Assignment 3: Implementation Prototype

ICT for Development (ICT4D)
X_405101

VAICARPA

Group: 8
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C. Changelog

For this last version of our application, we have significantly extended the VSDK functionality by introducing several new voice service elements. These have been made as generic as possible, such that they could be re-used in other voice applications.

Table 0: *Major changes made compared to the previous version of VACARPA.*

Change	Description
Added choice history	Choices are stored in the database when the user provides input to a choice. This allows the use of previous answers later in the call flow. This feature isn't limited to a specific voice service application, since it is an extension of the VSDK.
Added report element	Administrators of the KasaDaka VSDK can add a report element in which choices and spoken user inputs can be combined in a report. The report merges the stored choices in the history and the spoken user inputs that are selected.
Added retrieve reports element	Administrators of the KasaDaka VSDK can add a retrieve report element which is linked to a report element. The retrieve report element contains a selection of choices that are used to filter the reports that contain these selected choices. Reports that are retrieved are played back to the user through the choices and spoken inputs of them.
Shortened call flow	For assignment 2 we were given the feedback that VACARPA's call flow was too long. We have re-structured the call flow to feature fewer prompts at no expense of functionality, by merging some choice moments.
Fixed a VSDK bug	Fixed a bug in the VSDK where spoken user input could not be played directly from the admin panel. Opened a pull request in the kasadaka repo for this so future students will not face the same issue.

0. Name

VA)CARPA

VACARPA - Voice Accessible CARPA

1. Summary of key idea

The CARPA project offers a crowdsourcing platform for reporting incidents or initiatives in the value chains of international companies, operating on the African continent. The aim of this is to promote sustainable solutions as well as improve the dialogue between parties involved, such as local workers and governments.

In the current situation, CARPA is only accessible through a web application. Citizens without internet access thus remain unheard on the platform, and cannot retrieve reports from other citizens either. Given the relatively low internet penetration rate, this concerns a large part of the African population. Our key idea is to make the CARPA platform more accessible by offering part of its functionality via a voice application. Users can call in with any phone and then do either of two things:

1. *Report a new incident or initiative.* Consisting of the region, related company, spoken report content and optionally a category of the report (such as child labor or working circumstances).
2. *Request historic incident or initiative reports.* An overview of the last incident or initiative reports related to a selected region and company.

With the VACARPA application we aim to reach those citizens who could benefit from using the CARPA platform but are currently unable to, allowing them to share their experience and also hear what others have reported.

To provide an overview of our project at a glance, we have included a *business model canvas* of our project in Appendix A. This describes among other things the key partners, value propositions, key resources and cost structure of VACARPA.

2. Actors and goals

Table 1 below describes the involved actors we have identified for VACARPA. For each of these we formulated operational goals and responsibilities in the envisaged system.

Table 1: *Involved actors, their goals and responsibilities in VACARPA.*

Actor	Operational goal	Responsibility in the envisaged system
Users (citizens)	Report incidents or initiatives	Provide data in the form of incident or initiative reports. Retrieve reports from other users.
Academics and practitioners	Analyse data	Provide evidence based knowledge to develop new legislation
Government and policy makers	Anticipate on the data by implementing improvements	Monitor activities and use the obtained data for legislation improvements
Developers	Develop the VACARPA system	Develop and maintain the application

3. Context and scope
3A. Context diagram
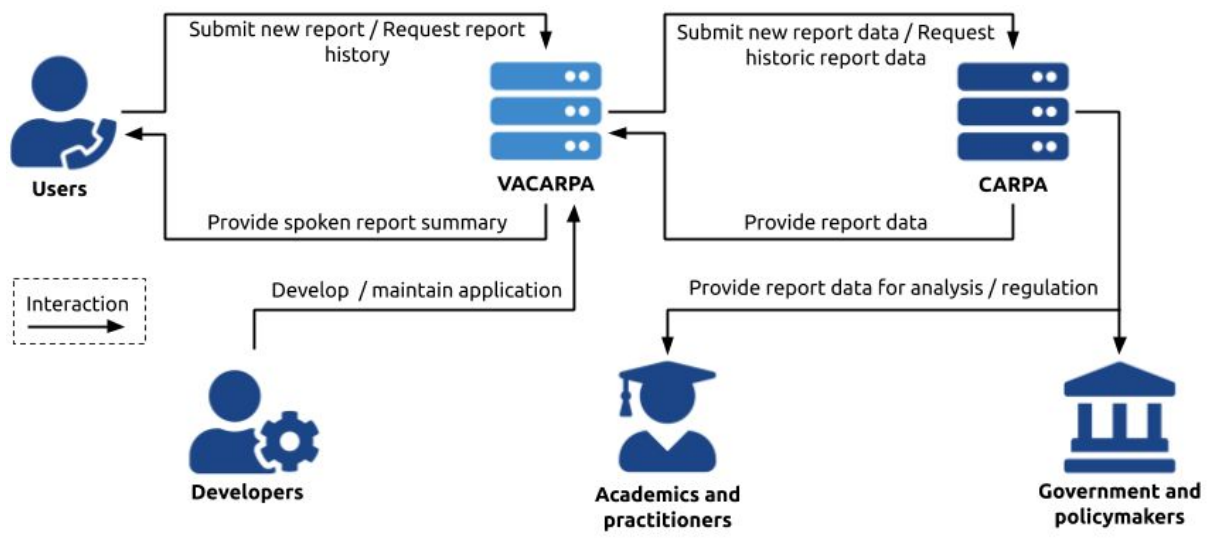
Figure 1: *Context diagram of the VACARPA application and the CARPA platform.*

