Mobile Clinic Electronic Medical Record System

*Deliverable 1 - Feasibility Study and Project Plan*

**Senior Project**

CIS 4911 - U01

**Instructor:** Sadjadi

**Team Members**

Steven Berlanga

Carlos Corvaia

Rigoberto Hernandez

Michael Montaque

Sebastian Zanlongo

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**Mentor:** Steven Luis

# Abstract

Orant Charities is a non-profit organization dedicated to bringing healthcare to at-risk Malawi citizens. Physicians travel to the country every few months, and stay there for about two weeks. Currently, Orant uses a paper-based system to track patients and their visits to the clinic. The paper forms are easily lost, and are difficult to analyze for trends and data. We are building a mobile app that will allow users to more easily record patient information and analyze these records at a later time on order to improve on their services.

This document will analyze the current system and its limitations. We will also look at the user requirements and constraints; and present alternatives to the problems in the project, along with the feasibility of the project and these alternatives. The criteria used include economic, operational, and technical criteria. After this, we move on to the milestones, tasks, and deliverables that fit the hardware and software requirements set forth. Finally, we will recommend the solution that best fits the problem and criteria.

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# Introduction

Currently, volunteer physicians working for Orant Charities lack a robust method of tracking patients through their clinic. They also need a way to improve their care by studying what the most common ailments and prescribed medicines are. Orant require a method of keeping a history of patient visits and outcomes to improve their patient tracking, and to streamline record keeping in order to improve patient processing rates.

The aim of this project is to provide this charity with a simple, effective, and robust method of managing patients and patient records with the goal of improving the effectiveness and quality of the care Orant provides.

## Problem Definition

The creation of an open source mobile app that can provide users with the ability to register and track patients and their visits, and allow for later analysis of these visits. The mobile client will implement a “triage app” that allows nurses, doctors, and pharmacists to manage patients. The app will provide users with clean, flexible forms to replace their existing paper-based forms. There will also be a local server and cloud server providing backups and synchronization of the data using a custom API.

## Background

Orant Charities is an organization that connects individuals who have a desire to share their abilities, time, and talents with the needs of the orphaned, the poor, and the vulnerable around the world. One of the programs they lead is an expedition to Malawi, in where volunteers (doctors, nurses and others) provide medical attention to those in need. These trips are done every few months, and last for about a week and a half each. Patients and their illnesses are both very varies, with patients ranging from infants to the elderly; and ailments including malaria and club foot.

Orant currently tracks patients using paper forms. However, the living conditions in Malawi as well as traveling back to the United States typically results in a loss of medical records. This complicates the task of tracking patients over time, so Orant cannot properly generate patient statistics and improve the medical care they can provide. Orant Charities also lacks the time and resources to improve their current system. Our goal is to provide an easy way of managing patient records through the use of iPads.

## Definitions, Acronyms, and Abbreviations

* + 1. **Triage:** A nurse that checks in patients and obtains personal information such as name, age, and village. Triage will also record patient vitals such as heart rate, temperature, and complaints. For minor issues, the triage nurse can also hand out medication and check out the patient, removing strain on the doctor and pharmacy.
    2. **Physician:** The doctor. The physician reviews patient vitals collected from triage, conducts exams, and renders a diagnosis. If necessary, they will also prescribe medication.
    3. **Pharmacy:** The pharmacy consists of a person that dispenses prescriptions, usually on a one-time visit.
    4. **MC-EMR:** Mobile Clinic Electronic Medical Record System
    5. **API:** Application Programming Interface
    6. **NFC:** Near Field Communication
    7. **App:** Application

## Overview of Document

Section one includes the introduction to this project and describes the existing problem and why a solution is required to fill this need. This section also presents the problem definition and relevant background information. In order to facilitate this discussion, section one also provides the relevant definitions, acronyms, and terminology that were used throughout this project, and subsequently throughout this document. This section then ends with a brief overview of what will follow in this document.

Section two will review the feasibility study, which describes the current system employed by Orant Charities, and the limitations and constraints of this system. It then covers the purpose of the new application, combined with a definition of the requirements set forth by the user, and alternative solutions. The section concludes with the selection criteria used in analyzing the various alternative solutions.

