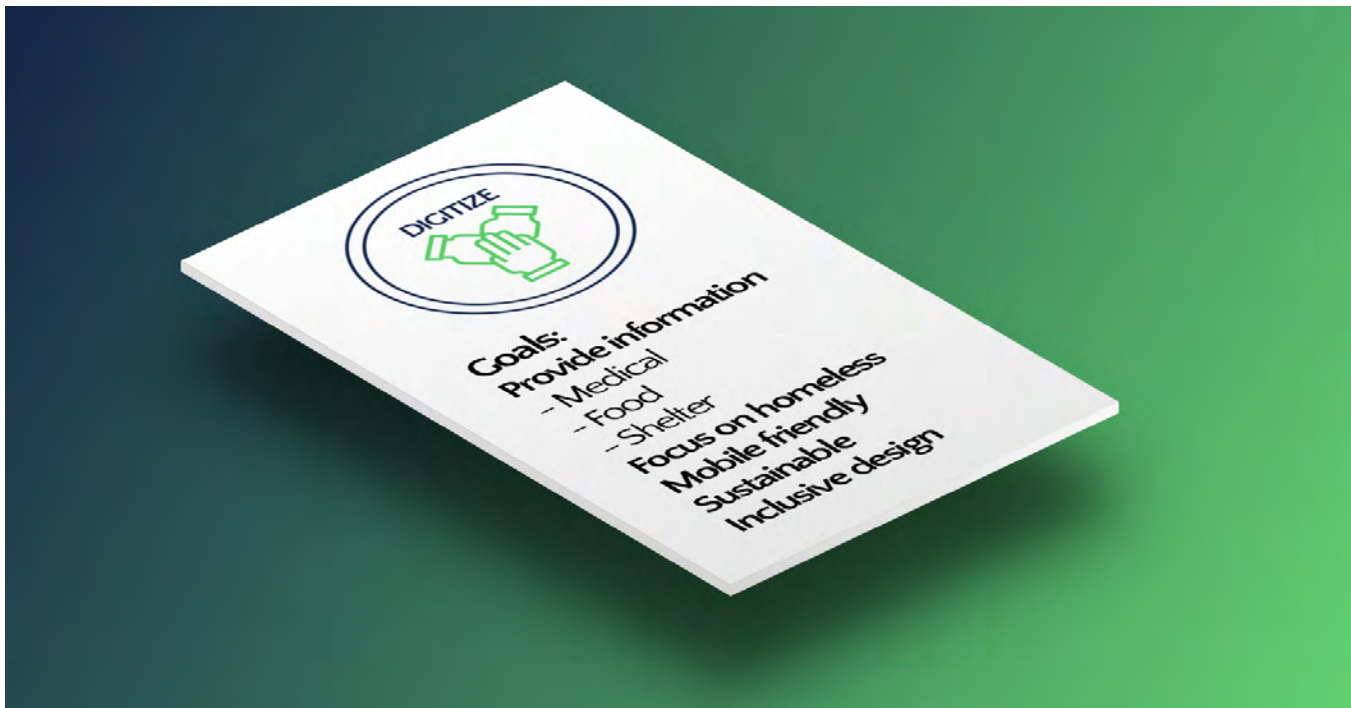


Mobile apps for homeless people: Co-creation of Information Solutions for Digital Inclusion

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ABSTRACT

This research focuses on the reduction of the digital divide in the Netherlands. It tries to do this by using an application that promotes inclusion for the homeless. At the moment this group finds it difficult to find important information online, while in the form of a smartphone and public Wi-Fi networks they have the tools to be able to gather this information online. In collaboration with the target group and by making use of the ICT4D 3.0 framework, an attempt was made to develop an application that could provide the homeless with practical, useful information. This paper explains how this process worked and whether such an application could be a solution.

KEYWORDS

Homeless, Mobile Application, Usability, Inclusive Design, Digital Information, Sustainable

1 INTRODUCTION

In recent years, the digital divide has become an increasing problem. More and more information is being supplied digitally and governments and municipalities are digitizing as well. Yet there are certain groups that lag behind technological and digital progress, according to research [15, 18]. Because of this growing problem, the municipality of Amsterdam is organising an event (PACT Amsterdam) to exchange knowledge and bring different parties together to address the problem. One of the target groups that is experiencing problems is the group of very poor people, homeless and less fortunate people. They will be referred to as homeless in the rest of this paper. A problem they often face is the difficulty of finding valuable information on the internet. This concerns in particular information about food supplies, important addresses, telephone numbers and information about assistance offered, for example on legal or municipal issues. This group could benefit from a digital, central place where they can be presented with this type of information in a reliable, up-to-date and user-friendly manner. However, this group does not always have the same skills as an average internet user [6], which brings new challenges in designing this application in a sustainable way. These challenges will have to be discovered and solved to make the

proposed application a success. The existing, worldwide literature has shown, among other things, that there is still much to be gained in the digital field in supporting disadvantaged groups and homeless people in, among other things, information facilities [7, 18, 21]. Research was carried out among people within the target group, from whom a number of very interesting insights were obtained. A frequently heard complaint from the target group was that they had the opportunity to access the internet, but had no idea where to start collecting reliable, valuable information. The maze that the Internet and search engines can already be for the advanced user of the Internet was often too high a threshold for these people to pass. From volunteers working with homeless people came the story that they were frequently asked the same type of practical questions by homeless people. Questions like where can I get a meal tomorrow, how often can I come here to eat, where can I get free coffee or gloves were the majority of the questions. Questions that often had an answer, information that is still often passed on from word of mouth to word of mouth. It is believed that this type of information could reach a much larger target group if it does not depend solely on mouth to mouth communication to be distributed. Especially since it has been shown that access to the internet is often not the problem, it could be a useful solution to make this type of information available in a simple application that can be reached via the internet. The emphasis will have to be on mobile user-friendliness in order to provide as many people as possible with reliable, user-friendly and high-quality information via their own device.

2 RESEARCH QUESTION

This section will describe the research question and its subquestions.

RQ How can a digital application be designed to provide a wide range of homeless people with access both to reliable, high-quality and up-to-date information?

The research question will be answered on the basis of six subquestions.

SQ1 How could the target group be best provided with information

SQ2 Who are the information providers?

SQ3 Who are the information seekers?

SQ4 Which information is needed?

SQ5 Which form of information providing is effective?

SQ6 Which barriers are an obstacle?

