Appendix 2

Method development and online testing of travel aid using audially simulated trip

The proposed method for evaluating and comparing user benefits developed in the study “Measuring the benefit of automated driving” was tested as a work package in the study “Guidance for travels with autonomous vehicles for persons with blindness, deafness and deafblindness”.

The study’s aim was to evaluate the proposed method’s useability in early-stage user testing of a service development project. A common method of early-stage user testing for digital services is “paper prototyping” where an early prototype of a service or product is developed in the form of a series of images depicting a user-interface. A scenario is built up around the sketches to explain the workings and interactions of the prototype. This can then be used to test user interactions by simulating the proposed function of the service.

The planned activity was to use a form of paper-prototyping to simulate the function of an app that would help guide users to the door of a bus parked several metres away on a long bus-stop platform. In this case, the paper prototype would be replaced by a person giving audio instructions. Originally this was planned as a physical test at a suitable bus stop but due to the social distancing restrictions in place because of covid-19 the project group examined whether the testing could be performed in a way that would not necessitate a physical meeting but that would be accessible for a user-group involving people with visual impairments or blindness.

Scenario based user testing is a common methodology in service-design. The decision was made to conduct the testing digitally using scenarios based upon an audio description of the situation and environment and an audio representation of the navigation service. Common messaging services such as Teams or Zoom would be used to communicate. The test would be designed to use as little visual information as possible. In this way, an accessible, digital scenario based test would be used to gather results from the user group.

User testing in this way provides value in a development or planning project where a service or product is being developed. By involving users early in testing it is possible to cheaply test a number of iterations of a service or product and gain insights into the users’ experience. The evaluation framework developed in the study “Measuring the benefit of automated driving” can be used to quickly benchmark a prototype and to compare benefits and drawbacks specific to a particular user-group with their experiences of existing services.

The service for testing

Workshops in the Vinnova project SOSSUM (Samverkande system för sjukresor och sjukhus) identified that a primary area of accessibility issues for users with reduced vision or blindness is self-supported navigation to a vehicle. In automated transport systems, there is no driver, which removes a potential area of support for users trying to locate a vehicle. Users noted that a similar situation exists in today’s public transport systems when multiple busses arrive at a long bus stop platform.

The issue that occurs today is that while drivers have instructions to always stop at the front-most part of the platform, in practise this is often ignored. Passengers move along the platform, board the following busses and a bus driver that is in second or third place in a queue will often assume that all passengers have boarded and drive out from the bus stop without stopping a second time.

There are strong similarities between the challenge of navigation to a bus several tens of metres away and of navigation to an autonomous vehicle.It was decided to test an initial early prototype of an app-based service that could provide a user with audio instructions and information to help them navigate to the bus door. The aims of the service were to:

- Increase the possibility of independent navigation over the final metres to a vehicle for users with reduced visual capacity or blindness.
- Reduce uncertainty regarding whether one has arrived at the correct vehicle.

While the service is based upon earlier results from the work in the project group, the primary aim of the study was to evaluate the testing method. The test service was designed to provide a realistic test of an early-stage prototype and the results gathered during the study are of interest as material to support potential future development work.

The scenarios

Two scenarios were designed in order to first present the user with a familiar everyday situation and then present them with a similar situation where the service being tested is utilised. The scenarios were scripted to first describe the situation and surroundings and then present the user with a point in the scenario where they would then describe their actions or the steps they would take in that situation. This involves an element of role-play and to reinforce the situation for the users the audio description was recorded with a background noise recorded at a bus stop with street sounds and the sounds of busses driving up to the platform and stopping.

The test subjects

Synskadades riksförbund (SRF) organised recruitment of users to the study. In total five users were tested plus an additional user from the SRF staff who assisted with initial testing of the material. While a small number of users, this was deemed suitable for the purpose of evaluating whether the methodology offers value and is realistically applicable in early-stage user testing.

Users were sent preliminary information about how the testing would be conducted. Four test subjects were people with full blindness, one test subject has partial sight remnants. All subjects are able to travel independently over routes they have had a chance to travel with support previously. All make use of a white cane to assist navigation in a public space.