Section three goes over the project plan, and the hardware and software requirements. This section also covers how the project itself is organized, along with the personnel organization and the identification of tasks, milestones, and deliverables for this project.

Section four contains the appendices with a project schedule and diary of meetings. The section also has a feasibility and cost matrix for this project.

Section five includes the references.

# Feasibility Study

In this section, we will evaluate the different alternative solutions to this problem. The first subsection will review the current system being employed, allowing readers to better understand what the goal is for this project. Next, the purpose of the replacement system will be described, along with the definition of user requirements. We then move on to the evaluation of the feasibility of the proposed system compared to other alternatives. Finally, the evaluation criteria that are being used will be explained.

## Description of Current System

Orant Charities currently employs two paper based forms in order to track the events in their clinics. Triage nurses start by taking down a new patient’s name, family name, village, age, sex, and weight. They can also record what the patient is complaining of, and any symptoms they exhibit. The patient and this form then move on to the Physician, which will exam the patient and diagnose them with a condition and possible a prescription. This prescription is written down on a second form, with details such as tablets per day, time of day to ingest, and any other additional instructions. Finally, the patient will take these forms to the Pharmacist, which dispenses medication.

The issue of managing patients and patient records is one that has constantly affected clinics and hospitals. Orant cannot afford nor requires the conventional record management systems being employed in hospitals today.

### Limitations and Constraints

The current system suffers from many of the issues that affect any paper based system. There is the loss of patient records during normal operation or traveling to and from the United States. The largest issue is that paper based records are difficult to analyze and data mine. Orant cannot refine its processes and planning because it relies mostly on patient and doctor feedback, rather than on collected data.

Moreover, the paper based records are sometimes difficult to pair with a returning patient, which can also compromise patient privacy.

## Purpose of New System

The MC-EMR app will be utilized by nurses, doctors, and pharmacists. Each station will have their own iPad that will be synchronized with the others to allow a patient to fluidly move across the clinic. Nurses will check in patients and collect patient’s personal information during registration, and then supplement this with vitals (heart rate, blood pressure, complaints, etc.) for each visit to the clinic. Depending on the severity of the patients’ conditions, they will be assigned a priority and put into a queue for doctors. Doctors can then select patients from this queue and put them through further examinations and then assign a condition to the symptoms that the patient is exhibiting. The doctor can also prescribe medication to the patient, which then gets filled by the pharmacist.

There will also be a local server in the clinic serving to assist in the synchronization of the iPads. This local server is also responsible for backing up patient information from the iPads in the event of an issue such as battery failure. It is expected that once a day, this local server will also be able to synchronize with a cloud server. The cloud server will provide both a more reliable backup solution, and also the ability for administrators and record keepers to analyze patient records in order to better plan their next visits to Malawi.

## High-Level Definition of User Requirements

The final system should accomplish the following tasks:

### Triage

* + - 1. The app will allow nurses to collect a new patient’s personal information.
      2. The app will allow nurses to search for existing patients.
      3. The app will allow nurses to register a patient’s fingerprint.
      4. The app will allow nurses to search for a patient by their fingerprint.
      5. The app will allow nurses to collect a patient’s vital information, complaints, and symptoms.
      6. Improve patient processing rate

### Physician

* + - 1. The app will allow doctors to review vitals.
      2. The app will allow doctors to record their examination notes and diagnosis.
      3. The app will allow doctors to prescribe medication.

### Pharmacy

* + - 1. The app will allow pharmacists to fill prescriptions.

### Record Keeper

* + - 1. Improve patient tracking by keeping a history of patient visits and outcomes.
      2. Streamline record keeping.
      3. Create a data repository to support future studies.
      4. Provide a cloud-based backup of records.
      5. Provide patient records administration.

### Security Requirements

* + - 1. At check in, the system will use a biometric system for automatic patient identification.
      2. Medical workers are required to login with credentials.
      3. Log account activity.
      4. Account permissions are role-based.
      5. API requires authentication.
      6. Patient records are encrypted.

### Privacy Requirements

* + - 1. Biometric authentication of patients.
      2. Compare patient record photo with returning patient.
      3. Password protected, only administrators can access cloud app.
      4. Each station has limited access to records.