3B. Stakeholders and concerns
Table 2 describes the stakeholders we have identified for VACARPA.

Table 2: *Stakeholders and their concerns in VACARPA.*

Stakeholders	Concerns
Users (citizens)	*Privacy when reporting an incident:* reporting an incident should not have negative consequences on users' physical or job security. *Follow-up on reports:* action should be taken in response to reports, to improve the situation.
Academics and practitioners	*Usability and availability of data:* report data submitted through VACARPA should be usable for analysis.
Government and policy makers	*Completeness and availability of data:* information submitted through VACARPA should be complete enough to implement new legislation that improves sustainability.
Developers	*Availability and usability of the application:* the application should be available to the intended users, even those who cannot access the internet or are unable to read.

3C. Scenario scope
The submission of reports by users is the most important aspect of our envisaged system, and thus determines the main scope of our project. Our main focus here is on the usability of the application for users. This aspect is vital to the success of our main goal: to improve the accessibility of CARPA. The usability of the submitted data for analysis is also important, to contribute to CARPA's goal of improving sustainability and dialogue between citizens, governments and companies.

Because the CARPA platform itself is only reachable via the internet and only has a pre-approved set of users, the barrier for submitting a report is relatively high. We aim to offer the ability to submit reports also for low-income workers who only have a simple cell phone. In addition to this, we want to offer everybody the ability to obtain reports to increase transparency and accessibility of the application. For this reason, VACARPA supports report retrieval as well. This is useful for e.g. prospective workers of a company.

For this prototype, we do not establish the actual connection between our application and the CARPA platform. This is considered out of the assignment scope. We do, however, propose a strategy for synchronising VACARPA and CARPA.

3D. Performance measures

To measure the success or performance of our application, we consider two key indicators:

1. *The amount of reported incidents and initiatives.* HIgher amounts would mean that more citizens can let themselves be heard on CARPA. This contributes to our main goal. It would also show that users have trust in the application, for providing their data. This indicator is relevant while the application is deployed.
2. *Ease of submitting a report.* If users can submit a report with ease, they will intuitively be more inclined to do so. This results in more data to analyse.

3E. Conditions

There are several conditions that we will assume to hold during VACARPA's development:

1. *Availability of the CARPA platform:* VACARPA relies on CARPA for the processing and storage of report data, hence we assume this is available.
2. *Names of regions and companies:* a database of regions and companies who operate in each region is required to assign reports to a specific location. We assume that upon deployment of VACARPA such a database exists.
3. *Language and audio support:* since text to speech is not available for many local languages, we assume that audio clips are provided.