3 METHODOLOGY

The research question will be answered by doing an action research. Action research has been defined by Avison as: "Action research is an iterative approach, combining theory and practice [1, 2]. It has been widely used in education and is increasingly used in disciplines with challenging target groups. There are various formulations of action research, but at its simplest it consists of two steps: collaborative analysis by the participants, leading to the formulation of theory; followed by collaborative change with studying of results. Action research is strongly focused on action and change, operates over reasonably short time spans, and involves substantial collaboration and participation." At the moment it is

not entirely clear how research from other countries translates into Dutch problems. In addition, not much research has been done on specific usability methods aimed at interfaces for homeless people who have different digital skills than those who the average user interface designer considers as basic skills. We need to look explicitly at usability methods in which theories about user-centered design [11], mobile-first design [8] and human-computer interaction [9] will have to be tested on the target group. To put the action research into a framework, the ICT4D 3.0 framework developed within the VU University is used [5]. This framework consists of 5 different phases:

- Context Analysis
- Needs Assessment
- Requirement Engineering
- Engineering
- Sustainability Assessment

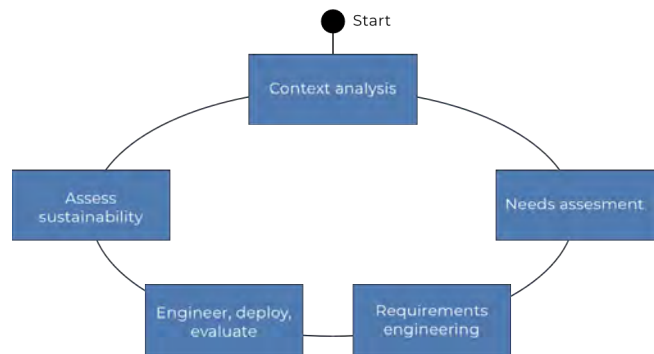


Figure 1: The ICT4D 3.0 Framework

The aim of this framework is to give the homeless the necessary tools via an information system to overcome the problems they encounter. Data will be collected from interviews, processed in requirements and needs and applied in the design of the application. Testing this application by organizing thinking aloud sessions will yield new results with which the cycle can be followed again to iteratively improve the application[13]. The different steps of this framework will be briefly explained.

3.1 Context Analysis

During the first phase, the exact composition of the research domain will be identified. Information is mainly collected. In the case of this project, the organised event Digi Challenge by the municipality of Amsterdam was the first introduction to the domain and thus the start of the context analysis. In addition, various experts in the research domain were interviewed. Examples of these experts are employees of LostLemon, TNO and the municipality of Amsterdam. In addition, many discussions were held with volunteers in the homeless care sector, for example at the institution Sant'Egidio. These volunteers have also made it possible to get in touch with homeless people on a regular basis.

3.2 Needs assesment

When it was possible to make contact with the homeless, it was time to map out their wishes and needs. Questions like, what kind of people are the target group, and what do they need could be answered by means of interviews. We went deeply into what is really important for these people in order to survive as well as possible. Do they have a smartphone at all, and what do they use it for at the moment? It immediately became a collaboration between developers and target group, something that is also explicitly described in the ICT4D 3.0 framework [5].

3.3 Requirements engineering

Based on the identified needs within the target group, a list of functionality could be drawn up that the end product had to meet. This list consists of a list of must haves and nice to haves. In addition to this functionalities list, a list of qualitative requirements is also drawn up. These guarantee the quality of the end product in several ways, which will be explained later in this paper.

3.4 Engineering

The list of functionalities has been applied to a number of sketches, which were later incorporated into a wireframe and finally into a prototype. With this prototype we went back to the target group several times to check if it met the needs that had been determined earlier. With the resulting feedback, the product has been improved a number of times, with the mentioned ICT4D 3.0 cycle being repeated.

3.5 Sustainability assesment

Throughout the project, the sustainability of the final product will be taken into account in several ways. In this way we try to maximize the viability of the product. In order to guarantee this aspect, contact was made with parties such as the municipality of Amsterdam, TNO and LostLemon, who could possibly play a role in the further development and viability of the application. The different ways in which sustainability plays a role will be discussed later in the use case and the discussion of this paper.

4 RELATED WORK

4.1 Related literature

From the Vrije Universiteit in cooperation with OostWest a research has been done from which an advisory report has emerged [21]. Among other things, it concludes that many minima are only digitally reasonable to a limited extent and cannot manage sufficiently in today's society. It also appears that a large group of digibetes are lagging behind the rest of the Netherlands, according to various reports. This is also described in the report "De sociale staat van Nederland 2017" of the SCP[3]. The report focuses primarily on a group of Amsterdam children, adults and parents living in poverty, precisely because developments affect them in particular and their learning ability is limited. In recent decades, several researchers have investigated how mobile phones can improve the quality of life for people living in relative poverty or homelessness [10, 19]. They have also found that technology plays a role in the way homeless people connect with their family and friends. According to other

research, technology also plays a very important role in creating the social ties needed for cooperation in neighbourhoods and cities [17]. As been said by Roberson and Nardi the needs of homeless for survival and involvement in social worlds beyond their immediate communities were a source of motivation in the use of digital technologies making technology a powerful but not obvious part of the culture of homelessness in our field sites. American research showed that almost every adult homeless person had access to a mobile phone [16]. From this they conclude that mobile applications can be very promising to support target groups such as the homeless and the very poor in, for example, health care. Scottish research has shown that it is very well possible for homeless people to be digitally included, for example by using a mobile phone. This study indicates that this does not immediately mean that they are no longer socially excluded. The study has shown that access and use of ICT can lead to everyday practices and facilitate contact with homeless subcultures [7]. However, it appears that access to ICT alone is not always enough because the road to social and digital inclusion is a complex one. For example, certain skills will be needed and the will to learn them is necessary Clair stated [7]. The existing, worldwide literature has shown, among other things, that there is still much to be gained in the digital field in supporting disadvantaged groups and homeless people in, among other things, information facilities [7, 17, 21].

4.2 What the municipality has done

In its 2018 coalition report, the municipality of Amsterdam included a section on "Democratie en de Digitale Stad". This section states, among other things, that attention will continue to be paid to people who have difficulty with digitisation, in the form of digital services and participation. The report can be seen in figure 13. In addition, access to data is considered important, which means that all residents have access to important information. The manifesto "[Tada, duidelijk over data](#)" will also be implemented. Among other things, the manifesto forms a manual to deal with the possibilities of digital technologies and fair access to these technologies to reduce the existing knowledge gap. Contact was made with the municipality of Amsterdam, where a conversation has taken place with an employee of the department responsible for the digitisation of the municipality of Amsterdam. They currently have several projects in progress as a result of research from the Vrije Universiteit [21]. Examples of these projects are community centres with computers, computer lessons for adults at primary schools and digital buddies for the elderly. It became clear that there are currently no projects that are aimed at providing information to homeless people and that this problem could not currently be given the highest priority out of the municipality, partly due to a lack of personnel. Not much research has been done on specific usability methods aimed at interfaces for homeless people who have different digital skills than those that the average user-interface designer considers as basic skills.

4.3 Similar Information Systems

There are currently no information systems that are equivalent to the outlined image of an application aimed at the homeless. There is an application of givemeshelter where people can donate

money so that homeless people can eat and sleep, the so-called 'bed, bad, brood app voor daklozen'. There is also the [Street Messenger](#) messaging service, which sends a message to the homeless when it freezes about a shelter or location where extra beds are available, so this is especially for emergencies. In addition, there are several pages with information about shelter on the websites of different municipalities. At the time of writing, these are the only existing options in the field of information provision specifically aimed at the homeless.

