real-time navigation providing greater accessibility friendly routes and stores
- Quick real-time status updates of lift and ramp services at DART stations - Avoiding many pre-trip phone calls and website checks to see if the lift is working and are ramps available. Helps independent travel.

Frustrations
The issues or pain points they encounter or are trying to avoid

- Solving mobility issues - Narrow pavements on the routes she travels, bulging tree roots obstruction, and broken footpaths
- Find accessibility-friendly cafes, restaurants, and charity shops
- Navigating into Dart's website involves many steps to find live information or updates about the availability of lift service at Dart stations
- Inability to check if the next bus has an available wheelchair-accessible seat in advance
- To avoid many pre-trip phone calls to the stations
- Avoiding cafes or restaurants that aren't accessibility friendly

Opportunities and Insights
What might contribute to the ideal user experience?

- Live status of lift services at stations
- Public bus information about seat availability and reservation system for wheelchair users before boarding
- Recommendations for accessibility-friendly routes, restaurants, and cafes via maps

Quotes
What might they say? What does your persona say about their goals or the tasks they are trying to complete?

- "I find my daily activities hard to accomplish alone but a bit easier to do only when I have a friend around to help."
- "I love visiting charity shops as I love vintage things but they are difficult to navigate"
- "Mobility issues on streets make it difficult to do the things I love to do alone."
- "The introduction of raising tram platforms, automated ramps, and lower checkout points in shops would improve accessibility."

Figure 21: A persona – Fiadh Boyle and their goals, pain points, opportunities identified and thoughts.

The persona Fiadh Boyle (name anonymized) is a 19-year-old wheelchair user with Cerebral Palsy and is living and studying in a South Dublin suburb. The data about this persona was extracted from a real-life experience of a teenager in a day out in Dublin with her friend and this was studied from an article in the Irish Times [7]. As described in Figure 21, Fiadh faces real time issues navigating around the city using public transportation like the bus and train and runs into several obstacles on her pathway to her favorite city-center café and some stores.

Fiad's goals: In summary, the persona seeks to see improved availability of wheelchair spaces on buses as only one such space is available. As an alternative, a means to instantly check for availability of wheelchair space on the bus and ramp and lift service availability in DART stations prior to her journey

would be useful. This would help her make independent travel plans on the go. She would also like to find better mobility routes and pathways as the current routes she travels are riddled with obstacles on footpath's limiting her mobility.

Fiad's Pain points: Gaining information from DART's website about lift and ramp service availability involved going through many steps and making prior phone calls. Due to no status updates available about wheelchair space on the next bus, prior reservations needed to be made and therefore making immediate travel plans was not possible. The café that she likes to go to is not accessibility friendly where the counters are above waste level and communication becomes difficult.

Opportunities identified from Fiad: Some opportunities that were identified from Fiad's experience to generate a design solution were – Viewing live status of lift services at DART stations, live public bus wheelchair space availability information of upcoming buses and recommendations for mobility friendly routes and accessibility friendly restaurants and cafes via maps.

Name and Occupation:
Give your persona a name
Cian Murphy
(anonymized)

Personas Created by: Shreyash Sheth

Portrait
Include a picture of your persona


Biography
Provide some details about the persona your product or service aims to solve for

Gender - Males
Age - 35
Resides in Cork and utilizes a wheelchair due to a cycling accident. He enjoys exploring and capturing images of historical architecture. Relies on both an adapted car and public transportation for commuting. Is an avid advocate of 'equality'.

Goals
Cian is motivated by the desire for a more inclusive and accessible environment, particularly for wheelchair users. He is passionate about advocating for equality and wants the government to acknowledge the challenges faced by disabled individuals he faces. Cian is outspoken about the need for equal treatment for disabled individuals, aiming to address issues like inaccessible bus stops.

Frustrations
The issues or pain points they encounter or are trying to avoid

- Accessibility issues in buildings, especially historical ones.
- Desire for designated parking spaces for disabled individuals.
- Moderate satisfaction with public transport but notes a lack of emphasis on accessible sidewalks leading to bus stops.

Opportunities and Insights
What might contribute to the ideal user experience?

- A digital solution can help find whether locations are accessible and show parking availability.
- An app can be a means of broadcasting issues and sharing experiences with other peers.
- Wants the issue of inaccessible bus stops to be addressed.

Quotes
What might they say? What does your persona say about their goals or the tasks they are trying to complete?

- "I appreciate the accessibility at my workplace, but it's frustrating that this isn't the case everywhere in public."
- "Relying on public transportation remains inconvenient, and there's always the risk of facing parking shortages when I opt for my car."
- "Exploring historical buildings is my passion, but it's disheartening that they often lack accommodations for wheelchair users."

Figure 22: A persona – Cian Murphy and their goals, pain points, opportunities identified and thoughts.

Residing in Cork, Cian Murphy navigates life in a wheelchair following a cycling accident. Passionate about exploring and capturing images of historical architecture, he relies on both an adapted car and public transportation for commuting. This persona is an amalgam of various real-life individuals whose

information is accessible through various online articles. The Irish Times addresses the challenges of navigating pathways and pavements [7], while a Newstalk article highlights the dissatisfaction expressed by a wheelchair user with authorities regarding accessibility and the user's passion to advocate for equality [12]. The Irish Independent features an article discussing the convenience of having an adapted vehicle and the joy of avoiding daily negotiations with public transport [13]. Enable Ireland sheds light on the difficulties faced in old buildings with regards to accessibility [14]. Additionally, an article in Uccello delves into the hassles and challenges experienced by wheelchair users when using public transport [15].

Cian's Goals: He envisions a digital solution that not only identifies accessible locations but also helps navigate public transport. Cian also proposes an app as a platform for sharing experiences, broadcasting issues, and fostering a community of peers. Motivated by a passion for inclusivity, particularly for wheelchair users, Cian strongly advocates for equality. His outspoken stance urges government acknowledgment of the daily accessibility challenges faced by disabled individuals, with a specific focus on addressing issues like inaccessible bus stops.

Cian's Pain Points: Cian encounters significant accessibility challenges within buildings, particularly older buildings. The absence of designated parking spaces for disabled individuals proves to be a notable pain point, adding to the overall struggle for accessibility. While Cian expresses moderate satisfaction with public transport, he notes a lack of emphasis on accessible sidewalks leading to bus stops.

Opportunities identified by Cian: Cian's persona has identified several opportunities, including the need for recommendations based on parking spot availability, information on the accessibility of buildings, especially historical ones, the establishment of a platform enabling disabled individuals to share experiences and highlight issues to the concerned authority, and the provision of route suggestions with minimal obstructions for wheelchair users.

The screenshot shows a persona profile for 'ALEX TAYLOR (Anonymous)'. The top navigation bar includes 'Name and Occupation: Give your persona a name' and 'Created by: Nilesh Khatya'. The main sections are:

- Portrait:** Includes a photo of a smiling Black man with curly hair.
- Biography:** Provides details about Alex, noting he is male, 32 years old, uses a wheelchair due to a spinal cord injury from a car accident, and works as a graphic designer.
- Goals:** Lists aspirations like seeking accessible work environments and starting a blog about accessible design.
- Frustrations:** Lists challenges such as encountering accessibility barriers in public spaces and facing misconceptions about wheelchair users.
- Opportunities and Insights:** Lists potential opportunities like a wheelchair-accessible workplace with ramps and accessible fitness apps.
- Quotes:** Reiterates goals like seeking accessible work environments and transportation.

Figure 23: A persona – Alex Taylor and their goals, pain points, opportunities identified and thoughts.

The Persona Alex has been using a wheelchair since a car accident a few years ago, resulting in a spinal cord injury. Alex is a skilled graphic designer and works for a design agency in the city. Alex is passionate about accessibility in design and advocates for inclusivity in both their personal and professional life. The persona was created using an AI tool called ChatGPT [16]

Alex's goals – As described in Figure 23, the persona in this situation, Alex, is dedicated to promoting diversity in both her personal and professional life, as well as accessibility in design. As a talented graphic designer, Alex wants to help create designs that consider a variety of user demands and visual appeal. As a member of the design team at the firm, Alex tries to promote accessibility guidelines by creating a culture that values diversity and makes sure that design solutions are usable by people of all abilities.

Alex's Pain Points - With Alex's personal history of a spinal cord injury and need for a wheelchair, coming across non-inclusive or inaccessible designs may be one of the possible pain spots. When Alex uses goods and services that do not consider the requirements of people with disabilities, he can run

into difficulties. Alex's passion for fighting for accessibility is fueled by their direct experience, which has helped them appreciate the difficulties and restrictions that can develop when accessibility is neglected in design.