4. Use case scenario script

Figure 2 depicts the use case diagram of the VACARPA application. VACARPA is an intermediate service between them and CARPA. CARPA handles the storing and processing of reports submitted by VACARPA users, and facilitates the accessibility of these reports to the other stakeholders such as government bodies and academics.
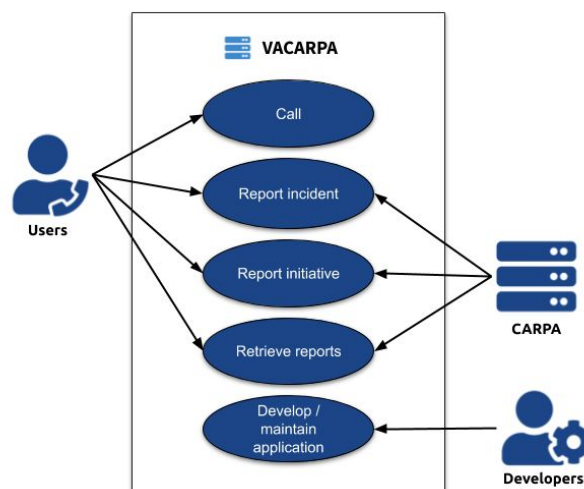
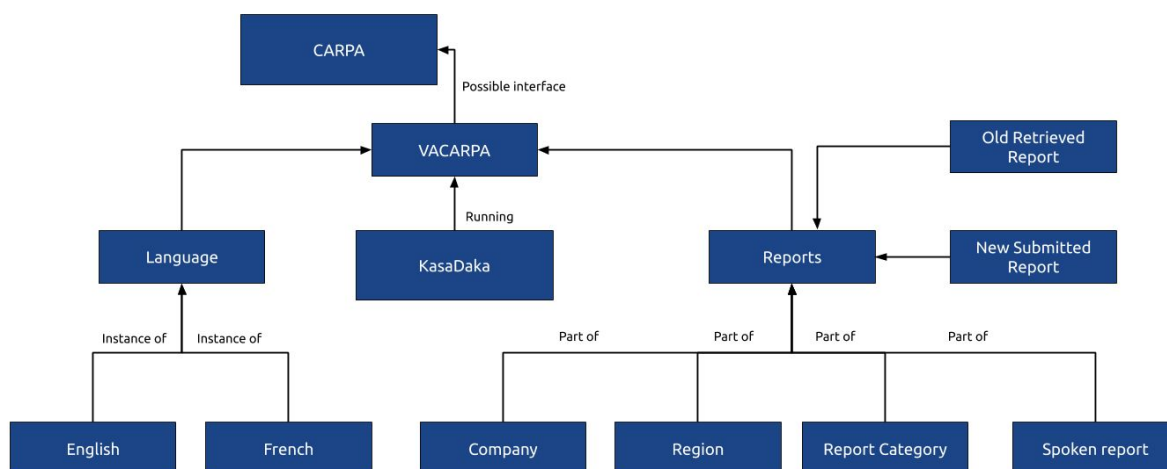**Figure 2:** *Use Case diagram of the VACARPA application and the CARPA platform.*