4.4 Development frameworks and methods

Because it concerns a very specific target group, it is important to choose a design approach in which the user is central. This is the case with Inclusive Design. Because this is a very specific target group as well as a diverse target group, it is important to include a more specialised method during the development. In addition to Inclusive Design, there are numerous design approaches in which the user is central. A number of approaches focus on involving users in the design process (such as human-centered design, user-centered design, participatory design and co-design). Other approaches focus mainly on principles and guidelines that the design (product or service) must meet (such as usability, user experience, persuasive design and value-driven design). Inclusive Design deals with both the process and the design, but focuses specifically on the diversity of users.

4.4.1 Inclusive Design. A very suitable design method to consider is [inclusive design](#). The core corresponds to other design approaches where the user is central. An example of this is user centered design. With inclusive design, special attention is paid to the diversity of the user group. It's about designing for the needs of people with permanent, temporary, situational, or changing disabilities. Inclusive Design focuses on seven principles, these will now be mentioned, the further explanation of these principles can be found in appendix A.

- Provide comparable experience
- Consider situation
- Be consistent
- Give control
- Offer choice
- Prioritise content
- Add value

The Inclusive Design Principles are shared under a Creative Commons [license](#) that allows copying, sharing and redistribution, in addition to remixing, transforming and building upon the material, also commercially.

4.4.2 Toolkit Inclusie. Two of the parties with which the research was in contact, TNO and Lost Lemon, contributed to the development of the 'Toolkit Inclusie', which was developed to provide guidelines for the design of systems for, among others, the following target groups:

- (Light) mental disability
- Autism
- Homeless
- Immigrants
- Elderly

The toolkit is made available within the community '[Gebruiker Centraal](#)'. The design for inclusion takes into account various possible limitations of users, both in terms of skills and in the circumstances in which the user may find himself. This may include stressful situations or situations in which, for example, sound is not desirable in the interaction. The five design principles that have been proposed are as follows:

- Putting the user first
 - Design from the needs and context of people, not from the technology or your organization. Assume a diversity of users ms of skills and circumstances.
- Don't be satisfied until your user is satisfied
 - Design, test, measure and improve. And continue to do so. Involve a diversity of users.
- Make it easy for the user
 - Design simple processes, make user-friendly systems and write easy to understand. Take into account the physical, cognitive and psychosocial limitations of your users, and limitations due to circumstances, in your design. Use design guidelines and examples.
- Proceed on the basis of facts, not assumptions
 - Design based on facts and user research, and don't assume that your user is like you. Get to know the characteristics of your users and involve a diversity of users.
- Be transparent and share your knowledge
 - Work together and share your knowledge and experience. And be open to feedback. Create awareness about inclusion among all parties involved in the design process. Record your insights and share them with others.

4.4.3 Powertoolkit. Another project TNO has worked on is the Powertoolkit. This design principle kit is intended for:

- Designers of technology who want to gain more insight into the user group of people with a cognitive disability (a light mental disability and/or autism) and their care providers.
- Healthcare providers who want to gain more insight into participation in participatory design processes
- Care innovators who want to gain more insight into the possibilities of technology for clients with a cognitive disability.
- Knowledge institutions that want to carry out projects in education and research at the interface of care, design and technology.

This consists of design guidelines that indicate what you have to take into account in the design when designing for people with cognitive disabilities. It is a comprehensive set of practical guidelines. These guidelines include navigation, layout, use of colour, information presentation, error messages, feedback and personalisation. The complete list can be found on the website of the [powertoolkit](#).

5 CASE STUDY

This section will present a case study an information system for homeless was developed. The development and design of the system follows the steps from the discussed ICT4D 3.0 framework taking into account the set of guidelines for inclusive design, the powertoolkit and the toolkit inclusie. A total of three iterations have taken place during the project.

5.1 Context Analysis

The context in which the use case will be developed and tested is the foundation Sant'Egidio where homeless people can get a free meal every week. Here it is possible to actually come into contact with a group of homeless people in Amsterdam, to carry out tests, to map wishes and to get reactions. There are about 100 people per week for dinner. Not everyone is open to help, but in the end, during the iterations, there were about 15 to 30 people who participated at least once in a user test. When the intention of the investigation was explained and the possibility of helping in a product from which they could actually benefit themselves was explained, it appeared that there was a certain willingness to share an opinion. It turned out that a cautious approach and a good explanation with this group is very important. This, because of some of the distrust mentioned, could probably have to do with the fact that many people within the target group said that they had already been affected many times in their lives.



Figure 2: Bandro Edoga and Marc Hegeman at Sant'Egidio in Amsterdam

From volunteers of Sant'Egidio came the story that they were frequently asked the same type of practical questions by homeless people. Questions like where can I get a meal tomorrow, how often can I come here to eat, where can I get free coffee or gloves were the majority of the questions. Questions that often had an answer, information that is still often passed on from mouth to mouth. It is believed that this type of information could reach a much larger target group if it does not depend solely on foundations such as Sant'Egidio to be distributed. Especially since it has been shown that access to the internet is often not the problem, it could be a useful solution to make this type of information available in an easy to use application that can be reached via the internet. The context analysis has shown that the target group is a very diverse group. For example, homeless people often have to deal with multiple problems (psychological problems, addiction, debt or physical problems). In the (easily accessible) social care, it is reported that the number of homeless people with mental disorders is increasing. New groups are emerging within social care. Although there are no precise figures, there are signs that more and more people are becoming homeless without any addiction problems and/or psychiatric problems. There are usually several problems at the same time. 30,000 to 70,000 people of the Dutch population are

currently homeless.¹ It was interesting to see that about 40 percent of the people who come to the dinner have access to a smartphone. This percentage will only increase because the percentage of people who have become homeless in recent years and have access to a smartphone is even higher². In addition, the people often indicated that they were hanging out with fellow homeless people and that they were often living together in groups. As a result, there is a good chance that at least one person will have access to a mobile phone in such a group. This makes it very interesting to make information accessible via this device, because a very large part of the homeless could be reached in this way. In order to get a good feeling for the needs of people, a questionnaire has been drawn up that can be found in figure 14. This is mainly used to get an open conversation going. The results of this questionnaire, together with the information from meetings with the municipality of Amsterdam and experts from Lost Lemon and TNO, have been compiled in order to draw up a needs assessment.

5.2 Needs Assessment

Based on the context analysis, a list of needs and wishes that the application must meet can be drawn up. These have been mapped out by talking to the target group. In the conversations that were held, it became clear that the greatest need was for information, especially about shelter. Information about this should therefore be prominently present. Information about food was then most frequently mentioned, followed by medical information, information about education and help, free items such as blankets and gloves and public WiFi spots in the city. On the basis of this list drawn up by the target group, it was decided that the prototype should be based on this information categories.

The list is prioritized on the basis of most named category to least named category. The information should also be easy to access, as many people within the target group indicated during conversations that they had limited digital skills. The target group also consists of people from different countries who speak different languages, so multilingualism can also be defined as a need. At least 40 percent of the people who were interviewed at Sant'Egidio had a smartphone, and an even larger group had access to the internet by using for example computers in the public library.