## Alternative Solutions

This section will review the existing alternatives to the problem. It will also cover the alternatives to each section of the solution. There are currently several alternatives to our proposed system. However, these patient record management systems are intended for use in large hospitals, and not mobile clinics in rural areas. The next subsection will compare each solution against selection criteria.

### Description of Alternatives

Current medical record alternatives are very expensive, requiring large servers for the processing and storage of thousands or millions of patients, combined with a large amount of information about each patient.

Because of the large amount of information that these systems are meant to collect, Orant would not have a use for a large part of these applications, and so would be paying for something they aren’t going to use. Moreover, the multitude of features can be overwhelming to new users, which could discourage volunteers.

These systems are also not meant to be mobile, and require constant internet connections in order to properly synchronize data across mobile devices, or perform backups. We can see an example of this with CloudCare, which requires an internet connection in order to function.

Moreover, many of these systems do not allow for biometric authentication of patients. We looked at several alternatives for authentication, including retina and fingerprint scanners, and NFC bracelets.

For the server, we looked at different providers, including Heroku and Amazon web services.

For the mobile application, we were limited to a tablet, leaving us with either Android or iOS.

The local server will be a laptop capable of providing a local hotspot for the tablets to work on. This will be closely related to the choice of tablet. We were particularly interested in the MacBook Air, and the Lenovo ThinkPad.

### Selection Criteria

This section covers the selection criteria used to pick the best alternative solution. We used operation, technical criteria, schedule, and economic cost to make decisions.

#### Operation

* + - * 1. Performance

System should have an adequate response time.

* + - * 1. Information

Users should receive only relevant information.

* + - * 1. Scalability

Allow for multiple iPads to run simultaneously.

Allow for the addition of more iPads to a local server.

Allow for the addition of more clinics and more local servers.

* + - * 1. Interface

Easy to learn.

Simple forms.

Flexible input.

* + - * 1. Efficiency

System should increase the throughput of clinics.

#### Technical Criteria

* + - * 1. Availability and Maturity

The solutions used must be reliable enough to operate for extended periods of time.

Technology must be available for the client.

#### Economic

* + - * 1. Operation

Final solution should have a low maintenance cost.

* + - * 1. Infrastructure

Equipment used should be within an acceptable budget for the charity.

#### Schedule

* + - * 1. Training

Time needed to learn tools required for solution.

Time to implement solution.

Time needed to train users of the application.

#### Deadlines

* + - * 1. Consequences of not meeting deadlines.
        2. Required to ship before next visit to Malawi.

### Analysis of Alternatives

|  |  |  |  |
| --- | --- | --- | --- |
| **Cloud Server** | **Pros** | **Cons** | **Rating** |
| Amazon Web Services | Reliable Fast Easily Scalable | Expensive | 3 |
| Heroku | Economic Support for Ruby | More difficult to scale | 3.2 |
|  |  |  |  |
| **Biometry** | **Pros** | **Cons** | **Rating** |
| Tactivo | Commercially available Developer-friendly Cannot be forged | Expensive | 4 |
| Flomio | Inexpensive | Not in commercial production Can be lost | 2 |
|  |  |  |  |
| **Tablet** | **Pros** | **Cons** | **Rating** |
| iPad | Physicians already own them Could be more compatible with local server Long battery life | Expensive | 4 |
| Android | Less Expensive | Could have compatibility issues with server Many different versions | 3 |
|  |  |  |  |
| **Local Server** | **Pros** | **Cons** | **Rating** |
| MacBook Air | Should be more compatible with iPads Long battery life | Expensive | 3 |
| Lenovo ThinkPad | Economic Long battery life | Could be incompatible with tablets | 2.5 |

## Recommendations

The server chosen was Heroku, as it provides a reliable and simple setup for Ruby, upon which we will build the cloud server. Heroku is also provides much more affordable pricing options which are in line with the relatively small amount of traffic the servers will be handling.

For biometric authentication, the Tactivo fingerprint reader will be used. Tactivo is one of the few iPad-compatible fingerprint readers on the market, and appears to be the most developer-friendly, with an SDK and support.

iPads were chosen to run the mobile application, since the majority of the volunteer physicians already own one, allowing us to reduce the cost to the clinic. iPads should also be more compatible with the local server.