Opportunities identified from Alex - Including tools that let users plan their travels more efficiently by providing information on physical sites' accessibility, such as elevators, wheelchair ramps, and accessible bathrooms. Putting in place social aspects that facilitate communication amongst wheelchair users and enable them to exchange advice, experiences, and details about accessible locations and activities. To improve wheelchair user safety, items that provide information about accessible emergency exits, evacuation routes, and emergency services should be included.

3.1.4 Empathizing with wheelchair user's thoughts and behaviors for problem identification with Empathy maps

Along with the goals, opportunities and problems identified using personas, to further visualize the persona's behaviors their thoughts and feelings were observed to discover gaps in our findings. The empathy map is accessible on a Miro board [here](#).

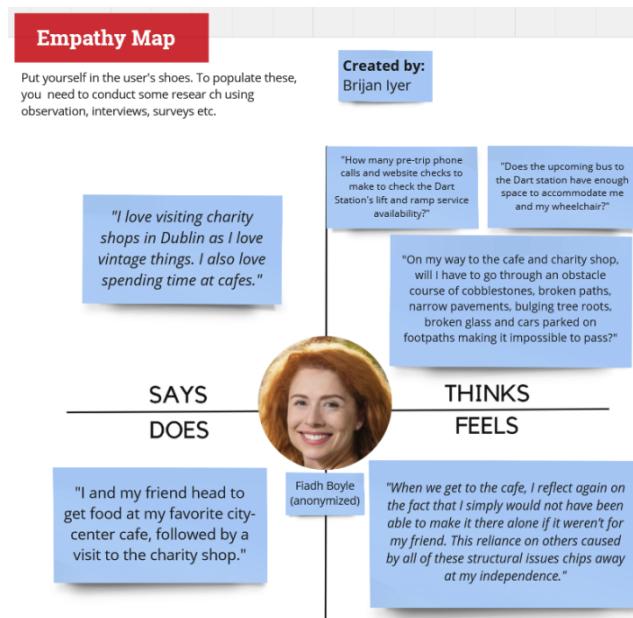


Figure 24: Empathy map of a persona – Fiadh Boyle [7].

As described in Figure 24, observing Fiad's experience on her day out in Dublin [7] reveals information about her thoughts and feelings. In her thoughts she expresses her desires to travel independently but is concerned about the number of pre-trip phone calls and website checks to make with the DART stations, to inquire about lift and ramp service availability, limiting her ability to make immediate travels on her own. She questions if the upcoming bus will allow her to board as the only wheelchair

space may be occupied. She also thinks about the obstacles involved with her mobility on her way to the café and charity shop. She reflects on her thoughts, and she feels dependent on her friend to help her navigate around the city. Based on her thoughts and feelings her problems were broken down into three key focus areas – public transportation ramps, lift service and wheelchair space tracking and ability to navigate via accessible routes.

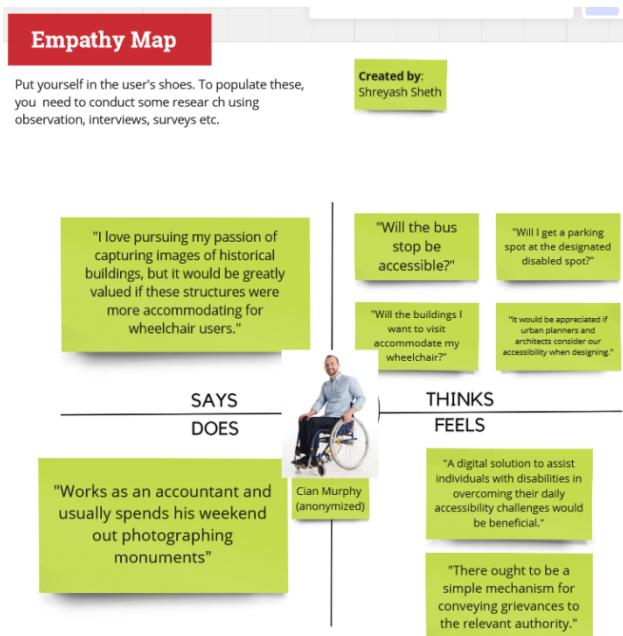


Figure 25: Empathy map of a persona – Cian Murphy.

As described in Figure 25, observing Cian's sightseeing past time, visiting historical buildings, provides information about his thoughts and feelings. In his thoughts he expresses his concerns wondering if the bus will be accessible, will he get a disability parking spot at his destination, will the historical buildings be able to accommodate him in his wheelchair and the need for urban planners to provide accessibility. He feels a need for a digital solution to overcome the accessibility concerns that he has and a way to convey grievances to the city council on accessibility limitations at historical sites. Based on his thoughts and feelings his problems were broken down into two key focus areas – an ability to report accessibility grievances to the city council and the need for a disability parking digital solution.

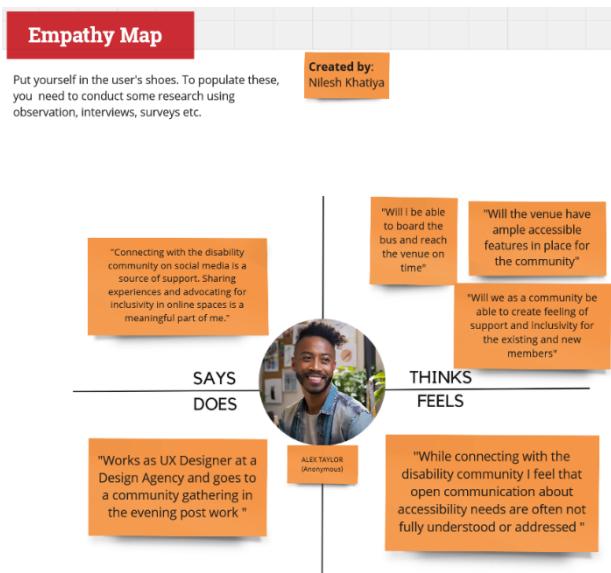


Figure 26: Empathy map of a persona – Alex Taylor.

As described in Figure 26, Alex's thoughts and feelings were explored. In his thoughts he expresses his desire to connect with the disability community and advocacy groups on social media to share experiences about inclusivity. He thinks about reaching his destination on time via bus, worried about the wheelchair space limitations and will the venue have accessibility features in place for the community he is visiting. He expresses his feelings about a need for open communication about accessibility needs and its awareness. Based on his thoughts and feelings his problems were broken down into two key focus areas – an ability to interact with disability support groups and communities and a way to track public transportation wheelchair space availability.

3.1.5 Approaching key problems with user stories.

After identifying the key focus areas using empathy maps, a one-sentence user story from the persona helps determine if their key problems would be addressed with a beneficial digital service solution. The user stories are accessible on a Miro board [here](#).

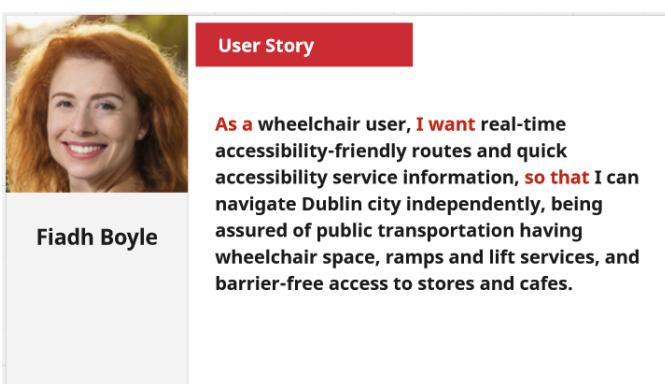


Figure 27: User Story of a persona – Fiadh Boyle.

Figure 27 describes Fiad's one-sentence user story where she desires the ability to navigate in the city independently with a confirmed wheelchair space in the bus, firm information about ramp and lift services in DART stations and obstacle free mobility to stores and cafes by mobility route solution that provides accessibility friendly routes and accessibility service information from public transport providers.



User Story

Cian Murphy

As a wheelchair user, I want to access real-time information on building accessibility and parking availability through an app, so that I can plan my route efficiently, navigate sites without unexpected barriers, and contribute to a more inclusive environment for individuals with mobility constraints.

Figure 28: User Story of a persona – Cian Murphy.

Figure 28 describes Cian's one-sentence user story where he wants a digital solution to real-time building accessibility and disability parking availability to travel and navigate historical sites and be more inclusive.



User Story

Alex Taylor

As a wheelchair user, I want environments that are wheelchair-accessible and accommodating. At home, I desire an inclusive living space so that with adaptable furniture arrangements, accessible counters, and ramps I can move around easily . In the workplace, I advocate for a culture that values diversity and understands the importance of creating an accessible workspace, from ergonomic desk setups to accessible meeting spaces

Figure 29: User Story of a persona – Alex Taylor.