5. Interaction and communication

The diagram in figure 3 shows the interaction between the user and VACARPA. All prompts in the application itself are pre-recorded audio clips, which ensures that the system can be adapted to local languages and company names with basic effort of translating the standard English recordings. Instead of written text like on the CARPA web application, VACARPA uses spoken reports.
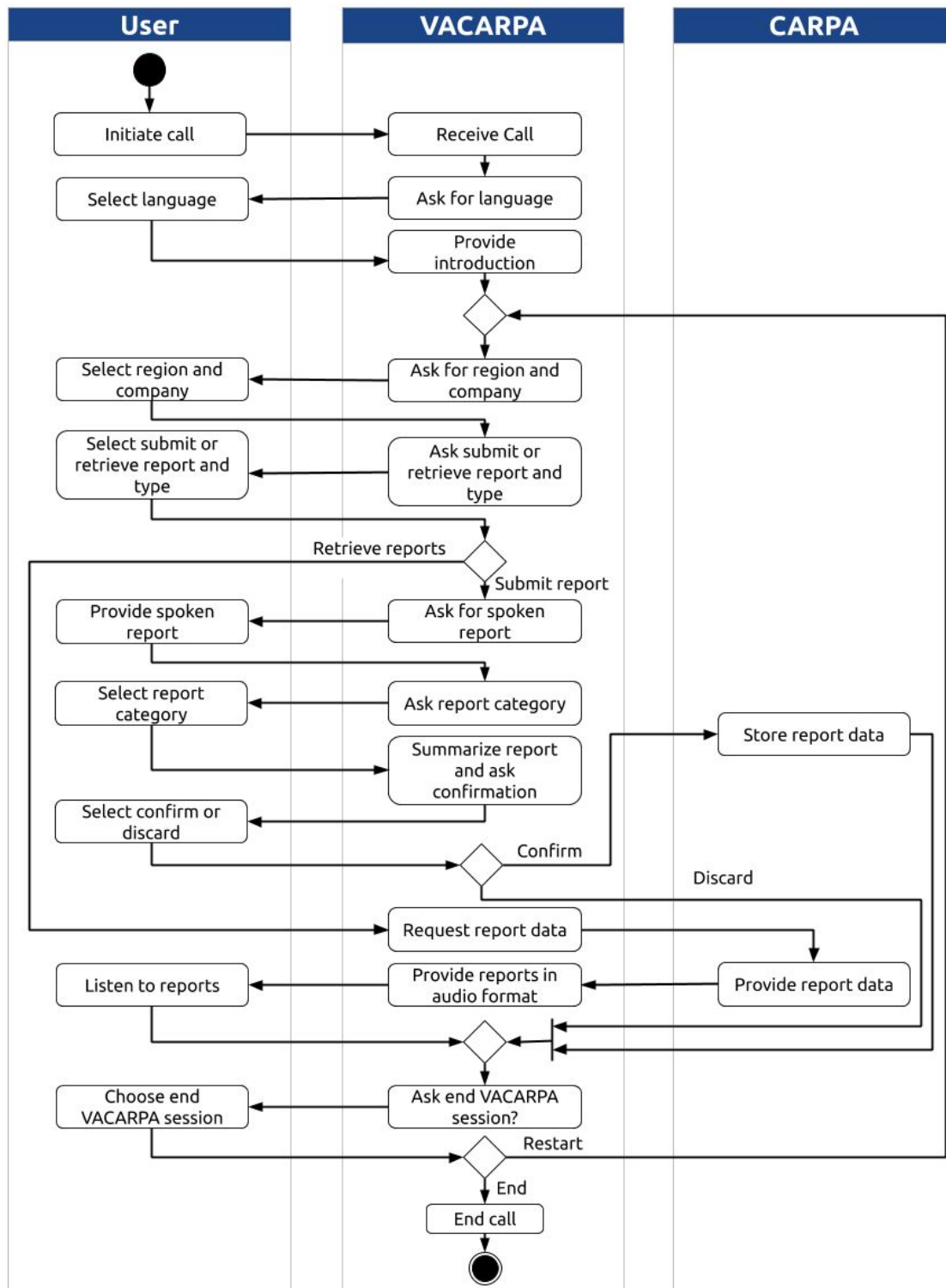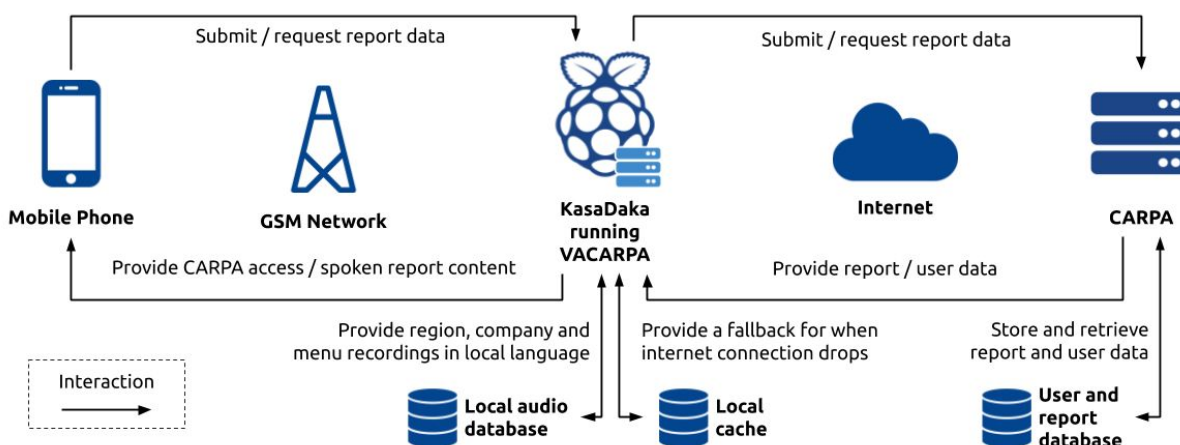

Figure 3: *Activity diagram of the interaction and communication in the VACARPA application.*

6. Information concepts

Figure 4: *Diagram of the information concepts in the VACARPA application.*

7. Technology infrastructure

Figure 5: *Technology infrastructure diagram of the VACARPA application.*

Figure 5 shows the components that are involved in the VACARPA application. We aim to develop the application such that it fits the context of developing regions in rural Africa, more specifically in countries like Mali. Given the relatively widespread availability of mobile phones in these regions, we chose them as the designated hardware to access the VACARPA services. Since proper mobile phone internet access like 4G could be lacking, we used the 2G GSM network as the main medium to be accessible for the user. This also ensures accessibility for low-literate users.

Considering that the KasaDaka might not always have a reliable internet connection, we propose the addition of a local cache database By synchronising this with the CARPA database on a regular basis, dependency on network reliability is decreased.

Table 3: *Technology Infrastructure Components.*

Component	Description
Mobile Phone	This type of hardware is needed to have access to the application.