There is therefore a need to be able to make the information available on as many digital devices as possible. This is also one of the recommendations made in the article 'Bouwstenen voor Digitale Inclusie'[21], which advises: "*The smartphone is by far the most widely used device. Invest in good digital interaction with citizens with low digital skills. By making more offers (websites, systems, etc.) suitable for smartphones and making it easier to use. With the help of decision trees and visualizations, the possibilities of using smartphones can be increased and the target group gains confidence to use digital applications. Experiences gained by the municipality can be shared and made available to partners. For example, the municipality can commission a startup to further develop existing offerings into attractive and accessible offerings that can be used on the smartphone.*"

¹Gebruiker Centraal. Figures vary, depending on the definition and method of counting. Among other things, this group has no fixed place of residence and often no money for primary goods and food.

²Pechmannen zijn de nieuwe daklozen

In this way, existing knowledge can be safeguarded, but also knowledge from outside can be used. The Commission has also been able to achieve a high level of commitment to the development of new technologies, so that innovative steps can be taken".

However, low literacy, which affects many people within the target group, must be taken into account [14].

In addition, in the form of public Wi-Fi hotspots within the municipality of Amsterdam, there is the possibility for the homeless to connect wirelessly to the Internet. During the conversations that were held, many people indicated that internet access is possible in certain places, but certainly not everywhere. It should therefore not be expected that they will be able to obtain a constant update of information during the day.

There are many different parties that provide the information that needs to be provided. One assumption was that the municipality would be an important provider of valuable information for them, but this does not appear to be the case in the discussions held. If we want to focus on primary information provision for the homeless, then the institutions that offer this information will be the most important information providers. The information collection will take place on the basis of information available from different organizations. This include providers of food, shelter, medical information, public internet providers, providers of free equipment and providers of education, for example in the field of reintegration.

5.3 Requirement Engineering

A requirement analysis is used to determine the requirements to be met by the end product. This analysis initially consists of a list of functional requirements, which can be guaranteed on the basis of a list of qualitative requirements, both of which will be discussed and explained in the following sections.

5.3.1 *Functional Requirements.* The list of functional requirements is a result of the need analysis in the previous section. Because the flow for the application was very clear quite quickly, functional requirements were established easily. They can be found in table 1.

Requirement	Definition
<i>Caching</i>	Since users do not have access to the Internet at all times, it should be possible to hold the information on the device so that it is also available without Internet access.
<i>Multilanguage</i>	Because the target group speaks many different languages, it is nice if they can use the application in different languages.
<i>Text-to-speech</i>	In order to make the application accessible to people who are struggling with low literacy, a function that allows text to be spoken is a useful tool. This could be done using a service such as Readspeaker .

Table 1: Functional requirements

5.3.2 *Quality Requirements.* A list of qualitative requirements has been drawn up which has been pursued during the development

of the application. These will be defined with the corresponding rationale included in table 2. It is important to establish qualitative requirements in order to implement the idea as a real product. In this way, the story with its characters, the use case and functional requirements are shaped into a form that can actually be developed technically.

Requirement	Definition
<i>Customer Experience [RQ1]</i>	This requirement deals with the user experience. This aspect is crucial for the success of our solution. Because of the lack of much technical knowledge the application must be easy to use, because otherwise users will soon stop using it. Here, the design principles presented in the Power Toolkit, Inclusive Design and the Toolkit Inclusie will be used as a guide.
<i>Accuracy [RQ2]</i>	To become a reliable tool, the application must present accurate information that can be relied upon. The context analysis has shown that many people within the target group have difficulty trusting something unknown. Therefore, the application will have to present very accurate information and the possibility to continue to guarantee this.
<i>Up to date [RQ3]</i>	It is very important that up to date information is shown, so that people are not sent to places where they can no longer actually go. This also promotes user confidence in the application.
<i>Sustainable [RQ4]</i>	Efforts should be made to keep the information up to date in an efficient manner. Field research has shown that it is difficult for all the different services from which information is collected to keep the supply up to date. Therefore, the possibilities for automated information collection will be explored. In addition, it will be examined how as few different platforms as possible need to be developed in order to maintain the whole system in a durable manner.
<i>Consistency [RQ5]</i>	In order to maintain the user-friendliness and confidence in the application, the information about the different categories must be offered in the most consistent way possible, this will improve usability and is in line with the previously mentioned design principles.

Table 2: Quality requirements

5.3.3 *Supporting development choices with QOCs.* In order to explain a number of considerations made, a number of QOCs with a question, the options and rationale will be shown.

5.3.4 QOC 1. Either an existing system can be connected to make the information available or a tailor-made application can be developed. The reasons for choosing the second option are explained in figure 3 on the next page. The lack of an existing specialized application or a specialized platform was included in the decision to develop an own application. This is to take sustainability into account and not to develop something that already exists.

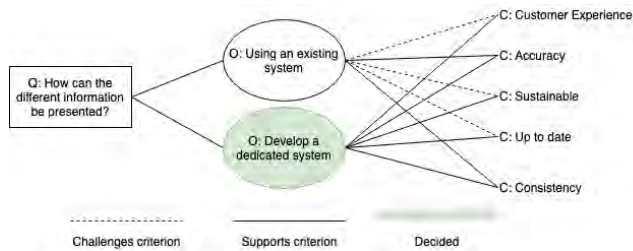


Figure 3: QOC 1: How can the different information be presented?

5.3.5 QOC 2. The information can be entered manually in a CMS or can be crawled automatically. This second option was chosen, because it was possible to realize this by means of another research project, and this offers a very sustainable solution. It has also been shown that the required information can be crawled very easily. How exactly this script works can be read in the work of Carlbando Edoga who developed the algorithm and describes it in detail in his paper. The advantages of this method can be seen in figure 4.

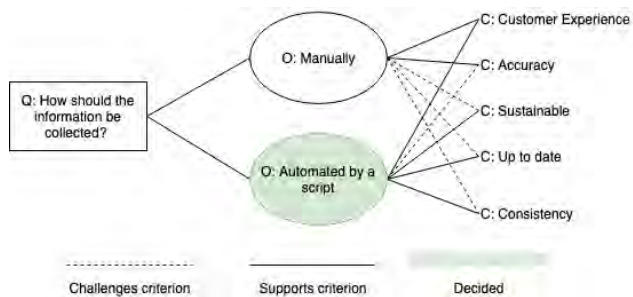


Figure 4: QOC 2: How should the information be collected?