Figure 29 describes Alex's one-sentence user story where he requires information about wheelchair accessible environments, furniture and ramps in buildings, accessible workspace and desk setups, and interaction with the disability community, which would address his concerns.

3.1.6 Slicing through phases of wheelchair user's customer journey and touchpoints to identify problems and opportunities.

To explore and understand the path and phases that the wheelchair customer takes at different physical locations or service points, to understand their actions, their touchpoints at the place of service, their needs, and moods and insights, customer journey maps were created for each of the three personas. Their actions, touchpoints, their needs, moods, and insights helped us understand the problems and opportunities at each subsequent phase of their journey. This process also helped identify and generate additional digital touchpoints that were embedded into the prototype solution to improve their public services experience. The customer journey maps are accessible on a Miro board [here](#).

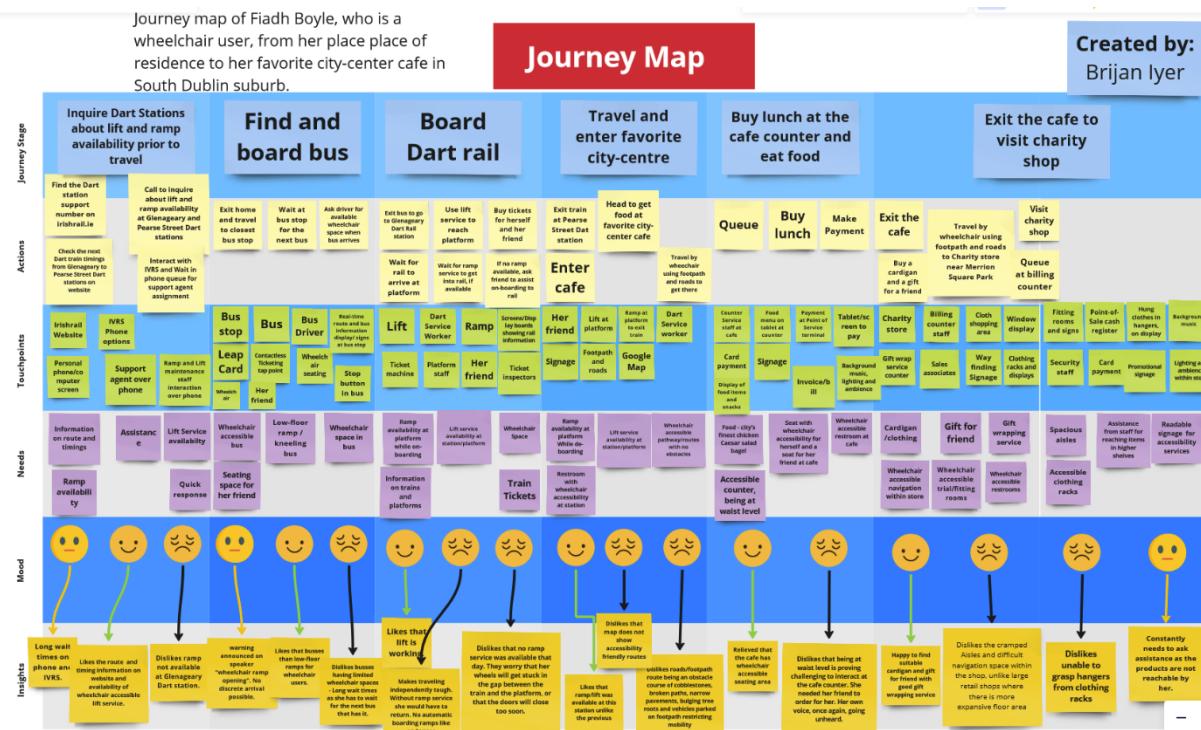


Figure 30: Customer Journey map of persona – Fiadh Boyle.

Figure 30 displays the journey map for Fiadh Boyle, who is a wheelchair user. The journey focuses on their day out travel experience from her place of residence to her favorite city-center café and charity shop in a South Dublin suburb.

Problems identified at each phase: Fiadh Boyle, a wheelchair user, frequently encounters various accessibility challenges during her journey from her residence to her favorite city-center café in a South Dublin suburb. At her first phase of journey, Fiadh had to make many prior phone calls and website checks with DART transportation service to inquire about ramp and lift service availability. If Fiadh had to travel individually to the Glenageary Dart station, the lack of a ramp would have been an impediment, and she would have had to either wait for assistance or return home. At the second phase of her journey to find and board a bus, being aware that buses have limited wheelchair space, she must wait for an extended period for the next bus that had an available wheelchair space. At the third phase of her journey to the DART station to board the rail, the absence of automatic boarding ramps, like

those available on buses leads to her being concerned about her wheelchair getting stuck in the gap between the train and platform or the doors closing prematurely. At the fourth phase of her journey traveling to her favorite city-center café, she is faced by the inadequacy of accessibility-friendly routes, and the obstacle course-like conditions of cobblestone streets, uneven paths, narrow pavements, protruding tree roots, and improperly parked vehicles that limit mobility. At the fifth phase of her journey within the café to order and eat food, interactions at the counter prove difficult due to her being at waist level, often necessitating reliance on her friend to order, leaving her voice unheard. At the final phase of her journey to a charity shop, the aisles inside the shop and navigation space in comparison to larger retail stores are limited. Reaching for clothing racks remains a challenging task for her and she needs to seek assistance.

Opportunity identified: The ability to get instant information on a digital app instead of calling public transportation support, information about vehicle seat availability and recommendations for stores that provide accessibility within stores based on crowd sourced ratings.

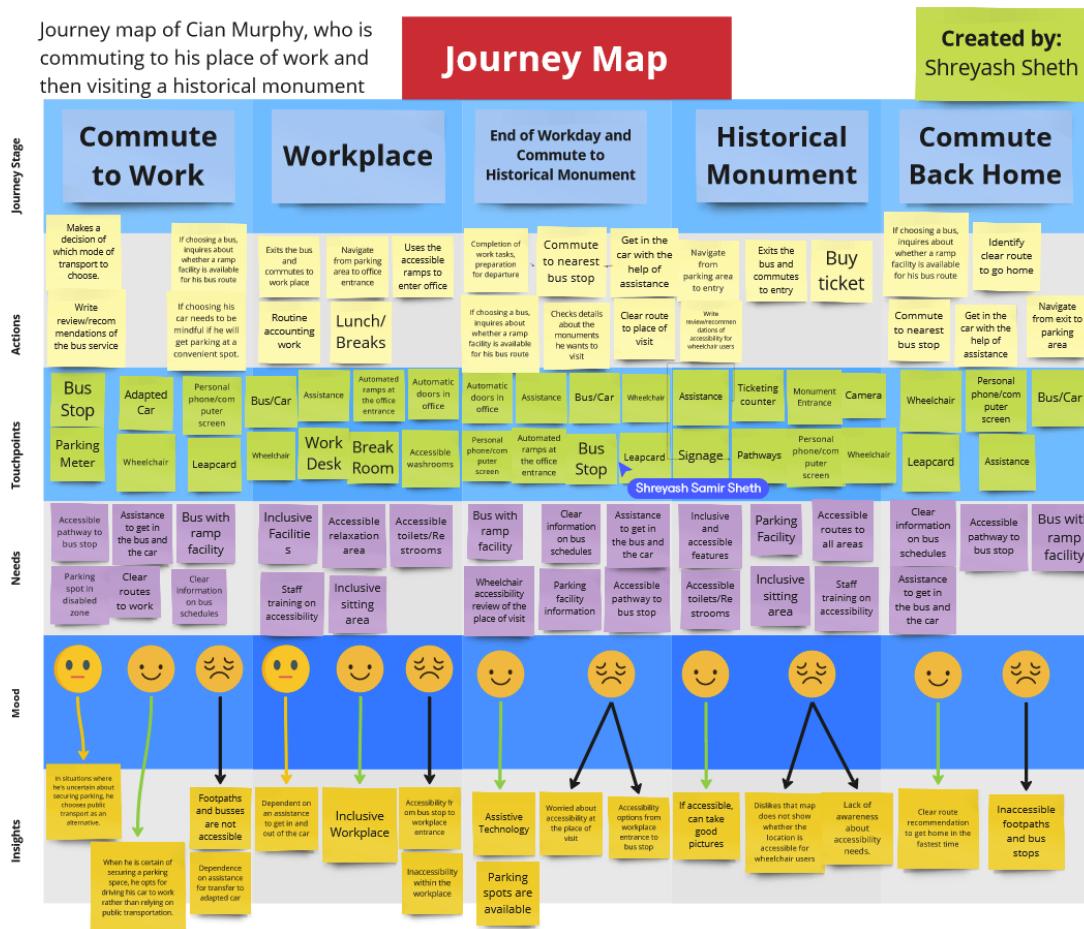


Figure 31: Customer Journey map of persona – Cian Murphy.