VACARPA	VACARPA is the intermediate app between citizens and CARPA.
KasaDaka	A Raspberry pi with added GSM dongle, running VACARPA.
Audio Files Database	Database that contains all audio files for the local regions and companies that operate there. Local languages could also be added here. This allows the geolocation of reports to local regions.
Local Cache	A local cache of reports which is used in case the internet connection to the CARPA platform gets lost. This ensures that VACARPA does not suffer from outages due to network loss.
CARPA	The main platform which the KasaDaka's running the VACARPA application connect to for submitting and retrieving reports.
User and Report Database	Contains the report data submitted to CARPA, including the data submitted via VACARPA. Also contains user accounts.
Internet	The internet is essential to let the application work and and connect the components together.
GSM Network	2G phone network connecting users and the KasaDaka.

8. Cost considerations

We envision that the initial and operational costs for VACARPA are on account of the organisation for scientific research, governmental bodies and (responsible) companies. All of these parties benefit from the data generated by the application, be it for their research, policy making or reputation of empowering sustainability. Users (citizens or workers) of the application should not have to spend anything on the usage other than their cell phone usage costs, to keep VACARPA more accessible and obtain more reports.

Table 4: *Cost considerations for VACARPA.*

Category	Estimate	Description
Operational	~ €10 per unit per month	Operational costs that can be identified are electricity costs for the KasaDaka infrastructure, a phone subscription, maintenance personnel and the additional costs made for the CARPA platform to facilitate synchronisation. These costs can be kept low since the KasaDaka is energy efficient and no outgoing calls are made.
Investment	~ €125 per unit	KasaDaka hardware (consisting of a Raspberry Pi with an added dongle) and some expanded storage to cache CARPA reports at the local KasaDaka instance are required for the system to work. A SIM card for connection to the GSM network and (if no mobile data is available) an internet connection shall be established.
Prototype Development	None	There are no salary costs for the development of the initial version of VACARPA, because it is developed for educational purposes.

9. Feasibility and sustainability

The requirements we have defined for VACARPA in Table 5 are not technically feasible without major additions to the existing KasaDaka VSDK. Since these additions do not conflict with the existing functionality, the changes are backwards compatible with existing KasaDaka applications. The developers first have to familiarise themselves with the KasaDaka VSDK code before implementation of the new functionality can start. The fact that the VSDK does not have extensive documentation may delay this process.

To use the application, users must establish a connection via mobile phone. A GSM network is thus vital to the workings of the system. If the GSM network would fail, users are not able to submit reports anymore. This is a risk that cannot easily be circumvented. As a fallback for VACARPA's communication with the CARPA platform via the internet a local cache for storing reports is proposed, so internet outages do not pose a risk.

Given that there are many parties involved in the CARPA project and they all could benefit in their own way from the additional report data submitted through VACARPA, we expect that the relatively low estimated costs do not introduce problems in terms of business feasibility. Besides, the development of VACARPA is a voluntary initiative. This saves otherwise high development costs.

For the trustability of reports, litigation is concerned if reports differ highly. This will cause difficulty to examine this data and improvements in legislation to enhance sustainability for academics and policymakers. The reports themselves could also be fake, which could put a company in an unfairly positive or negative position. This would counteract the goals of the academics.

To be feasible, users must have the impression that their information is used for improvements. Otherwise, participation of users will decrease. However, users could also be interested in reports of specific companies which would increase participation of users.

There are no additional preconditions for the scenario to work. The system is interoperable in a wider business process since it is designed to induce better working environments and conditions for workers. VACARPA is also interoperable in a technical sense because the data can be used in other systems.

10. Key requirements

Table 5: *Key requirements for VACARPA.*

Name	Category	Description	Rationale
[REQ-1] Submit report	Must have	The ability to submit an initiative or incident report about a company.	Submitting a report is the main goal and therefore the most vital part of our application. The more reports are gathered, the higher credibility of the data.
[REQ-2]	Must have	Privacy of users	To prevent workers from negative

		when submitting a report.	prosecution or losing their job after submitting an initiative about a firm, their identity should not be revealed to these companies.
Privacy			
[REQ-3] Different languages	Must have	The ability to use the application in (at least) both English and French.	The application should provide the users access in at least two languages. English and French have been chosen for their relatively widespread usage in Africa.
[REQ-4] CARPA synchronisation	Must have	Synchronisation of reports between CARPA and VACARPA.	To allow collection of data and further processing of submitted reports, VACARPA should interact with the CARPA platform.
[REQ-5] Retrieve reports	Should have	The ability to retrieve previously submitted reports.	Users should be able to retrieve reports for a company and region that have been submitted by others as well.
[REQ-6] Geolocation and categorisation	Should have	The possibility to label a report with a geolocation and categorisation.	This is valuable information for further analysis into the reports. Knowing where exactly incidents took place allows for integration on a map and filtering.
[REQ-7] User authentication	Won't have	Authentication before retrieving or submitting reports	CARPA makes use of SMS as a method to log in. Since the user has a caller ID, no such verification is required in VACARPA.