5.4 Engineering

During the actual development, the ICT4D 3.0 Framework was used in an iterative way. With this method we have tried to test quickly with a minimum valuable product³ with the target group. To get a feel for the use of colour, text presentation and layout direction, three possible, different homepages were designed and directly showed in a thinking aloud session with the target group. Based on available work such as the way in which Sant'Egidio offers an information paper in Italy⁴ and the discussed inclusive

³<https://rubygarage.org/blog/what-is-a-minimum-viable-product>

⁴Information flyer for homeless by Sant'Egidio Rome, Italy

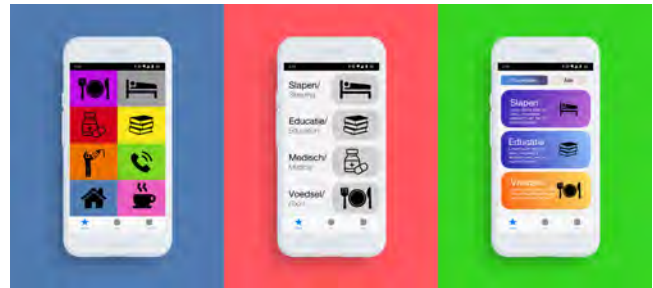


Figure 5: The first proposed designs

design principles, these different options were developed. These first presented designs can be seen in figure 5.

5.4.1 First test session. We showed all three designs to 10 different people on a phone. At first we only asked to look at the phone. We showed all three designs without any assignment. Then we explained that all three designs showed the same categories for the same information. The next question was which design they would prefer if they used this app themselves.

Very interesting was the unanimous result for the first design. Some of the given feedback:

"I'm not very good at language and here I immediately understood what it was all about without the text distracting me like those other pictures."

"If you keep those colors the same I know them after a while and I don't even have to look at the icons anymore."

"My Polish friends also understand this with the icons, handy"

5.4.2 Iterate on the first product. It was clear after this session that we had to continue with the design presented in figure 6 for the rest of the application. Other things that were often seen as user-friendly were simplicity, use of colour, icons and as few texts as possible. With this feedback, which fitted in well with the methods discussed earlier, the rest of the application was developed, first working out the category of food. We noticed that a lot of people

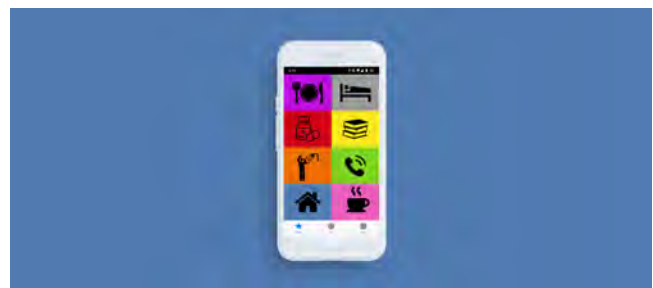


Figure 6: The unanimously chosen design

didn't speak Dutch during our test sessions, so multilingualism would be a very important priority for the next test session. Because we will try to use as few sentences as possible to keep it easy to read, we will use as much information as possible from Google. We were able to get a picture of the data that needed to be indexed and

its design, which will be shown in table 3 and figure 7 on the next page.

Datafield to show	Reason
Name of the instance	To identify the place
Adress	To know where to go
Phone number	To be able to call them
Opening hours	To know when they are open
Image	To enrich the application and identify the place

Table 3: First list of data fields to show



Figure 7: First sketch information page

We developed this design. Then we noticed that the data was generic enough to be translated by Google translate, there are almost only keywords and loose words presented so that this translation could be effective enough. In this way it was possible to quickly build in support for many different languages that are well represented within the target group. Examples of supported languages are: Arabic, English, German, French, Spanish, Russian and Polish.

5.4.3 Next test session. Now that we had finished the start page, a number of different archive pages with all results for the relevant categories, we were able to test the entire flow of the application for the first time. Again there were a lot of people who wanted to help us. The news that we are developing an application for them has been circulating and clearly promotes cooperation with this group of people. This time we can receive feedback from more different people with very valuable input. This proves to be a high priority requirement: presenting information in different ways (because many people seem to have trouble reading). Also, it is sometimes difficult to determine the location of an organization in the city on the basis of an address alone, especially for the people within the target group who have not been homeless for very long or have only just arrived in the Netherlands. People who have been homeless for a long time say they can manage well in terms of food because they have been in this situation for a long time. Incidentally required information such as medical information, current news and places for education are more interesting for these people. Being able to translate the text seems to work very effectively, this has been tested with Polish and Moroccan people who indicated that the translation is accurate enough to understand what it is all about. We also notice that it is valuable to show more information, which will be listed below.

5.4.4 The next iteration. In the next iteration we want to focus on the improvements presented in table 4.

Improvement	Reason
Add location on a map	To be able to see the location on a small map makes it clear how far a location is (improves RQ1)
Add the Google Maps description of a place	Google Maps shows a small description of places making it very fast clear what kind of instance it is
Button for direct navigation	A lot of the people are using a Android phone, having Google Maps pre-installed makes it easy to give them a direct navigation route to the place (improves RQ1)
Images of a instance in the archive instead of the detail page	The image doesn't add much to the page with details about an instance, but it makes navigating the archives easier (improves RQ1)
A way to generate feedback	To keep everything as updated as possible it must be easy to give feedback about an instance when the presented information isn't accurate, (improves RQ2 and RQ3)
Text to speech	To help low literate people using the app, will be configured to be able to have text-to-speech functionality

Table 4: List of improvements

5.4.5 The last test session. With an application that has been successfully improved with all the above mentioned points, the possibility arose to go to Sant'Egidio for another test session. This was again well received. Frequently asked was where they could

find the application. This indicates that there is a real demand for it to be developed, even people who indicated that they were quite capable in the field of information found it a nice idea to be able to use this application, both as a backup should their situation be getting worse, but also to expand their knowledge. A good tip was to give the information according to priority, taking into account the map. In our test, this standard covered the lower part of the screen, which meant that not everyone knew that it was possible to scroll to the opening times, which was very important information for this group. Based on this feedback, the map has been moved to a lower part of the detail page so that some of the opening times are immediately visible, and when people see half a week of opening times, they are more likely to scroll down. The translation function and the text-to-speech function were again very well received, and have therefore become indispensable functionality within the application. Again we understood that there are occasional giveaway actions in the form of for example gloves in winter, free coffee or other free stuff. These exceptions are often difficult to find, and could therefore be offered in the form of a newsfeed within the application. The already existing category of items would consist partly of this information. This was not immediately clear to the target group from conversations, after which the name of this category was changed to news, which can cover a broader scope and is easier to understand for these people. This category will contain news that is difficult to crawl from Google Maps, and will have to be provided by the appropriate organizations that offer something.

5.4.6 *The final product.* At the end of the iterations there is a very complete prototype of which several screens will now be shown. First the homepage of the application is shown in figure 8. It is an easy page to use according to the users, where you can quickly make the choice of what you want to search for. This can be done in various ways that comply with the mentioned design guidelines for inclusion.

After clicking on 'food' in the screen above, the user will be taken to the page with all places for food. This page is shown in figure 9 on the next page. This page is prioritized based on the Google indexation that preceded the crawl process. Each place is presented here as its own card. This so-called card contains a picture of the location, the name of the location and a 'read more' button. In addition, a label is attached to the card with the category in which the user is located. This combination of information was seen by the tests with users as the most pleasant and useful, without it becoming cluttered for them.