Figure 31 displays the journey map for the persona Cian Murphy, who is commuting to his place of work and then visiting a historical monument.

Problems identified: Cian Murphy faces many accessibility challenges while commuting to his workplace followed by a planned visit to a historical monument. At the first phase of his journey to commute to work, Cian encounters that the footpaths and buses are not wheelchair-friendly, forcing him to rely on assistance to transfer to an adapted car. At the second phase of his journey to his workplace, Cian faces accessibility issues from the bus stop to the entrance of his workplace and faces mobility issues within the workplace. At the third phase of his journey after work to commute to a historical monument, Cian once again has accessibility concerns from the workplace entrance to the bus stop. He is also worried if the historical monument place that he is commuting to would be accessibility limited. At the fourth phase of his journey at the historical monument site, he becomes aware of the lack of awareness about the wheelchair accessibility needs at the site and dislikes that the information that he referred to in a digital map did not provide this information. At the final phase of his journey back home, he is faced with obstacles such as inaccessible footpaths.

Opportunities identified: Two opportunities were identified by exploring Cian's journey map. The ability to find live information about accessible routes without obstacles and crowd sourced information and reviews about historical sites and public venues regarding accessibility.



Figure 32: Customer Journey map for persona – Alex Taylor.

Figure 32 displays the journey map for the persona Alex Taylor, highlighting his daily routine from his residence to his workplace on a wheelchair.

Problems Identified: In the first phase of Alex's journey, which is his morning routine to get ready for work and travel to the bus stop, he requires family care for morning activities and requires independence. In the second phase of his journey involving his commute to work, he struggles waiting for buses due to limited wheelchair space and the long wait. He must also travel a longer distance to reach a bus stop. In the third phase of his journey to work at his design agency, he dislikes the inaccessible workspace. In the fourth phase of his journey after work to the gym for a workout, he dislikes that the gym has no wheelchair accessible workout area. In the fifth phase of his journey at an evening social event, he faces issues finding proper restroom facilities for disabled users or wheelchair users. In the final phase of his journey after returning home he likes to connect with an online disability community but feels a disconnect with their contributions not being valued by society and thus needing to interact with more groups to create more awareness.

Opportunities Identified: For wheelchair users, three opportunities identified are finding mobility routes to the nearest bus stop, information about bus wheelchair space availability in advance, location of other gyms which are more accessibility friendly and nearest accessible lavatories.

3.2 Defining the problems and needs using problem statements.

Based on the problems identified from the personas with the tools used in the empathize phase, a single problem statement is generated for each of the three personas. This helps break down the problem by understanding the stakeholder experiencing the problem, their pain points, the location where the problem occurs, the time it occurs, why it is an important problem to solve and how the personas goals are achieved. The problem statements are accessible on a Miro board [here](#).

Problem Statement
<p>Fiadh Boyle is a wheelchair user who needs a solution to find accessibility friendly routes, stores and cafes, and information from public transportation services in Dublin about their availability of wheelchair facilities such as ramps, lifts and space because she finds that the current routes that she travels have a plethora of obstacles like cobblestones, broken footpaths, narrow pavements, bulging tree roots and cars parked on footpaths making mobility difficult, limiting her awareness about stores having navigable wheelchair space, and the long time it takes for her to get information about lift and ramp availability from public transportation services while traveling independently.</p>

Figure 33: Problem statement of Fiadh Boyle.

As in Figure 33, to improve her independence, Fiadh Boyle looks for all-encompassing solutions to her everyday problems, such as wheelchair-accessible routes with up-to-date information on routes that do not have broken footpath's, tight spaces, and have wheelchair-accessible cafes, and shops.

Problem Statement

Cian Murphy faces daily accessibility challenges, hindering his passion for exploring historical buildings and creating inconveniences during commutes, highlighting the urgent need for a comprehensive digital solution that provides real-time accessibility information, route suggestions, and a community forum to enhance inclusivity and independence.

Figure 34: Problem statement of Cian Murphy.

As in Figure 34, Cian Murphy requires a comprehensive digital solution providing real-time accessibility information, suggesting accessible routes, and fostering a community forum to enhance inclusivity and independence in daily activities.

Problem Statement

Alex is interested in innovative solutions that enhance wheelchair accessibility in public spaces, from well-designed ramps to accessible transportation options. Alex also seeks technology and apps that cater to diverse needs, offering customizable settings and an intuitive user interface. On a broader scale, Alex advocates for increased awareness and education around inclusive design principles, envisioning a world where accessibility is not an afterthought but an integral part of the design process. Whether it's in the workplace, public spaces, or the digital realm, Alex is on a quest for solutions that foster a truly inclusive and accessible environment, ensuring that everyone, regardless of ability, can participate fully in all aspects of life

Figure 35: Problem statement of Alex Taylor.

As in Figure 35, to create a truly inclusive environment, Alex fervently supports creative and inclusive solutions and a way to discuss within groups to create awareness about it. Alex also describes the pain points about accessibility in public spaces and the need for better designed ramps for transportation.

3.3 Creative ideation – generating digital solutions for wheelchair accessibility.

To generate creative ideas through a brainstorming exercise, solutions to the problems identified in the empathize and definition phases above were generated using the crazy 8's approach. We researched competitors' products to identify gaps and opportunities in their offerings as compared to our solutions to provide a unique value proposition to meet the accessibility needs of our end users.

3.3.1 Generating multiple ideas using Crazy 8's with feedback to find the best solutions.

Brijan's Crazy 8 Ideas	Shreyash's Crazy 8 Ideas	Kumuda's Crazy 8 Ideas
<p>Brijan</p>  <p>Digital app with map showing accessibility friendly routes for wheelchair user - Roads with accessible footpath and better accessible infrastructure.</p>  <p>Report feature on digital app to report issues to City Council for footpath or infrastructure issues hampering mobility</p>  <p>Emergency contact feature to contact local emergency services or wheelchair advisory groups for assistance</p>  <p>Book wheelchair accessible vans/taxi/ride through digital app</p>  <p>Accessibility groups - Ability to interact with disability services groups and associations to come up with community plans and outreach services for support</p>	<p>Shreyash</p>  <p>IOT based parking meters to identify availability</p>  <p>Location based recommendation of best routes/cafes/restaurants/parks etc.</p>  <p>Location based recommendation of best routes/cafes/restaurants/parks etc.</p>  <p>Integrate wheelchair accessibility into the regulations/laws in such a way that necessary steps are taken</p>	<p>Kumuda</p>  <p>A sensor based fall detection, and an immediate call to any emergency contact at any wheelchair authority</p>  <p>Easy and accessible pathways with better connectivity around the city so it is easier to commute on daily basis</p>  <p>Access to a GPS-based location to any close family or friends, so it becomes easier to keep track</p>  <p>An all in one app which provides all information including accurate weather forecast so that the day can be planned accordingly</p>
<p>Nilesh's Crazy 8 Ideas</p> <p>Nilesh</p>  <p>Emergency Assistance Button</p>  <p>Wheelchair-Friendly Routes</p>  <p>Wheelchair-Friendly Restrooms</p>  <p>Real-Time Accessibility Information</p>  <p>Elevator Status Alerts</p>  <p>Emergency Evacuation Information</p>  <p>Smart Home Integration</p>  <p>Community Events for Wheelchair Users</p>	<p>Aria</p>  <p>voice-activated pushbutton</p> <p>Personalisation: The voice-activated buttons can be personalised to suit different voices and</p> <p>Maintainability: Ensure that function buttons are easy to maintain and repair to prolong their life.</p> <p>These buttons can control multiple devices and provide a variety of functions such as calling, texting, checking the weather and more!</p> <p>Ensure that the design complies with relevant accessibility and assistive technology regulations and standards, such as the Americans with Disabilities Act (ADA).</p> <p>Product testing: User testing and evaluation of functional buttons prior to production to ensure their usability and reliability in actual use.</p>	<p>Avinash</p>  <p>Ability of the app to accommodate unexpected loads during festive season.</p>  <p>Having multiple fault domains and load balancing for zero downtime maintenance activities</p>  <p>Having appropriate colour coding of app for photosensitive epilepsy patients</p>  <p>App should have a direct connection to the local authorities in case it is required.</p>

Figure 36: Crazy 8 exercise to rapidly generate 8 ideas from 6 members of our group.