11. Prototype description

The application prototype has several functionalities which extend the functional prototype as well as the KasaDaka VSDK. These functionalities concern additions to the backend of VACARPA as well as the backend and frontend of the KasaDaka VSDK.

11.1 KasaDaka VSDK functionalities

11.1.1 Backend

The backend of the KasaDaka VSDK didn't originally have the functionality of storing choices that a caller made during a call. It was only possible to change the call flow and thereby change the path of the decisions made during a call, which would result in the possibility of "storing" choices. The functionality that was added uses the call session to store all choices a caller makes in the database that is linked to the KasaDaka VSDK. These could then later be processed in a summary of any kind. This functionality isn't limited to the use of VACARPA, since the ability to store generic choices and spoken input can be used for any project. User choices can be combined with spoken input for a summary of the whole call session, which will be played back to the user for a confirmation of their input.

11.1.2 Administration dashboard

The user choices that were mentioned in the previous section are provided through the frontend of the KasaDaka VSDK. A new element was added to the fronted called "Report elements" in which choices and spoken user input elements can be selected (see Appendix C1). This selection is saved in a "User report" once a caller has confirmed the summary of this selection of choices and inputs (see Appendix C2). The report is accessible for administrators in a readable format such that they can use the data provided by users.

11.2 VACARPA functionalities

VACARPA makes use of the previously mentioned functionality that was added to the KasaDaka VSDK. It is possible to dynamically change the summary at the end of a call session which consists, in the case of VACARPA, of listing the region, company, report category and the spoken user report. After the user has provided a report, the call can be restarted such that a new report can be submitted. The user can also retrieve previous reports that have been submitted to VACARPA. This allows the user to listen up to a maximum of 5 most recent reports.

11.3 Data model

The shown data model depicts the relationships of the different data objects that are included in the VACARPA application. The user initiates the application through selecting a preferred language, the choice to report an incident/initiative, the company, region, and report type. These are processed as data objects and determines the data flow among these. If the user makes the choice to retrieve reports, the backend will processes this and provides the user the needed data.
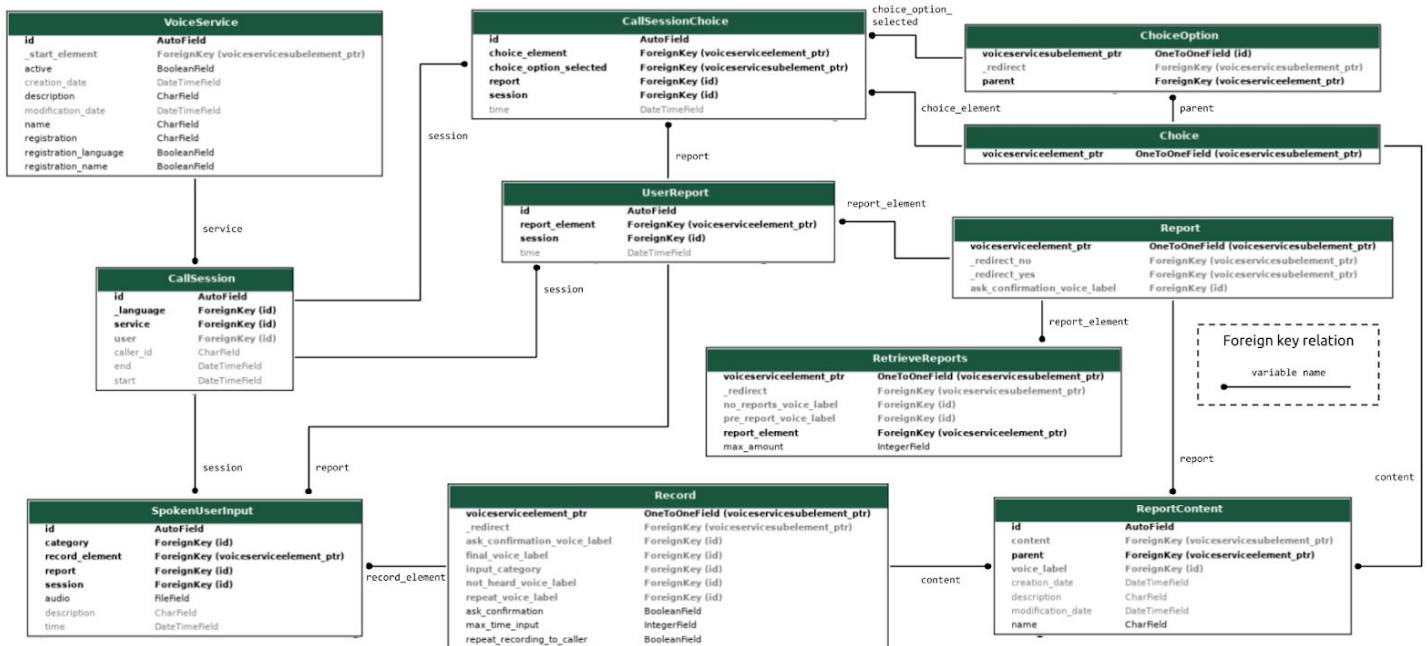
Figure 6: *Data model of VACARPA's most important elements.*