When the user clicks on the first result, in this case Sant'Egidio, he will see all the details about this place, as shown in figure 10. This figure is presented here as three separate pages to keep it readable in this document, in the application this will be a long page with all the information among each other.

5.5 Sustainability Assessment

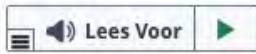
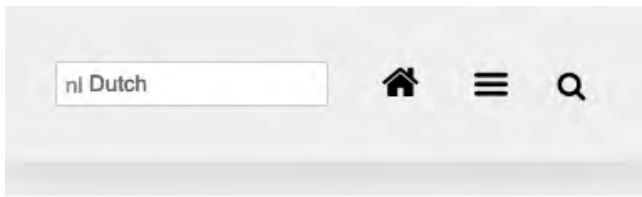
In this section we will discuss in more detail the role that sustainability has played during the entire project. The wish of the VU University Amsterdam research group in which this research took place has been to deliver something tangible and effective from the very beginning. Attention has therefore been paid from the start to developing the current product as sustainable as possible, but



Figure 8: The frontpage of the application

also to being able to offer a sustainable existence. In this context, a number of important choices have been made, which will now be discussed.

5.5.1 *The application form: progressive web app.* In order to keep both the development and the maintenance sustainable from a budget point of view, it was decided to develop the application as a progressive web app. This means that the application is not a native application for mobile phones. Instead, there is only one application that can be presented as a hybrid to iOS users, Android users as



Plaatsen om te eten:



Sant'Egidio

LEES MEER

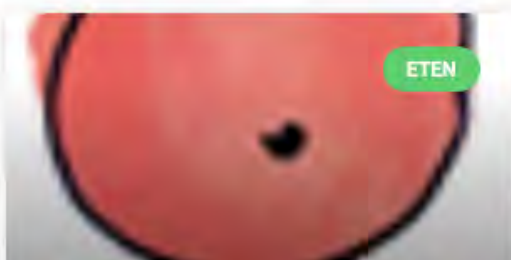


Figure 9: The archive page for food

well as computer users. This way only one application needs to be developed and maintained, which makes this modern hybrid form very efficient and interesting from a sustainability perspective [4]. The application can be accessed via an url and automatically adapts responsive to the size of the user's screen. The application can be added to the user's home screen on a phone to include some of the benefits of a native app as opposed to using a website. For example, a progressive web app can store data on the user's device. This way, the application can also be used without an internet connection. When the user is reconnected to the internet, the latest

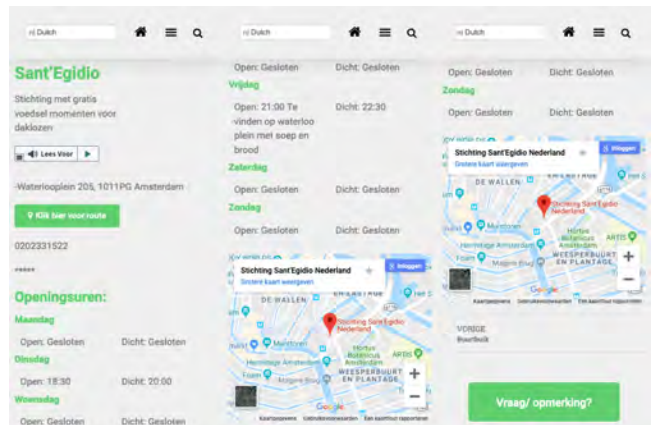


Figure 10: The detailed page

version is retrieved, just like a native application. This promotes the sustainability of the application because the chance of using the application is so much greater for the target group. It is also possible for users to receive notifications from a progressive web app, a feature that is not currently used by the described application but that will be discussed in a moment.

5.5.2 The automated data crawling. Because a large part of the data displayed by the application is automatically retrieved by an algorithm, the application will require little maintenance in terms of content. At the moment, only the news section requires manual input from organizations, furthermore, providing up-to-date data on Google Maps is sufficient to keep the information within the application up to date. This makes the application very durable in maintenance. The chance that the information is still correct in five years' time is much greater than if we were completely dependent on manual input from updates. There is a cronjob that can run every night that activates an algorithm that checks if there are any new instances on Google that meet the requirements of the algorithm. The exact functioning of this algorithm is further explained in the research project of Carlbando Edoga.

5.5.3 Keeping the information up to date using crowd sourcing. At the bottom of every page within the application you can quickly go to a contact form. Through this way of crowd sourcing feedback can be collected. For example, about incorrect information. In this way, the accuracy of the given information can be further improved, based on feedback from the actual users of the services that are shown in the application. This review system will only further improve the quality of the data in a way that is proven by Tong et al. The more active the community will be, the higher the quality of the content will be[20].

5.5.4 The scalability of the application. During the investigation, we came into contact with several parties. Specialized parties in the field of development for minorities such as Lost Lemon, TNO and the municipality of Amsterdam have already indicated that they are interested in the idea of this application. The automated method of data collection mentioned above is an important part of this. Another important part for this interest appears to be the generic

aspect of the application, they told us. The algorithm combines a number of search queries that consist of generic keywords with location keywords. At the moment, 'Amsterdam' has been used as the location keyword. In this way, the output consists of places that are located within Amsterdam. The same keywords also apply to the same kind of places for homeless people in other cities. For example, Amsterdam could very well be replaced by 'Utrecht' or 'Rotterdam' in combination with the same generic query to collect results within these municipalities. What this means is that the application could easily be launched in other municipalities, and is therefore not restricted by the city borders of Amsterdam or even by the national borders of the Netherlands. When a correct combination of appropriate keywords in combination with a location keyword is combined, the application can be of service anywhere.

6 DISCUSSION

In the discussion section, the methodology used will be reflected next to the results obtained. Also, future research and the possibilities offered by the development of the current application will be discussed in more detail. In addition, there is room to give recommendations.



Figure 11: The final app being used

6.1 The used framework, ICT4D 3.0

The ICT4D 3.0 framework was used throughout the study, but particularly during the case study carried out. This was also the most interesting practical part to test the development framework for what it is actually intended. ICT4D 3.0 has proven to be an excellent framework for the developed application, for several reasons. For example, it was not at all clear in advance in what form the application would finally have to work out next to a number of assumptions. In order not to start on the basis of assumptions and to throw away valuable time, it has been a very pleasant experience to use the framework and to start with a very extensive context analysis. This has resulted in many insights at an early stage that have remained intact throughout the project, something that is very difficult to achieve when starting on the basis of assumptions. Then the needs and after that the requirements were drawn up in consultation with the actual target group. This means that the framework

lends itself very well to inclusive design, in which co-creation and co-design in consultation with the target group is also an important part⁵.