As in Figure 36, through the crazy 8's exercise of rapidly generating eight radical solutions to improve the wheelchair user's accessibility problems, each member of the group generated eight unique solutions. The crazy 8's was performed on a Miro board [here](#). Followed by this, to receive feedback, a vote was conducted on Miro in which each member was given a chance to cast their vote on one best idea of the other members. This vote resulted in five best solutions:

- A map displaying mobility friendly routes with better footpaths and infrastructure for wheelchair users to reach their destination, and accessibility to friendly restaurants, stores, and cafes.
- A digital solution to interact in disability community and advocacy groups.
- A digital solution to find and reserve disability parking spots with information on available number of parking spots and crowd sourced reviews about the location.
- Live updates about wheelchair space availability in upcoming buses, and ramp availability and lift service availability in the nearest DART stations.
- A feature to report public space accessibility grievances to the city council.

3.3.2 Ideas not considered and their reasoning.

The five best solutions were selected based on cross member voting which by nature excludes many of the other ideas proposed by the team. Apart from the five best solutions, the team felt that some of the other ideas proposed could be a powerful addition to future versions of the product, while currently focusing on the most useful and necessary feature ideas to be included in the first version of the prototype. The idea such as the emergency contact feature and fall detection, ability to book WAV (wheelchair accessible taxi's), virtual accessibility consultations, AI powered accessibility assistant/Chatbot, location tracking by family members, accessibility themes, emergency evacuation information and voice assistance features were considered useful by the team overall and will be considered for the next version of the app. Based on agile methodology of software development, feature additions would be added on a continuous basis with continuous improvement and testing.

3.4 Conceptualizing tangible solutions through prototyping and visual designs

Considering the five best solutions that were identified based on the feedback vote in the crazy 8's exercise, a tangible interactive digital solution was designed consisting of various touchpoints and features for wheelchair users.

3.4.1 Designing mockups for digital solution solving accessibility problems.

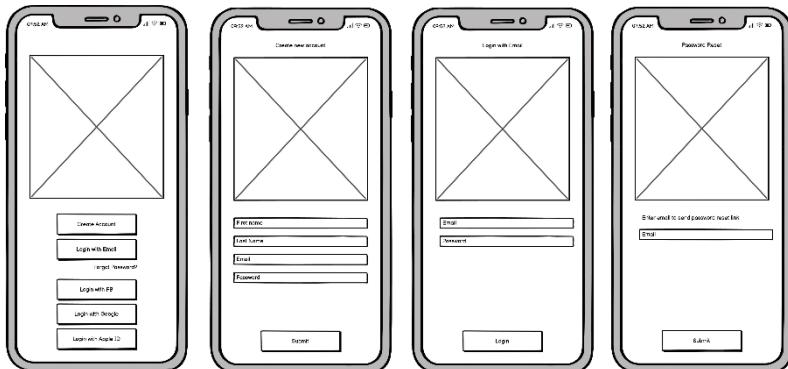


Figure 37: Login/splash page mockups using Balsamiq Mockup.

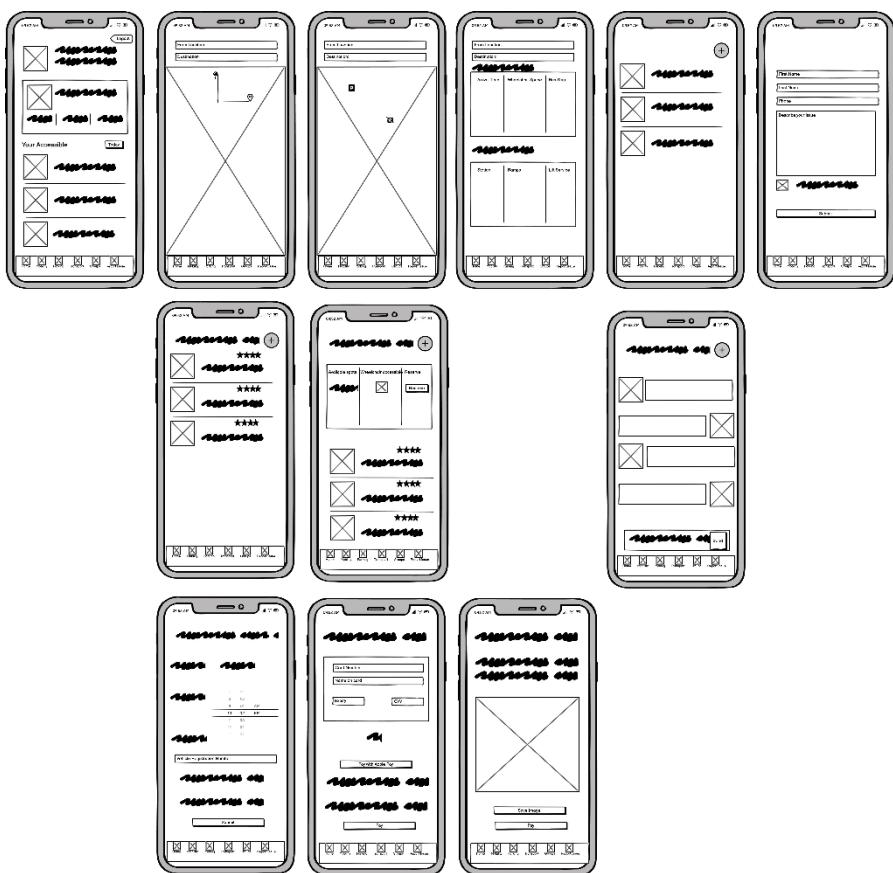


Figure 38: Prototype mockups of all feature screens using Balsamiq Mockup.

Figures 37 and 38 display a wireframe mockup of the digital mobile application solution that was designed using Balsamiq Mockup. The idea was to prepare a sketched wireframe prior to designing and developing a usable and interactive prototype in Figma.

Images are represented by an image object (a rectangle or square shape with a cross), squiggly lines indicate position for text labels or text areas containing information for the end user, rectangle tables indicate information that would be displayed for the end user, input fields are represented as text boxes, the navigation menu at the bottom of the screens consists of images and text menu names, and user triggered actions are represented with buttons.

The digital solution would feature a splash screen with the application logo, account creation and various login options. Upon logging in, as in Figure 38, the user would be presented with a home page displaying activities and options for the user to choose. The menu at the bottom would allow the user to navigate between various pages having digital features solving the wheelchair accessibility constraints for the user.

3.4.2 Building a tangible prototype using Figma.

Once the wireframe mockup was sketched defining the prototype's skeleton and objects, a visual wireframe was in place to design and build the prototype. The interactive prototype was designed and developed in Figma [10] and is viewable and accessible by visiting the Figma prototype [here](#).

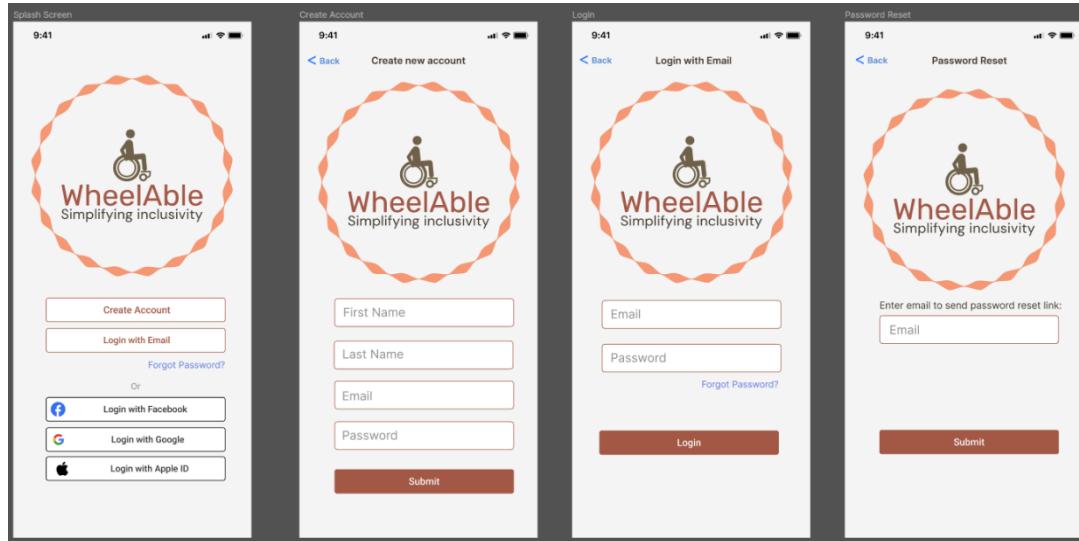


Figure 39: Figma prototype of splash screen, login screen and account creation pages.

