Ubiquitous and Mobile Computing
CS 403x: CommuniSense

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Introduction

- “Crowdsourcing Road Hazards in Nairobi”
  - Published in 2015
- Implemented a survey to gauge quality of roads and effect it had on the people
- Intended to make a crowdsourced app for reporting road hazards
  - Speed bumps
  - Potholes
Motivation

- Nairobi is a developing city
  - Population of 3.1 million in 2009

- Rapid development has taken a toll on the road conditions
  - Traffic congestion estimated to cost the economy 413 million USD

- City does not have the resources to monitor road conditions

- Current method of handling hazards to the city takes 2-3 months
Vision

- To create an app that will use crowdsourcing to monitor road hazards
  - Prototype for documenting Nairobi’s road conditions
- Users would be able to report a hazard on the go by taking picture and entering relevant information
- Speeds up the reporting process for citizens of the city
- Goal to create a system that is easily expandable to other locations
Related Works – Data Collection

- SMS is most common data collection in developing countries
  - RapidSMS, FrontlineSMS, Ushahidi
  - However, expensive and unreliable for data collection
- Increasing popularity of smart phones
  - OpenDataKit, Nokia Data Gathering
There exist other systems that allow citizens to report civic issues

- SeeClick-Fix, FixMyStreet, Citizens Connect
- None exist for Kenya

ma3route

- Submit traffic conditions via Twitter
- Analyzed 300 recent tweets from the service
  - 7 contained information on road hazards
  - 3 of those tweets contained images
Methodology – Initial Survey

- Goal was to understand the citizens’ opinion on the road quality in Nairobi
- Also used to gauge interest in reporting hazards
- Two survey methods used
  - Online survey with Google Forms
  - SMS-based survey
Methodology – Survey Results

- Demographics
  - Web survey
    - 62% male, 37% female
    - 76% owned a smartphone
  - SMS survey
    - 58% male, 42% female
    - 50% owned a smartphone
Methodology – Survey Results

- Status quo on road quality
  - Web survey
    - 45% indicated that road conditions in Nairobi were poor
    - 79% agreed that potholes are a major road nuisance
  - SMS survey
    - 30% indicated that road conditions in Nairobi were poor
    - 67% agreed that potholes are a major road nuisance
Methodology – Survey Results

- Overall impact of road hazards
  - Web survey
    - 65% reported that road hazards cause a major impact on their personal travel comfort
  - SMS survey
    - 46% reported that road hazards cause a major impact on their personal travel comfort
Methodology – Survey Results

- Reporting road hazards
  - Web survey
    - 96% of respondents did not know the process of reporting road hazards to Nairobi’s city council
    - 70% chose mobile app as preferred choice for reporting hazards
  - SMS survey
    - 77% of respondents did not know the process of reporting road hazards to Nairobi’s city council
    - 4% chose mobile app as preferred choice for reporting hazards
Methodology – Implementation

- Hazard report submission
  - Type of road hazard
  - Description
  - Picture
  - Corresponding location

- Two upload choices
  - Instantaneous
  - Saved locally until later
Methodology – Implementation

Create New Report

- Choose type of Hazard
- Describe Hazard
- Take a Picture
- Location of Hazard

Submit

Pothole Description

Size of Pothole
- Small
- Medium
- Large

Type of road
- Tarmac
- Muram
- Earth

Rate pothole

Comments (Optional)
Enter your comment

Submit

Location of Road Hazard

- Is the position of the Pothole correct on the map? Click on the right spot
Methodology – Implementation

- Mapping Hazards (MapIt)
  - Quick way to report road hazard
  - Chose a hazard type, then move the location marker to indicate where the hazard can be found
  - Intended to give users flexibility for reporting
Methodology – Implementation

![Map of Nairobi with points marked]

**Hazard Type**
- Pothole
- Speed Bumps

Save
Results – *CommuniSense* Field Test

- Two-week pilot study with limited release of app
- 41 users accepted the experiment, and 30 installed
  - Out of 150 users that were invited
- 101 full reports submitted
- 153 MapIt submissions
- Offered reward for top participants

![Chart (a): Minor, Moderate, Major, Severe](image)
![Chart (b): Faded, No Response, Yes](image)
Results – Image Verification

- Crowdsourcing often leads to abuse or spam
- Trusted GPS location for the hazards
- Used Amazon’s Mechanical Turk to verify submitted images
  - Type of hazard
  - Severity of hazard
- 39 MTurk workers
- 92% of images verified with same label for both MTurk worker and user
  - Exceptions were ones that had both or were difficult to see
Discussion

• Technical Challenges
  • Limited release of app on Google Play Store made it a challenge to download for some of the users

• Citizen Engagement
  • CommuniSense can help improve the city council in terms of improving road conditions
  • Save city council time documenting reported road hazards
Conclusion

- Lack of a plan to incorporate with city council
  - Mention that CommuniSense can help, but don’t mention how
- Analyzed entries for spam, but the test was private so less likely to have users abuse the system
- Effective crowdsourcing tool that makes it easy to report
- Could be easily implemented to help users avoid road hazards
References

- OpenDataKit, [https://opendatakit.org/](https://opendatakit.org/)
- Amazon Mechanical Turk, [https://www.mturk.com/mturk/welcome](https://www.mturk.com/mturk/welcome)
Questions?