The local server that was chosen is a MacBook Air. This provides one of the longest battery lives, and should provide a simple connection for the iPads.

The local server will communicate with the cloud server through an AirTel 3G hotspot. This will be provided by the charity.

# Project Plan

In this section, we describe the project plan. This will include the project organization and the personnel organization. After this we will review the hardware and software requirements for the solution. Finally, there is the identification of the tasks, milestones, and deliverables.

## Project Organization

This section explains each person's role and their accompanying responsibilities.

### Project Personnel Organization

This subsection reviews the personnel roles throughout the project.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Deliverable 1** | **Deliverable 2** | **Deliverable 3** | **Deliverable 4** |
| Steven Berlanga | System Analyst | Architect | Developer | Minute Taker |
| Carlos Corvaia | Architect | Leader | Developer | Developer |
| Rigoberto Hernandez | Leader | Developer | Minute Taker | Architect |
| Michael Montaque | Developer | Minute Taker | Developer | Leader |
| Sebastian Zanlongo | Minute Taker | Architect | Leader | Developer |

### Hardware and Software Resources

For this project, we will be developing an iOS mobile application. This requires XCode running on OSX. Most of the team has their own MacBook, allowing them to work from home and to use third-party tools to assist them. However, there is a team member that doesn’t own one, and will be required to work in the university’s computer lab to work on the project. In addition, there are different versions of iOS and XCode, so we had to verify that all iPad’s run 6.0.1, and the same version of XCode.

## Identification of Tasks, Milestones, and Deliverables

Here, we will review the work breakdown of the project. Table one covers the deliverables that need to be written. Table two shows the milestones for each deliverable. Table three indicates which tasks must be met for each deliverable.

### Deliverables

|  |  |
| --- | --- |
| **Deliverable** | **Description** |
| 1 | Feasibility Study |
| 2 | Requirements |
| 3 | Design |
| 4 | Final Document |

### Milestones

|  |  |  |
| --- | --- | --- |
| **Milestone** | **Name** | **Deliverable** |
| 1 | Requirements Elicitation | 1 |
| 2 | Analysis of System Requirements | 1 |
| 3 | Feasibility Study | 1 |
| 4 | Setup of Server | 1 |
| 5 | Setup of Development Environment | 1 |
| 6 | Creation of Schemas | 1 |
| 7 | Mockup App | 1 |
| 8 | Completion of Triage | 2 |
| 9 | Completion of Doctor | 2 |
| 10 | Completion of Pharmacy | 2 |
| 11 | Submit beta to Orant | 2 |
| 12 | Basic Cloud Server | 2 |
| 13 | Basic Local Server | 2 |
| 14 | Creation of API | 2 |
| 15 | Integration of Photos | 3 |
| 16 | Integration of Biometrics | 3 |
| 17 | Completion of Cloud Server | 3 |
| 18 | Finalized App | 4 |
| 19 | Finalized Local Server | 4 |
| 20 | Finalized Cloud Server | 4 |
| 21 | Finalized API | 4 |
| 22 | Submit to Orant | 4 |