As displayed in Figure 39, WheelAble was decided as the name for the mobile application with a subtitle - 'Simplifying Inclusivity' which was selected with the goal to provide accessibility and mobility solutions for wheelchair users. The logo for the app was designed using logo.com [8] and all the icon images used in the prototype were found and utilized from flaticon.com [11]. The splash screen consists of account creation, login options using email or social media OAuth login buttons for which we used social login button templates [9], and a password reset page for the user to reset their WheelAble account password. On the account creation page, the user will input and submit their name, email, and password to create an account. The email login page consists of an email and password input fields to login.

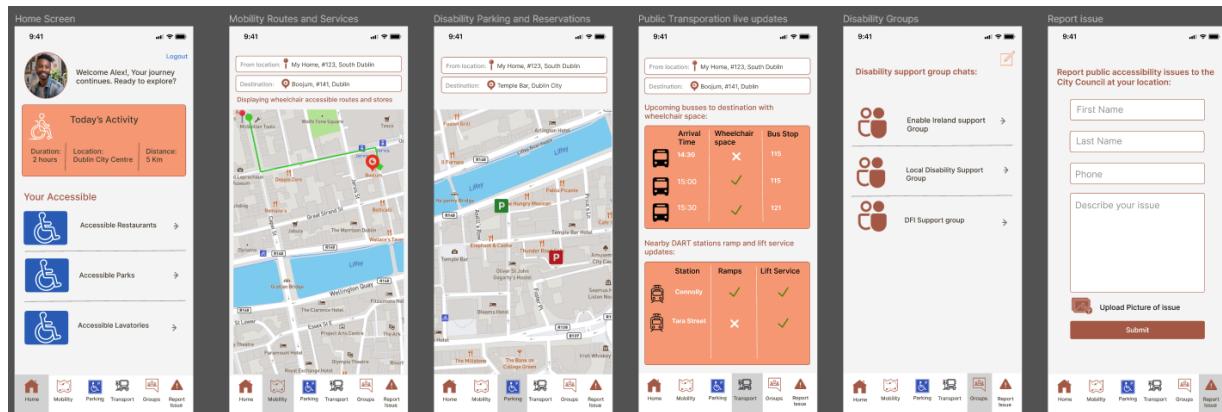


Figure 40: Prototype of home screen, mobility screen, disability parking reservation, transportation accessibility service updates, accessibility groups and city council report pages.

In Figure 40 there are multiple screens displayed after the user is logged in.

Home screen: The first screen shown on the extreme left of Figure 40 displays the wheelchair user's daily activity measured by means of distance traveled using the accelerometer functionality on the mobile device. Below this, based on the user's device location, shortcuts to the nearest available restaurants, stores, parks, lavatories, hospitals, and other public avenues are available to tap and view on the mobility maps screen. This feature adds usability to the application.

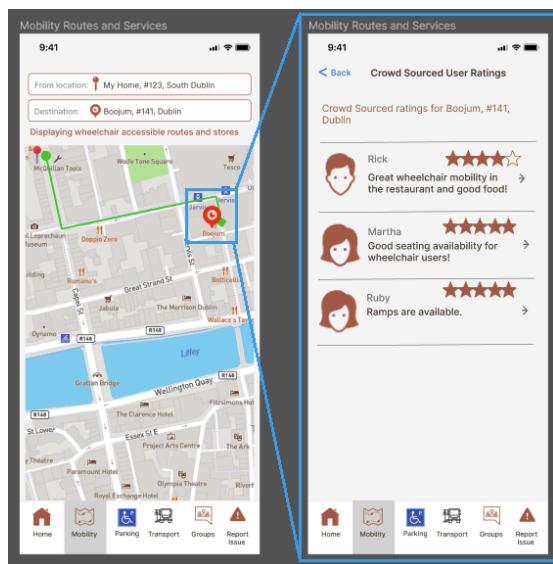


Figure 41: Prototype of crowd sourced user ratings of stores.

Mobility maps screen: The Mobility maps are accessible by selecting the 'Mobility' menu item on the bottom navigation bar and is the second screen displayed in Figure 40. This feature attempts to solve the mobility problems of wheelchair users by making AI based recommendations with confidence, for the user to reach their destination. Pathways consisting of well-developed, wide, and leveled footpath infrastructure, less object obstacles and routes with better vehicle parking barriers to prevent parking violations on footpaths are chosen for the user to independently navigate. In Figure 41, when the user selects their destination marker such as a store, restaurant, or any other public venue, they can drill down to view crowd sourced ratings and reviews for that location's accessibility to aid decision making for the wheelchair user prior to their journey.

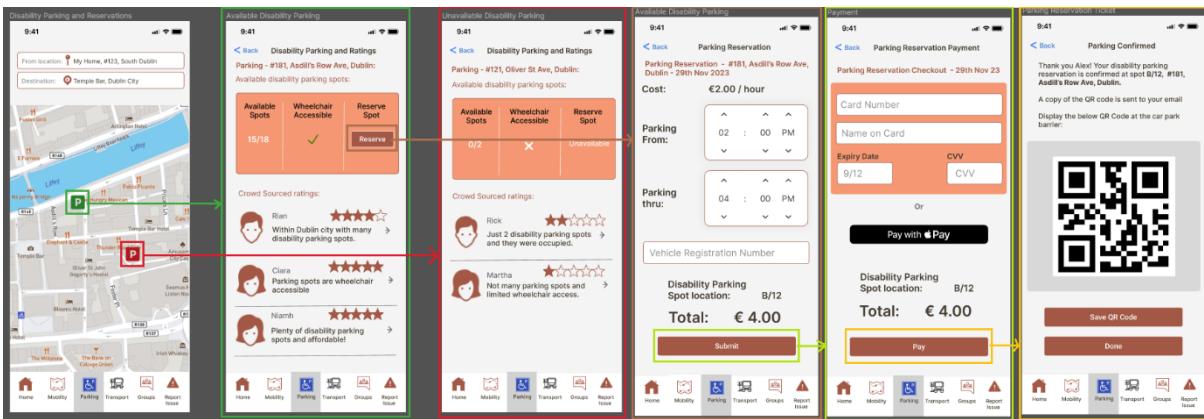


Figure 42: Prototype of parking reservation, payment process and crowd sourced reviews.

Parking screen: The user can browse disability parking spots by selecting the ‘Parking’ menu item on the bottom navigation bar and is the third screen displayed in Figure 40. Based on the destination entered the wheelchair user can find disability parking spots by a green or red indicator for the parking marker indicating availability or unavailability of spots. Selecting a parking marker will drill down to view disability parking spot information, wheelchair accessibility information, crowd sourced ratings from users about the accessibility in that parking lot and ability to reserve a parking spot. As displayed in Figure 42, if the ‘Reserve’ button is tapped, a disability parking spot that is wheelchair accessible can be reserved and paid for using credit/debit card or Apple pay details, followed by a QR code ticket that is generated with the option to save it to the user's device and presented at the parking barrier/machine during visit. This feature attempts to solve the problem of finding disability parking spots and being able to reserve them in advance.

Transportation screen: The user can view live status of public transportation information such as available wheelchair space and bus stops for upcoming buses, and lift and ramp service availability at the user’s nearest DART stations prior to boarding. As displayed in Figure 40, this feature can be accessed by selecting the ‘Transport’ menu item from the navigation menu. This feature attempts to solve the problem of having to make pre-trip calls and website checks on public transportation providers website.

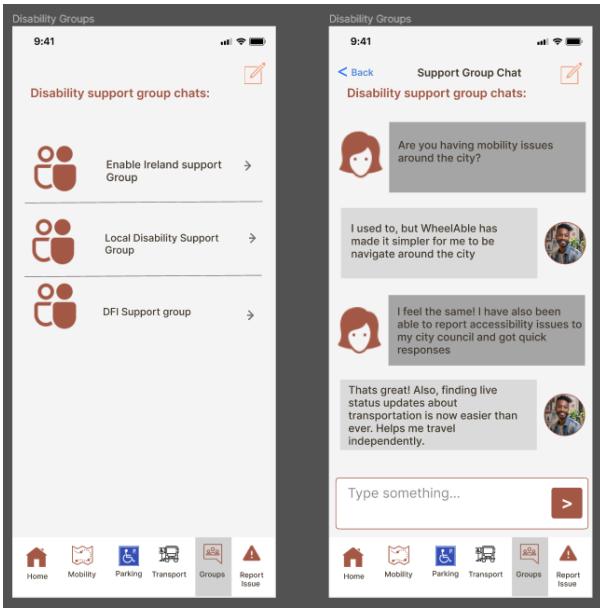


Figure 43: Figma prototype of ability to join and interact in disability groups.

Disability groups screen: As displayed in Figure 43, this feature is accessible by clicking on the ‘Groups’ menu in the navigation menu. It features the ability to create and interact in existing disability support groups to communicate with wheelchair users, create awareness and communicate issues with disability advocacy groups to seek assistance and solutions.