6.2 Collaborative

In order to get a good idea of the needs and wishes, there was a close cooperation with the volunteers and visitors of the weekly organized dinner at Sant'Egidio in Amsterdam. This gave us the unique opportunity to visit as many times for testing or knowledge gathering as we deem necessary. Also, the various volunteers who help here weekly have a lot of knowledge about the needs of the homeless visitors. To collect this information from this perspective has been very valuable during the development. In addition, we have been invited several times by *Lost Lemon* to exchange thoughts. This party with a lot of knowledge about developing for different less fortunate target groups was able to contribute a lot, especially in the orientation phase of the project, and put us on the track that was eventually followed. They indicated that they were always open to a session to discuss the prototype and to see if there could be a future in which the application is further developed. The introduction to TNO has also proved to be very interesting. Both to exchange knowledge about the subject and for possible future steps for the application. They indicated that they saw potential in the application and could put us in touch with a number of people who might be able to ensure that the application could also be launched in Utrecht. At this moment no concrete plans have been made for this together, but the invitation to discuss this later is there. This indicates that there is potential in the prototype and that there are possible partners with whom we could collaborate so that more people could make use of the application. Also the cooperation with Carlbandro Edoga went very smoothly. Every week we organized a meeting in which a backlog was kept and a todo list for the week in question. Because on this regular basis we discussed the possible improvements together, I believe that the final product has been received so positively.

6.3 Iterative

Both the framework and the possibility to organize regular user sessions ensured that iterative work could be done. In this way we were able to test an minimum viable product on a regular basis while little valuable time was lost. Because a lot of needs were collected from the target group during the project, the iterative working method was a very effective way to achieve an optimal result. If all the feedback after the first orientation phase had not been gathered, it would not have been possible to deliver a product that would meet the same number of wishes of the target group. It turned out that the target group had some difficulty to see the added value of the intended application and to indicate what in their opinion the application should fulfill without being able to see anything visual. When we came back with a visual example and design and layout choices they were allowed to make, it became a lot easier to get feedback, because they got a much better idea of our intentions and the awareness that they could benefit from it was also created.

⁵Co-design explained

6.4 Adaptive

From the iterations that have just been mentioned, many new needs and requirements arose during the course of the project. The implementation of these new requirements has resulted in an adaptive character to the project. Also the development of a single application for all common devices with associated changing screen sizes has made the application an adaptive, responsive application. Open source software was also used for the development of the application, which can also be seen as adaptability[12].

6.5 Future work

The application is ready to be shared with the target group within Amsterdam. It is also equipped with anonymous tracking and data collection functionality. This is done so that the use of the application by real users can be monitored. The expectation is that on the basis of this data, new improvements will come to light. Also, the mentioned possible roll-out of the application to other cities could result in an interesting use case. In this way it could be investigated whether there are significant differences in the use of the application in different cities. Here, too, the collected anonymous data can play a very interesting role. When the application is well known among the homeless, the number of users is likely to increase. If the number of users increases seriously, it is expected that more municipalities and other organizations will be open more quickly to enter into a collaboration. Therefore, the application will first have to prove itself on the basis of data. This could also promote the offerings in the news and stuff section, making it more interesting for users to keep an eye on them. One idea to make this easy for users could be to implement notifications for new news. Also implementing a community in which people can have contact with each other and with organizations is one of the ideas on the backlog at the moment. The past year has taught us that there is no comparable application available at the moment, and that the need for such an application is very clearly present. In an interview with an employee of the municipality of Amsterdam it appeared that the municipality finds the idea very interesting, but at the moment did not have the resources to start such a project itself. When convincing figures could be discussed about the use and effect of such a solution, they were absolutely open to discuss the possibilities.

6.6 Limitations

Despite the promising nature of the application, there are also certain risks and limitations in the current set-up. The greatest limitation is inevitable in the current set-up and has to do with the way in which data is collected.

6.6.1 Dependency on the algorithm. The output is as good as the algorithm, instances with valuable information that is not found by the algorithm will not appear in the application in first instance. There is a possibility to enter manual input that could tackle this limitation. This manual input and feedback from users could be collected via the contact form, and then added to the database by someone. This is workable but not as efficient as the described automatic way of collecting data.

6.6.2 Dependency on Google Maps. The application for the automatic data generation also depends on information available on Google Maps. It is crucial that the information on Google Maps about an institution is up to date and complete. A possible limitation we have encountered is the opening times. There are institutions that undertake multiple activities, not all focused on homeless care. These organizations have often mentioned very wide opening times on Google, which are included in the application by the algorithm, but are not fully applicable to homeless people. At the moment these would have to be changed manually afterwards to make them accurate.

6.6.3 Dependence on manual news supply. The news section will have to be filled with input provided by organizations. The power and degree of up-to-dateness of this section therefore depends on the cooperation of all the different related organisations. At the moment it is not yet clear whether it is so large that it will not cause any problems, that will have to be decided in the future.

7 CONCLUSION

This paper illustrates how a mobile application, designed and built with inclusive principles, using an iterative, adaptive and user-centered process based on the ICT4D 3.0 framework, can provide primary information needs, as outlined in several use case and requirement gathering session with homeless people in Amsterdam. The proposed mobile service – with many tools to make its human-computer interface as easy as possible for the various people of the target group – has been developed with long-term sustainability in mind. Since our research has shown that mobile phone is owned by large part of the target group, this medium has been chosen. Several parties have shown interest in continuing its development in the future. With scalability and data maintenance in mind we were able to automate a large part of the data collection. With this research we have validated the proposed mobile application together with real end-users in multiple sessions. With this research we have also validated the approach and framework ICT4D 3.0, which proved suitable for this type of research problem.

8 ACKNOWLEDGEMENTS

I would like to thank the following people for their help during this project. The municipality of Amsterdam for the opportunity to talk to each other and to offer the opportunity to come back again. Lost Lemon for sharing a lot of insights and the willingness to discover together possibilities for a possible cooperation. TNO for sharing insights and the willingness to think about how the product could reach as many people as possible in the future. AdValvas for inviting Carlbandro and me to listen to our story so that they can publish an article about it to increase awareness. I would like to thank Readspeak for making it possible to use their software for free in appreciation of the social character of the project. Finally, I would like to thank Sant'Egidio and especially Liduine Reuser for the unique opportunity to get in close contact with this normally difficult target group and all the valuable knowledge that all volunteers have shared with us.

9 WEBSITE

In order to keep all the people who have helped during the project informed, to inform those who are interested or to be able to refer people to what we have already done, a website has been created where we can keep track of our progress. (www.digitize.amsterdam)

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10 APPENDIX

On the next pages you will find the appendices that were referred to earlier in the paper.

10.1 Appendix A



The infographic is titled "Inclusive Design Principles" and is presented as a grid of seven numbered sections. Each section includes a title, a brief description, and illustrative icons. The sections are: 1. Provide comparable experience (laptop with closed captions), 2. Give control (hand interacting with a tablet), 3. Offer choice (multiple device screens), 4. Consider situation (login form and high contrast phone), 5. Be consistent (laptop with consistent layout), 6. Prioritise content (phone and laptop with prioritized elements), and 7. Add value (hand holding a phone with a colorful interface). The bottom of the infographic includes a footer with a URL, a Creative Commons license, and the Barclays logo.

Inclusive Design Principles

These Inclusive Design Principles are about putting people first. It's about designing for the needs of people with permanent, temporary, situational, or changing disabilities – all of us really.