### Tasks

|  |  |
| --- | --- |
| **ID** | **Title** |
| US-103 | As an administrator I want the server to connect with the physical Device so that information can be persistent throughout the system |
| US-44 | As a triage nurse I want to login into the system so that I can work securely |
| US-37 | As a potential user I want to create my own user profile so I can be properly identified in the system |
| US-2 | As a triage nurse I want to manually register a new patient so that I can Check-In a patient. |
| US-70 | As a triage nurse I want to link family members together so that I can quickly bring up other patients |
| US-5 | As a physician I want to diagnose a patient to provide the patient care. |
| US-11 | As a pharmacist I to want finalize and check out the patient so that the staff knows that patient's treatment is complete. |
| US-36 | As a pharmacist I want to fulfill the patient's prescription so that I can confirm they were given medication |
| US-13 | As a pharmacist I want see the doctor’s prescription so that I know what drug to dispense. |
| US-21 | As an application administrator I want to verify when the local system backs up to the Cloud so that I can verify the data's status |
| US-15 | As a Triage nurse I want to prioritize the patient so that the critical patients get attention first |
| US-25 | As an application administrator I want easily startup, shutdown and reset the local server so that adequate operating & troubleshooting measures can be executed |
| US-43 | as a physician I want to manually identify a patient so that I can find their records |
| US-67 | As a Triage Nurse I want to be able to check in a patient so that I can take their vitals and collect their family history. |
| US-68 | As a Triage Nurse I want to be able to search for an existing patient to record their vitals for the current visit |
| US-73 | As a Triage nurse I want to quickly discharge a patient so that patients with major issues can quickly see the doctor |
| US-81 | As a triage / doctor / pharmacist, I want to check in and search for patients using their fingerprints. |
| US-82 | As a doctor, I want to assign patient's medication from a table. |
| US-91 | As a triage / doctor / pharmacist, I want to search for a patient. |
| US-92 | As a doctor I want to be able to checkout a patient if no medication needs to be prescribed. |
| US-93 | As a triage, I want to assign patients a priority in queue. |
| US-94 | As a pharmacist, I want to select patients from a queue. |
| US-95 | As a doctor, I want to select patients from a queue based on priority. |
| US-96 | As a triage, I want to assign patient vitals. |
| US-97 | As a doctor, I want to save a patient's diagnosis to their current visit in queue. |
| US-99 | As a developer, I want to be able to test production on my rails application on a staging server before being live. |
| US-104 | As a triage nurse I want to be able to quickly abort the patient I am working on so that I can address other patients |
| US-105 | As a triage nurse I want to be aware of all the patients that are currently in the system so that I can monitor their progress |
| US-107 | As a Physician I want to be able to quickly select multiple medication for a patient |
| US-109 | As an Application Administrator I want to be able to sync (upload information) between the Local Server and the Cloud app |
| US-110 | As an Application Administrator I want to be able to sync (download information) between the Local Server and the Cloud app |
| US-112 | As a triage nurse I want to be able to login so that I can access my dashboard |
| US-113 | As a Pharmacist I want to be able to login so that I can access my patient queue |
| US-114 | As a Doctor I want to be able to login so that I can access my patient queue |
| US-115 | As an app user I want to be able to see the total number of tablets/fl oz. available for any particular medication |
| US-116 | As a triage, I want to have a dashboard to manage my account. |
| US-117 | As a triage, I want to assign patients temperature and brief explanation (title) of a patient's visit. |
| US-120 | As a physician, I want to see relevant patient information in the queue. |

# Appendix

## C:\Users\Sebastian\Downloads\MC-EMR (2).pngAppendix A – Project Schedule

## Appendix B – Feasibility Matrix

### Operation

|  |  |  |  |
| --- | --- | --- | --- |
| **Criteria** | **Mobile** | **Fixed** | **Cloud** |
| Performance | 3 | 4 | 5 |
| Information | 5 | 3 | 3 |
| Scalability | 4 | 3 | 3 |
| Interface | 4 | 3 | 3 |
| Average | 4 | 3.25 | 3.5 |

### Technical

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Tactivo** | **Flomio** |
| Availability | 5 | 2 |
| Maturity | 4 | 1 |
| Practicality | 4 | 3 |
| Expertise | 1 | 1 |
| Average | 3.5 | 1.75 |

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Amazon** | **Heroku** |
| Availability | 5 | 5 |
| Maturity | 5 | 5 |
| Practicality | 3 | 4 |
| Expertise | 3 | 3 |
| Average | 4 | 4.25 |

|  |  |  |
| --- | --- | --- |
| **Criteria** | **iPad** | **Android** |
| Availability | 5 | 5 |
| Maturity | 5 | 5 |
| Practicality | 4 | 4 |
| Expertise | 4 | 3 |
| Average | 4.5 | 4.25 |

|  |  |  |
| --- | --- | --- |
| **Criteria** | **MacBook Air** | **Lenovo ThinkPad** |
| Availability | 5 | 5 |
| Maturity | 5 | 5 |
| Practicality | 4 | 4 |
| Expertise | 4 | 3 |
| Average | 4.5 | 4.25 |