12. Application and code access

The newest version of the VACARPA application which uses the KasaDaka VSDK can be accesed via http://fierce-hamlet-05401.herokuapp.com/vxml/start/2. You can log in using `admin:Vacarpa2020` to easily inspect the application back-end as well as the report overview. The database dumps and recordings can be found in our GitHub repository, with the latest version being `final_version.json`. A demonstration of the application is given in this YouTube video.

13. Usage instructions

The following (DMTF) options can be selected in our application to test respectively the retrieval of reports (which are static), the submission of an incident and the submission of an initiative:

- 1 (English language) ⇨ 2 (region 2) ⇨ 2 (company Delta) ⇨ 3 (retrieve incident reports) ⇨ [listen to up to 5 most recent reports] ⇨ 2 (end session)
- 1 (English language) ⇨ 1 (Region 1) ⇨ 1 (company Alpha) ⇨ 2 (submit an initiative report) ⇨ [provide spoken report] ⇨ 1 (proceed) ⇨ 1 (add category to the report) ⇨ 3 (select child labor category) ⇨ [listen to summary of report] ⇨ 1 (confirm and submit) ⇨ 1 (restart session)
- 1 (English language) ⇨ 1 (Region 1) ⇨ 1 (company Alpha) ⇨ 2 (submit an initiative report) ⇨ [provide spoken report] ⇨ 1 (proceed) ⇨ 1 (No category) ⇨ [listen to summary of report] ⇨ 1 (discard) ⇨ 2 (end session)
- Instead of choosing 1 (English language) in the first step, all functionality of VACARPA is also available in French by choosing 2 (French language)

Administrators can log in to VACARPA with the credentials mentioned in Section 12. After logging in, the following link can be used to view the reports that are submitted by user through the VACARPA interface.

14. Discussion of scope and fidelity

For our designed VACARPA application, we managed to implement all functionality we had envisioned in the activity diagram in Figure 3. From the list of key requirements in Table 5, we have fully implemented REQ-1 (submit report), REQ-3 (different languages) and REQ-5 (retrieve reports). This has been achieved by expanding the VSDK's functionality.

REQ-2 (privacy) cannot be guaranteed from the technical implementation alone, but is also affected by the deployment of VACARPA in the field. Since reports are submitted via a phone call, their authors could be traced if one has access to the application back-end. To ensure the physical safety of users reporting an incident on VACARPA, administrators should not share this data with the user's employer or any other party. Similarly, REQ-6 (Geolocation and categorisation) depends on the deployment phase: sufficiently accurate geolocation is only possible if enough KasaDaka's are deployed. Categorisation is supported. REQ-4 (CARPA synchronisation) is considered outside the scope of this assignment, and has not been fulfilled for that reason.

We are convinced of the usability of our application. The only user requirement, a mobile phone, allows many users in developing regions to engage in VACARPA. Still, the functionality offered by VACARPA is quite broad. Furthermore, the functionality which we have added to the KasaDaka VSDK has been kept as generic as possible, to allow re-use in a different context.

15. User Evaluation

For a future user evaluation of the system, we would use the user evaluation method described in the book of Benyon (2014) [1] on designing interactive systems. This consist of the following steps, applicable as guidelines:

Table 6: *Possible evaluation methodology.*

Evaluation steps	Description
1. Writing a scenario	We would have used the scenarios described in Section 13.
2. Preparing of tasks for the user to complete	Call application, choose language, retrieve reports, submit reports, close the application.
3. Explaining of the scenario and the task the participant is going to perform	We would introduce the user with the application and the walkthrough scenario.
4. Conducting the evaluation and ask the participant to speak out loud	Evaluation would have been conducted performing the tasks and taking notes.
5. Taking notes throughout the evaluation	Notes would be taken during the evaluation regarding the failures and accomplishment of users.
6. Finishing evaluation with a concluding conversation	The concluding conversation would have been characterized by a usability discussion.