Report Issue: As displayed in Figure 40, the report issue screen is accessible by selecting it from the navigation menu. The screen features a contact form with the ability to upload and attach pictures and information detailing grievances and issues faced in public spaces and avenues regarding mobility and accessibility. The report's contents are submitted to the users nearest city council for inspection and assistance.

By implementing all the five solutions generated in the crazy 8’s exercise into the prototype, the mobility and accessibility problems faced by the wheelchair users may be reduced and would allow a more inclusive accessibility experience and the ability to travel independently. It addresses the key problems identified in the problem statement for the three core stakeholders, who are all wheelchair users.

3.4.3 Application design flow and solution implementation

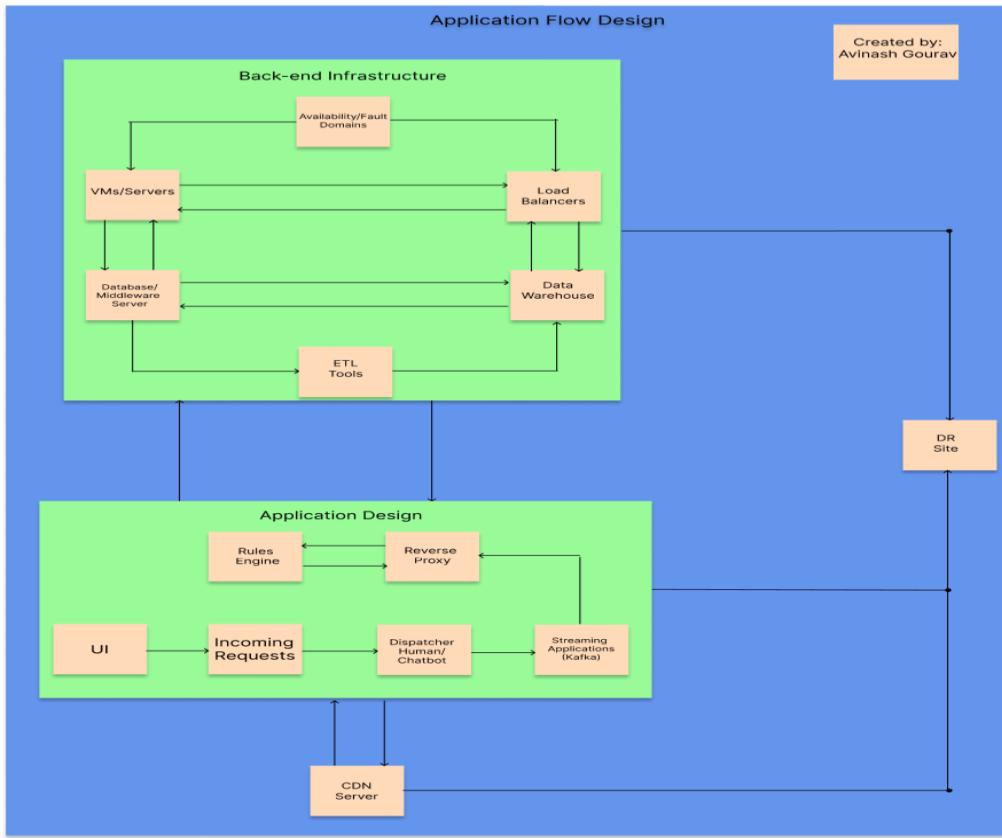


Figure 44: Application frontend and backend design flow.

Architecture:

The entire infrastructure of the application has been put in two separate availability domains to avoid a single point of failure, wherein the production system can be pointed to either of the domains in case of a disaster at the primary site. This design was undertaken to equip the application for always-on capability and to enable zero-downtime migration of critical changes for the back-end team. The application is also accessorized further with a load balancer that will redistribute the incoming requests equally to multiple servers to reduce system latency. Fundamentally, we were able to achieve this by having a real application cluster where we have a set of databases and application servers associated with each of the availability domains. The VMs (virtual machines), database and middle-tier servers, load balancers, and data analytics tools communicate with each other via availability domains, as displayed in Figure 44.

The application interface has been designed in such a way that all the requests coming through the UI, whether through clicks or through interaction with human or chatbot moderators, are fed into a streaming platform such as Apache Kafka, then data pipelines are created at this point and then sent to a rules engine through a reverse proxy, which is then redistributed into relevant sections of the system, as in Figure 44. The system is further equipped with a CDN (Content Delivery Network) server, which can aid in posting relevant ads to the users after the consented gathering of cookies. Finally, the

data flowing through the entire system is then fed in parallel into a DR (disaster recovery) site for BCP (business continuity management) purposes.

Solution Implementation:

Overall, the prototype design would be developed as a workable mobile/tablet application by the research and development team considering the above back-end implementations. Real-time data would be collected from local city councils, public transportation providers, parking data, maps, accessibility routes and a few wheelchair users' daily activities to generate the preliminary recommendations. Data privacy and security measures will be considered, and restrictive policies and data storage practices would be followed for managing wheelchair user's data. Our team would collaborate with local disability, advocacy groups and relevant authorities to help and support wheelchair users and to ensure data accuracy. The application would then be deployed on respective mobile platforms Play store or Appstore, and advertised to the target audience through accessibility groups, public programs, and disability advocacy groups to onboard wheelchair users. A feedback mechanism would be set up to collect user feedback and make continuous improvements to the application.

3.5 Business Analytics and core AI intent - Recommendations with confidence

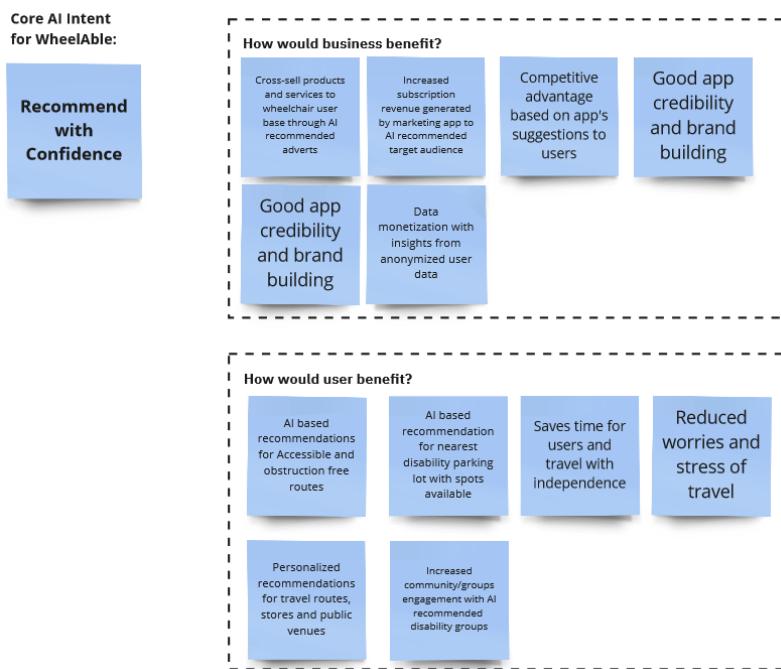


Figure 45: Core AI Intent's business and user benefits.

As in Figure 45, the application leverages the potential of data analytics and AI models with guided by the core AI intent to recommend with confidence, to assist wheelchair users by personalizing the user interface, content, and features to tailor content to the needs and demands of each user. By gathering real-time data from local city councils, public transportation providers, parking spots, retail shops, and

wheelchair user's daily activities and interests, descriptive and predictive data analytics can be utilized to make recommendations based on historical data for best accessibility routes for increased mobility on smooth terrain with least obstructions. This would result in travel time being saved for wheelchair users, greater travel independence and inclusivity. The outcome of this would materialize to user benefits such as reduced stress levels and worries about availability of wheelchair spaces in bus, ramps, and lift services in DART stations. By using AI to make recommendations for appropriate disability groups based on the users interests and daily activities, the user can feel more connected and open to communication, seeking assistance and creating awareness for local departments directly involved in making public amenities and services more accessible for wheelchair users.

From a business perspective, data monetization can be achieved by collecting anonymized data from wheelchair users' personalization, content and daily activity which can be utilized for cross-selling relevant products and services to increase revenue and make better fact-based decisions. Eventually the business can benefit from increased customer satisfaction, usage, and brand loyalty. By meeting wheelchair user's demands using data analytics and AI models our business can derive a better competitive advantage in comparison to competitors like wheelmaps and google maps by providing more up-to-date crowd sourced feedback. Overall, the core AI intent to recommend with confidence will help build trust, provide a personalized experience to the users, adapt to dynamic conditions based on real-time data giving a competitive advantage for business success.