Information with definitions of the terms used for evaluating the perceived value of the service was also sent in advance to give the test subjects a chance to familiarise themselves with the concepts that would be used in advance of the testing.

The test plan

Each test was booked individually with the test subject and the tester. The same tester was used for all tests. Each test subject was given a choice of Zoom or teams in order to reduce the potential for technical difficulties. Four subjects chose Teams and one chose Zoom. The test was booked with enough time to have a comfortable margin for technical setup and orientation before starting the test scenarios. In practise, four of the subjects experienced no technical difficulties.

One test subject did not have a device capable of opening the Teams meeting and after some discussion, we chose to complete the testing via telephone. This led to a variation in the testing method as it was not practical to play the pre-recorded scenarios so the tester read out the scenarios from the script instead. An observation was that the test subject in this case had no issues immersing themselves in the scenario and it was not deemed that this negatively affected the test method. However, the test subjects who instead listened to the recorded scenarios commented on the good quality of the material. So our evaluation of this is that using pre-recorded material will help ensure quality in testing, but scenarios read out by a tester can also be used, either as a back-up form of testing or potentially as the main form of testing in cases where perhaps there are several quick iterations of test and prototype and the project team wish to reduce the initial preparatory work.

The tester's initial task was to introduce how the testing would be performed and to help ensure the test subject was comfortable. When using Teams or Zoom, the sessions were recorded. Each test subject was informed of the recording in advance and then each recorded session began with the test subject being asked for their consent to the material being recorded and that the material would be retained only for the duration of the project's needs for recording the results.

The tester then would start playing the first scenario. Each scenario was accompanied by a number of questions to evaluate the subject's reactions and how they would choose to act in the situation that was presented. The purpose of these questions was to collect qualitative test data and create understanding of how users chose to act in the presented scenario.

The first scenario was based upon how the user would navigate to the bus door with no extra aids. This was designed to evaluate the user's existing strategy to navigate to the bus door. The second was based upon a similar situation, but with support from an app that would inform the user on when the bus was arriving at the bus stop and then give an audio instruction of where the bus was positioned relative to the user (22 metres to the left). As the user moved towards the bus, the app would inform them of how close they were and finally confirm when they arrived by the door of the correct bus.

Finally, the tester performed a quantitative test of how the user evaluated the prototype being tested based upon the proposed test methodology and the table of benefits. The descriptions of each benefit were read out one-by-one and the user was asked to evaluate how they rated the benefit delivered by the app as compared to their normal strategy. The user rated the benefit on a scale of 1 to 10. Each description gave an indication of what could constitute a low score as opposed to a high score. In practise, a low score would indicate that the service being tested would be substantially worse that the user's existing strategy and in effect create obstacles for the user, while a high score would indicate that the service being tested

would perform substantially better that the user's existing strategy and reduce obstacles for the user. Any comments given by the user were also noted at this point.

Results

The quantitative test results were collated in a table for comparison with the benchmark scoring from the proposed method.

Test person	Traffic safety	Personal safety	Travel time	Waiting time	Access-ibility	Comfort	Flexibility	Safeness	Indepen-dence	Predicta-bility	Social acceptance	Integrity
1	5	7	8	8	8	5	7	8	9	9	10	8
2	6	6	7	8	5	6	8	8	7	5	2	7
3	8	8	5	9	7	8	9	9	9	7	9	7
4	5	8	10	6	10	10	8	6	8	10	5	2
5	8	8	10	8	9	7	8	8	10	10	5	8
6	6	9	10	9	9	7	9	8	9	8	8	5
AVG	6.33	7.67	8.33	8.00	8.00	7.17	8.17	7.83	8.67	8.17	6.50	6.17

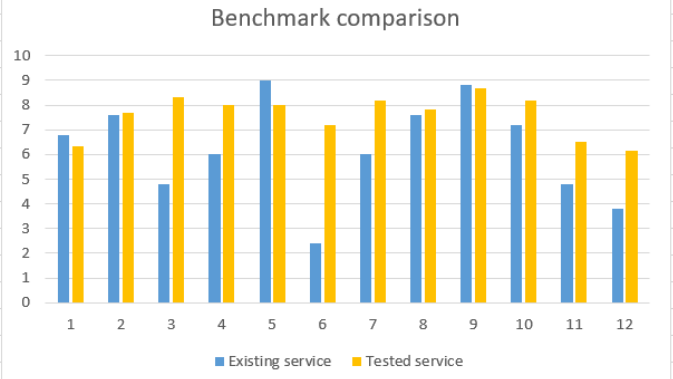
The value for social integration that was part of the original pre-study was not included in this test evaluation.