16. Conclusion

In this project, we proposed the Voice Accessible CARPA (VACARPA) application. The aim of this was to make the existing CARPA platform accessible to users who do not have internet access, via mobile phone. In order to do this, we designed services and developed the actual prototype behind it. The prototype is ready to run, and within this document we included all relevant aspects. In the process of developing the VACARPA application we have learned much about topics that we had not encountered before in our computer science education: human computer interaction, voice interfaces, low-resource hardware and cultural differences between users were all considered and have been an interesting introduction to ICT for development.

15. References

[1] Benyon, D. (2014). Designing interactive systems: A comprehensive guide to HCI, UX and interaction design.

Appendix A: Business Model Canvas

Table A: *Business model canvas for VACARPA.*

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
● Users (citizens, workers) ● CARPA ● Academics ● Practitioners ● Government ● Policymakers	Provide citizens and workers the opportunity to submit reports regarding incidents or initiatives in international value chains. Support research on sustainable development.	Providing users the possibility to contribute to environmental sustainability	We aim to provide access to the CARPA platform to citizens and workers who have no internet access using the VACARPA application. We provide user-reports to the CARPA platform.	This application provides reporting services to African users in developing regions. Additionally, the application provides report data which can be used for research purposes and policy making regarding sustainable development to academics, practitioners, government and policymakers.
	Key Resources ● Mobile phone ● GSM network ● Internet ● KasaDaka running VACARPA ● CARPA platform		**Channels** Communication with users occurs both via the GSM network (submitting and retrieving reports) and via the internet (forwarding reports to the CARPA platform).	

Cost Structure	Revenue Streams
Funding is required for: ● Costs of KasaDaka kits (Raspberry Pi with attached GSM dongle) ● Costs of electricity ● Costs of GSM connectivity ● Costs of system maintenance	We envision that the funds for initial and operational costs for VACARPA can be gathered from contributions by academics, governmental bodies and (responsible) companies together. All of these parties benefit from the data generated by the application, be it for their research, policy making or reputation of empowering sustainability. VACARPA shall operate on a not-for-profit basis. Users (citizens or workers) of the application should not have to spend anything on the usage other than their cell phone usage costs, to keep VACARPA more accessible and obtain more reports.

Appendix B: Feedback questions

Table B1 shows some questions that emerged during the discussion after our presentation in class on the 20th of April and in the Google presentation document afterwards. We have considered or will consider these aspects during development of the new versions of the VACARPA application.

Table B1: *Feedback questions and answers.*

Question	Answer
What is the use case of retrieving reports via VACARPA? *Can the users access all reports or only the most popular/most recent ones?*	By allowing users to retrieve previous reports from a company, they can get an impression of that company's sustainability practices. Since some languages don't support text-to-speech we only include the amount of reports and their category, or spoken reports that are present. For prospective workers or experts in the field who quickly want access to this information, It could be useful to hear that e.g. 5 incidents have been reported for a company the last month. Users can retrieve all reports for the past month or the past year. They can select between these two when calling.
Do you use a caller ID or user ID for authentication?	It can be assumed (according to the lecturers) that the users of CARPA are authorised and have their phone numbers registered in the CARPA database. VACARPA could look up the caller's phone number in the CARPA database to authenticate them. This is a very good suggestion which we intend to add in a future version.
How are you handling geolocation? *You could think about geolocation. How could you do this?*	As explained in Section 7, we intend to deploy a KasaDaka running VACARPA for each area that should be supported. When the user calls this KasaDaka, they are asked to select first a region (which provides some more specific location within the area of the KasaDaka) and a company that is related to the report. The accuracy of this method of geolocation will depend on the area which the KasaDaka should cover.
What other languages are you going to support?	Our application currently supports English and French, though local languages can be added by recording the relevant voice labels we have added in the KasaDaka VSDK, and some specific local regions and companies. Most CARPA reports are currently in Mali, Congo-Kinshasa, Rwanda and Burundi (see picture). French and English are official languages here. Logical expansions for real deployment could be other official languages in these regions, so Bambara (Mali), Lingala, Kongo, Swahili, Luba-Kasai (Congo), Kinyarwanda (Rwanda) or Kirundi (Burundi). These are currently out of scope.

We have also come up with some questions that we would ask to the stakeholders of the VACARPA and CARPA application, as shown in Table B2.

Table B2: *Questions for stakeholders.*

Stakeholder	Question
Users (citizens)	Would you be interested in using VACARPA/CARPA through a phone service? (asking different kinds of potential user groups) For the specific groups that are most likely to use the service: what particular kinds of reports would you submit?
Academics and practitioners	In what format should the report data be such that it would be usable for further processing?
Government and policy makers	How fast could new legislation be deployed after data has been supplied by academics and practitioners?
CARPA Developers	Would spoken reports be a compatible addition to the CARPA platform itself?

Appendix C: Admin interface screenshots

C1: Report element editor

C2: User report