3.6 Improvements to digital solution interface through usability testing

There are certain areas in the application design where improvements can be made. Areas such as testing the digital solution across various devices such as desktops, tablets, etc. Simulating test case scenarios to each of these device categories across various models is necessary before we go-live with the solution. Especially, when it comes to mobile devices, we must consider the fact that different functionalities such as fall detection and offline GPS mobility depend on the availability of the required sensors on the device it is being operated against. The operating system also plays a crucial role in usability testing as the might app might behave differently based on the platform. One more area of improvement is A/B testing — split testing is necessary wherein two versions of the application need to go through regression testing of all the test cases and then it is certain that the latest version performs better than the last one, random assignment technique will suit the best in our case. Analytics is yet another section where we see that our digital solution could be improved, usage of geospatial tools is where we see our most of the potential for improvement in our app.

A Usability testing survey results [here](#) revealed that the app had overall positive ratings with some scope for improvements.

1. How was your overall usability experience with the login and account creation process flow in the app?



Figure 46: Overall usability experience login and account creation rating.

In Figure 46, the prototype got a rating of around 4.71/5 pertaining to its login and account creation processes.

2. How do you find the overall menu navigation within the app?



Figure 47: Overall menu navigation rating.

In Figure 47, the menu navigation received a rating of 4.64/5 which indicated minor usability changes were needed.

3. Under the mobility menu, selecting the destination 'red' marker displays crowd-sourced reviews. Do you find this feature useful for knowing information about accessible stores?

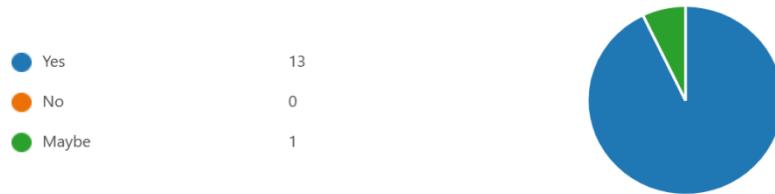


Figure 48: Mobility crowd source feature ratings.

In Figure 48, the feature crowd-sourced accessibility reviews pertaining to certain destinations got acceptance from around 13 out of 14 users which indicated high user usability.

4. Under the parking menu, selecting the 'green' parking icon features the ability to reserve parking. Do you find the reservation and payment process user friendly?

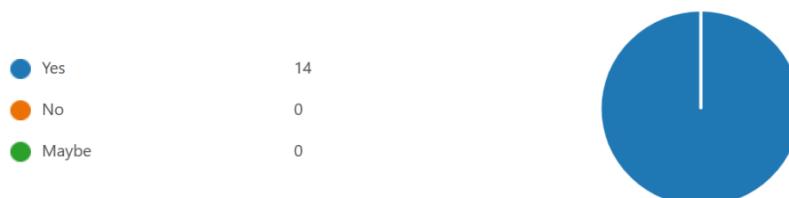


Figure 49: Disability parking reservation feature ratings.

In Figure 49, the reserve parking feature received complete acceptance indicating high user usability.

5. On the transport menu, do you find the overall information sufficient for the end user (Wheelchair user) to gain insights on wheelchair spaces and lift service availability with public transportation providers?

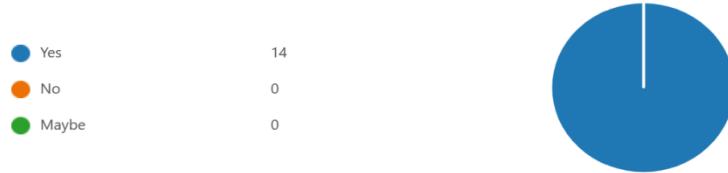


Figure 50: Disability parking reservation feature ratings.

In Figure 50, public transportation accessibility availability information for the target audience received full acceptance for its usability from the survey participants.

6. Under 'Groups' menu, how would you rate the usability interacting within accessibility groups?



Figure 51: Disability groups usability ratings.

In Figure 51, usability interaction within accessibility groups received a rating of 4.5/5 indicating high acceptance but with minor areas for improvement.

7. Overall, how would you rate the interactive features and usability experience of the app?



Figure 52: Overall application interactive features and usability rating.

In Figure 52, the overall usability experience of the app got a rating of 4.57/5 which indicates high usability across the app.

8. If you have any valuable suggestions to help us improve the usability experience, please let us know

4 Responses

ID ↑	Name	Responses
1	anonymous	Maybe a search filter to narrow down the group chats (if there are a lot in the list) will be helpful.
2	anonymous	Icon style at bottom could be improved
3	anonymous	Great and simple UI/UX
4	anonymous	Good features and design

Figure 53: User suggestions about usability experience.

In Figure 54, one respondent indicated a feature addition for a search filter in group chats which we plan to add as a future application feature. One user indicated that the icon style at the bottom could be improved which was taken into consideration and updated in the prototype. The other two respondents felt that the UI/UX was good.

3.6 Revenue model, target users and future solution improvements

Our revenue model is based on generating income with a weekly, monthly, or yearly subscription model for wheelchair users. The application would be available for free for a 1-month trial period to let users explore and utilize the features, and to collect feedback and data. Subscription plans would be available at €1.5 weekly, €5.99 per month or €60 annually to utilize all the features and to continue using the application beyond the trial period. The secondary revenue stream would be from data monetization by cross-selling products/services through personalized advertisements sent to user's emails collected during account creation stage. The target users would be any disabled user using a wheelchair or for users having an impairment requiring accessible routes.

In the future, solution improvements would be made by means of following agile methodology and continuous improvements based on user feedback and collected data. As mentioned in section 3.3.2, the additional ideas that the team found useful, but were not considered as key inclusions in the first version of the application, would be implemented in subsequent versions by new feature introductions, providing solution improvements over time.

4.0 Conclusion

In conclusion, this design thinking project has been a collaborative, imaginative, and empathetic adventure. The goal of this study was to identify wheelchair users' problems and to develop solutions to improve their quality of life. Progressing through each Design Thinking phase like empathizing, defining, ideating, prototyping, and testing, provided insights of their requirements and goals. The process of empathizing provided a broader understanding and firsthand perspective of the physical and emotional challenges faced by wheelchair users. Based on the insights gathered from the

empathize phase, the core problems and opportunities for improvement were identified. With the problem statements outlined, the Ideation phase helped explore solutions with the help of Crazy 8's technique, generating both conventional and innovative ideas to address the problem statement. Following this, in the Prototype phase selected ideas were incorporated into sketched mockups progressing to a more refined interactive prototype in Figma. With a constructed prototype design, usability testing was the next crucial step to validate user experience and usability with actual users by receiving feedback through a survey with several respondents providing their positive inputs and areas requiring improvements. User feedback played a key role as it helped us in refining and fine tuning our application. In addition to providing wheelchair users with the necessary digital solutions, the end goal was to empower them and instill in them a feeling of dignity and independence. Towards the end of this design thinking journey, we envision that the benefits of our solutions will go beyond this project.

5.0 References

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6.0 Appendix

[16] User persona created using ChatGPT.

You
create a persona for alex taylor who is a wheelchair user and has been living in ireland

ChatGPT
Name: Alex Taylor

Background:
Alex Taylor, a spirited individual, has called Ireland home for as long as they can remember. Originally from a close-knit community in County Cork, Alex's love for the Emerald Isle's rich history, scenic landscapes, and vibrant culture runs deep. A few years ago, life took an unexpected turn when Alex experienced a car accident, resulting in a spinal cord injury. Undeterred by the challenges, Alex embraces life with a positive attitude and a strong sense of resilience.

Occupation:
Currently residing in Dublin, Alex is a seasoned IT professional with a focus on web development and accessibility. Working remotely for a progressive tech company, Alex ensures that digital experiences are inclusive and user-friendly for people of all abilities. This role allows Alex to merge technical expertise with a passion for creating a more accessible online world.

You
what would be the touchpoints for alex's

ChatGPT
Touchpoints for Alex, the wheelchair user living in Ireland, would encompass various aspects of daily life, including personal, professional, and community-related interactions. Here are some key touchpoints for Alex:

1. **Accessible Home Environment:**
 - Home accessibility features such as ramps, widened doorways, and adapted bathroom facilities.
 - Home automation systems to control lighting, temperature, and security features.
2. **Remote Work Setup:**
 - Accessible and ergonomic workstation with adaptive technology.
 - Regular virtual meetings with colleagues and project collaborations using video conferencing tools.
3. **Accessible Transportation:**
 - Wheelchair-accessible public transportation options.
 - Accessible taxi services or ride-sharing options for commuting within the city.
4. **Inclusive Design Tools:**
 - Use of assistive technologies and software tools for graphic design work.
 - Collaboration with colleagues and clients to ensure digital designs are inclusive and comply with accessibility standards.