Adapted from inclusivedesignprinciples.org/

- 1 Provide comparable experience**
Ensure your interface provides a comparable experience for all so people can accomplish tasks in a way that suits their needs without undermining the quality of the content.
- 2 Give control**
People should be able to access and interact with content in their preferred way.
- 3 Offer choice**
Consider providing different ways for people to complete tasks, especially those that are complex or non standard.
- 4 Consider situation**
Make sure your interface delivers a valuable experience to people regardless of their circumstances.
- 5 Be consistent**
Use familiar conventions and apply them consistently.
- 6 Prioritise content**
Help users focus on core tasks, features and information by prioritising them within the content and layout.
- 7 Add value**
Consider the value of features and how they improve the experience for different users.

For more information go to barclayscorporate.com/accessibility
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Figure 12: The inclusive design design principles

DEMOCRATISERING EN DE DIGITALE STAD

Samen maken we Amsterdam

Bewoners hebben net zulke goede, zo niet betere, ideeën als het stadsbestuur. Wij streven naar een open en transparant bestuur, een naar buiten gerichte organisatie die open staat voor maatschappelijk initiatief en een gebiedsgerichte werkwijze. We voelen het als onze verantwoordelijkheid om de zeggenschap van bewoners te vergroten. Niet door nieuwe stelsels maar door met de stad het gesprek en debat aan te gaan over hoe dat kan.

Democratisering

- Samen met de stad stellen we een ambitieuze agenda voor democratische vernieuwing op waarin we onderzoeken hoe de participatieve en representatieve democratie kunnen worden vernieuwd, versterkt en uitgebreid. Doel is inwoners van Amsterdam grotere zeggenschap te laten hebben over hun directe omgeving, gemeentelijke dienstverlening en de stad als geheel.
- We versterken met maatschappelijke partners zoals debatcentra en initiatieven de betrokkenheid van burgers bij de stad en de politieke besluitvorming.
- Nieuw beleid maken we waar mogelijk samen met de stad. Beleidsstukken krijgen daarom standaard een participatieparagraaf waarin inzichtelijk is gemaakt op welke manier Amsterdammers betrokken zijn geweest en wat er met hun inbreng is gedaan.
- We leggen buurtrechten vast en gaan experimenteren op basis van ervaringen in andere steden.
- We gaan buurtbegroten invoeren.
- We stellen per buurt een buurtbudget in. Het stadsdeelbestuur kan (binnen kaders), in overleg met de buurt, besluiten over de bestemming.
- Buurtinitiatieven krijgen alle ruimte en we onderzoeken hoe we deze beter kunnen ondersteunen.
- Er komt een fonds voor maatschappelijk initiatief waar kleinschalige initiatieven een beroep op kunnen doen.
- We creëren fysieke en vrije ontmoetings- en ontwikkelplekken in de stad (zoveel mogelijk op buurtniveau). Een deel van het gemeentelijk vastgoed kan hiervoor worden ingezet. Er wordt gezocht naar combinaties van werkplekken met gebiedsmakelaars en handhavers.
- We creëren co-creatieplekken in alle stadsdeelkantoren.
- De gemeente ondersteunt actief het opzetten van commons bij bijvoorbeeld energietransitie, zorg of het opzetten bij buurtactiviteiten. De gemeente deelt best practices en geeft juridisch advies.

- Amsterdam sluit zich aan bij het Fearless Cities Network: een internationaal verbond van gemeentes die zich onderdeel voelen van een internationale 'municipalistic' beweging. Hierin staan onder meer verdieping van de lokale democratie en andere beleidsterreinen centraal. Doel is uit te wisselen met, en te leren van andere deelnemende steden. We organiseren in 2020 de jaarlijkse Fearless Cities conferentie.

Digitale Stad

- Er komt een Agenda Digitale Stad waarin concepten worden uitgewerkt voor digitale dienstverlening en participatie (moderne, open overheid), cybersecurity en veilige digitale infrastructuur en data-soevereiniteit.
- We blijven aandacht hebben voor mensen die moeite hebben met digitalisering.
- De digitale stad richt zich op de opgaven van de stad. Daarvoor maken we een goede digitale infrastructuur om de mogelijkheden goed te benutten en goed te kunnen handhaven.
- We werken waar mogelijk met open source en open data.
- Dataminimalisatie wordt de norm. Data wordt alleen verzameld als dat nodig is en er toestemming voor is gegeven. Amsterdammers krijgen inzicht in hun eigen gegevens binnen het wettelijke kader. De manier waarop burgers regie hebben over data die ze met de gemeente delen wordt vastgelegd.
- We ondersteunen coöperaties die een alternatief willen bieden voor platform-monopolisten.
- Wifi-tracking door bedrijven wordt verboden.
- Voor het maken van keuzes is toegankelijke informatie cruciaal. De gemeente Amsterdam zorgt er daarom voor dat alle inwoners toegang krijgen tot belangrijke keuze informatie. Dat is niet alleen goed voor een sterke lokale democratie maar ook voor het versterken van de zeggenschap van inwoners, besluitvorming, beleid, verantwoording en de besteding van publieke middelen en de resultaten daarvan.
- De gemeente Amsterdam gaat uit eigen beweging meer informatie openbaar maken. Er komt een informatiecommissaris die samen met de gemeentelijke privacy officer ervoor zorgt dat de uitgangspunten 'open tenzij' en 'privacy by design' worden gewaarborgd, aangejaagd en gehandhaafd.
- Inwoners moeten in staat worden gesteld om beleid beter te volgen en gericht input te kunnen leveren. Voor meer zeggenschap, hebben zij niet alleen betere toegang tot keuze informatie nodig, ook belangrijke informatie over wat er in hun buurt nodig is en de besluitvorming daarover is daarbij onontbeerlijk.
- Raadsinformatie, WOB-verzoeken en documenten worden toegankelijk.
- Het 'tada, duidelijk over data'-manifest wordt geïmplementeerd. Dit manifest biedt een handleiding om bewust om te gaan met de mogelijkheden en bedreigingen van digitale technologieën, voor het beschermen van burgerrechten en voor eerlijke toegang tot, en het eerlijk verdelen van de opbrengsten van digitale technologieën.

Figure 13: Coalition Agreement of Amsterdam 2018

Figure 14: Used questionnaire

Carlbandro Edoga
Marc Hegeman

Questionnaire App Usage

As part of two master thesis projects under the supervision of Anna Bon at the Vrije Universiteit Amsterdam this questionnaire aims at assessing the usage of mobile applications. No personal data will be retrieved. All data will be solely used for academic purposes. You can leave out questions that you cannot or do not want to answer.

1. Do you own a smartphone? If not, please go to question 4.

- Yes
- No

2. How often do you use your smartphone per day?

- < 1 hour
- 1 hour
- 2 hours
- 3-5 hours
- > 5 hours

3. Which applications would you consider the most useful?

- _____
- _____
- _____

4. Which information do you get offline because you do not find it online

- _____
- _____
- _____