### Economic

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Criteria** | **iPad** | **Android** | **Heroku** | **Amazon** |
| Infrastructure | 5 | 2 | 4 | 3 |
| Operation | 5 | 5 | 4 | 3 |
| Average | 5 | 3.5 | 4 | 3 |

### Schedule

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Tactivo** | **Flomio** |
| Training | 4 | 3 |
| Risk | 4 | 2 |
| Deadline | 4 | 5 |
| Average | 4 | 3.333333333 |

## Appendix C – Cost Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Quantity** | **Cost** | **Total** |
| MacBook Air | 1 | 999 | 999 |
| iPad 2 | 3 | N/A | 0 |
| Heroku | 1 | 150 | 150 |
| Total |  |  | 1149 |

## Appendix D – Diary of Meetings

|  |  |  |
| --- | --- | --- |
| Meeting | 1 | 1/29/2013 |
| Attendance | Everyone |  |
| Review | Accepted Stories and Tasks |  |
|  | Unacceptable Stories |  |
|  | Time limit |  |
|  | Limited communication |  |
|  | Synchronization |  |
|  | Learning curve |  |
|  | Client-Server Implementation |  |
|  | Flojack API |  |
|  | Architecture Review |  |
|  | Acceptability Tests |  |
|  | Automated Tests |  |
|  | Story Map Refactoring |  |
| Next | Allow synchronization |  |
|  | Client and Server |  |
|  | iPad GUI |  |
|  | MVP of Triage |  |
|  | Login/Logout |  |
|  | Patient Creation |  |

|  |  |  |
| --- | --- | --- |
| Meeting | 2 | 2/5/2013 |
| Attendance | Everyone |  |
| Review | Accepted Stories and Tasks |  |
|  | Unacceptable Stories |  |
|  |  | Detailed Vitals |
|  |  | Sending patient data |
|  | Problems |  |
|  |  | Time |
|  |  | Synchronization |
|  | Solution |  |
|  |  | Git |
|  |  | Standard Schema |
|  | Architecture Review |  |
|  | iPad Client Architecture |  |
|  | OSC Architecture |  |
|  | WebApp Architecture |  |
|  | Story map Refactoring |  |
| Next | Diagnosis |  |
|  |  | Assign diagnosis |
|  | Sync iPad and Server |  |
|  | iPad GUI |  |
|  | MVP of Diagnosis |  |

|  |  |  |
| --- | --- | --- |
| Meeting | 3 | 2/12/2013 |
| Attendance | Everyone |  |
| Review | Storied attempted |  |
|  |  | Stories Removed |
|  |  | Stories Completed |
|  |  | In Progress |
|  | Tasks |  |
|  |  | Completed |
|  |  | In progress |
|  |  | Not initiated |
|  |  | Deleted |
|  |  | Removed |
|  | Architecture |  |
|  |  | Web Services |
|  |  | Client |
|  |  | Server |
|  | Internal Architecture |  |
|  |  | Presentation Layer |
|  |  | Objects |
|  |  | Base Object |
|  |  | Database |
|  | Class Diagram |  |
|  | Acceptability Tests |  |
|  | User Stories |  |
|  |  | I want to see all patient in system |
|  |  | Add medication to webApp |
|  |  | Update medication |

|  |  |  |  |
| --- | --- | --- | --- |
| Meeting | 4 | 2/26/ |  |
| Attendance | Everyone |  |  |
| Review | Stories Burn down |  |  |
|  | Tasks Run down |  |  |
|  | System Architecture |  |  |
|  |  | Client |  |
|  |  |  | iPad |
|  |  |  | Bonjour |
|  |  |  | CoreData |
|  |  | Web |  |
|  |  |  | Bootstrap CSS |
|  |  |  | jSQuery |
|  |  | API |  |
|  |  |  | Restful |
|  |  |  | Heroku |
|  |  | Server |  |
|  |  |  | MacBook |
|  |  |  | CoreData |
|  |  |  | OSX |
|  |  |  | Bonjour TCP |
|  |  |  | PostgreSQL |
|  | Acceptability Tests |  |  |
|  |  | Add visitation |  |
|  |  | Easy access to forms |  |
|  |  | See visitation records |  |
|  | Stories |  |  |
|  |  | Add medication through web |  |
|  |  | Update medication as pharmacist |  |

# References