The qualitative test results contained many details and insights about how users perceived the proposed service and are presented at the end of the report.

Benchmarking of results

The values for the mean scoring for each benefit were then used as benchmarking figures for comparison with the baseline figures for the original service as reported in the pre-study.

		Existing se	Tested service
1	Traffic safety	6,8	6,33
2	Personal safety	7,6	7,67
3	Travel time	4,8	8,33
4	Waiting time	6	8
5	Accessibility	9	8
6	Comfort	2,4	7,17
7	Flexibility	6	8,17
8	Safeness	7,6	7,83
9	Independence	8,8	8,67
10	Predictability	7,2	8,17
11	Social acceptance	4,8	6,5
12	Integrity	3,8	6,17
Benchmark per journey step		**74,8**	**91,01**



The results show a number of areas where the tested service performed considerably better than the baseline service. There are also areas where the service was rated lower than the baseline service. In a full analysis of a new product or service these differences could be analyzed together with the users

information in the qualitative results to provide insights into how the service could be improved to provide greater value. Additionally, further follow-up questions could be presented to users in order to gain more detailed insights.

Summary and insights regarding the benchmarking method

The benchmarking method shows promise as a means of performing early-stage user-testing of accessibility issues for autonomous transport services. The scenario-based approach was successful in enabling users to visualize and provide usable insights into a prototype or a service - and could be performed using digital communication methods even during a period of social distancing.

The combination of quantitative benchmarking with a comparison against the baseline figures for the user-group and a qualitative evaluation of the service can provide service designers with information allowing them to know where changes can be made to a proposed service and gain an idea of which forms of benefits those changes will bring to users. The testing method is lightweight enough for use iteratively in projects at an early stage. This can be useful as part of an agile project methodology or in a service design/design thinking process.

In common with the results from the pre-study, the quality of the results has potential to be improved by testing using a larger sample size of respondents. There may be a trade-off between sample size and the value of the qualitative test results. Within this study, there were many areas where the respondents gave the same or similar insights and with testing of a larger group many insights may be repeated until the value of the responses decreases. However, increasing the number of quantitative responses should increase the value of the results and minimise the effect of variations in responses.

Qualitative results

Scenario 1:

How do you find out when the bus is coming?

The test subjects mentioned the following methods to be informed about when the bus is coming. Some subjects mentioned more than one method.

- Five people mentioned asking other people at the bus stop.
- Four people mentioned using an app.
- Two people said they use an information button or listen for an announcement at the bus stop.

Where do you choose to stand on the platform?
There was a larger variation in the answers for where the test subjects choose to stand when they wait for the bus.

- Try and work out where the bus will stop.
- Stand at the front of the platform.
- I want to stand in the middle.
- I walk back and forth.
- I stand at the front.
- Stand at the front or where I can see the number on the bus.

How do you get on board the right bus?

Even here the test subjects mentioned a wide range of strategies. Most are prepared to ask for help, but a variety of other methods are used as well. The test group's answers give a good indication of how stressful a situation this can be for people with visual impairments.

- Now I get really stressed - this is the reason I don't often use public transport. I go to the nearest person and ask them for help.
- I ask other people nearby who are travelling. I ask other passengers and often get very good help.
- I listen to see if they have their bell sounding (a new service to help locate a bus). Most probably I would ask someone else who is there. Often a stressful situation as other people are also trying to get to their bus.
- If I hear there is more than one bus coming I will go to the front door of the first bus and ask the driver. I ask people on the platform. If necessary I rush to the next bus and ask. I wave my arms and my white cane. If I need to I will wave my cane in front of the bus. Once a driver asked "How dare you do that?" I replied "How dare you drive past?"
- I stand at the front of the platform so the driver sees me and puts on their announcement. I normally ask someone outside the bus to help guide me.
- The most important thing is to ask people around or the driver first. I often stand in front of the bus and check the sign - that indicates to the driver that one has difficulty seeing, but not always.

Scenario 2

What do you do after getting information on where the bus is from the app?

22 metres is a long way. It is good information, but I would be irritated that it is such a long way to go. I would need someone to help me navigate. I would have to ask “Can I take your arm so you can help me find the bus?” - perhaps unthinkable in coid times. If there were difficult conditions - darkness, bad weather etc, it would be very difficult. I would not feel safe in this area.

It is a very long distance to go when you cannot see. You can bump into people or objects, especially difficult if you have heavy bags.

I would go straight forward, feel for the edge of the platform, turn left and find the bus if it is still there.

I can hear where there is a space between busses (using echolocation), so I would use that to find where the next bus is and ask there.

I start to walk the 22m - if I can estimate that - and hope I come to the right bus - that would be great.

I try to go to the left and try to see if there are more busses there.

What are your feelings regarding the usefulness of such an app?

It feels fine and informative. Good to avoid having to ask strangers.I would like to see that it could communicate with the bus that one is on the way on board.

It is a little awkward to have the phone in your hand and listen to the app. That would depend on which other things one has to deal with. It is an improvement, but still difficult. Easier for a person who has other issues than visual impairments. In principle it could make things easier for me.

I don’t think that it would be a problem. It is similar to an app that I am making. You would need to have over-the-ear headphones to be able to also hear what is going on around, other people, street sounds etc. It would require training if you are not used to it. It is difficult with GPS - it can differ by up to 5m.

I don’t think that I would listen to it, I would go as quickly as possible and listen for the gaps between busses. I make my way quite quickly. The final announcement “You are at the right bus” is very useful. It would be good for someone who isn’t so quick, or when I had an injury and couldn’t walk so fast.

When you hear this, it sounds quite perfect - but that supposes that there aren’t a load of people in the way, a lot of noise so that you can’t hear. There can be a lot of noise that disturbs the information.

It feels safe. How much of a hurry does the bus driver have? Can I trust that the driver will not drive on before I reach the bus? If it could give extra information to the bus driver that would be best.

Comparison between strategies

Test persons were asked to rate compare with their previous strategy and say which of the following statements they agreed with:

1) That they would keep their initial strategy without information from the app.
2) That they would complete their initial strategy with information from the app.
3) That they would replace their initial strategy with information from the app.

All test persons answered 2, with two respondents stating that 3 would be possible with small changes or in perfect conditions.

What is required from an app or supporting service to help you navigate independently to the bus?

The information given here provides a large amount of feedback to developers to aid development of an app and to be able to form well-designed user stories which could inform changes in a next revision of an app.

- That it could give me adequate information.
- Easily accessible, that it doesn't take too much time to get into the app and get the right information.
- Good if it is voice operated.
- It needs to be simple to operate and search to get the right information.
- The visual perspective - there cannot be too much information. Think of contrast, think of a visually impared users perspective.
- It requires that it is easy to find.
- There needs to be a clear and easily understood voice.
- A good volume.
- Technically simple - easy to use for me as a person with a visual impairment.
- It requires great precision for the GPS in order that two metres is two metres and not five metres.
- Your data connection needs to be reliable.
- It should not use too much data or batteries.
- You need to practise the base technique to be able to use the app comfortably.
- I recommend training, especially if a person is blind. A connection to a vision centre Syncentralerna is recommended.
- Partly that it is easy to use and find.
- Avoid having to fill in lots of things.
- Apps are often used for many purposes so it is good if "Wait for a bus" is easy to find.
- I think the number of metres is good, but it should be able to know there are multiple busses at the stop so it could say "Bus number 2" or "Bus number three".
- It requires that it talks about which bus, which platform it is stopping at and then the information about when it is coming.
- At Brunnsparken (the location in the example, with many bus stops within a spread-out area), I must know which bus stop.
- It could be difficult to use if you have to navigate around other people.

- Usability. Simple to use, not more complicated than other alternatives.
- Compatibility with existing aids. That it works with a screen reader and aids built into the phone’s system.
- No extra complications.
- Reliability over time.