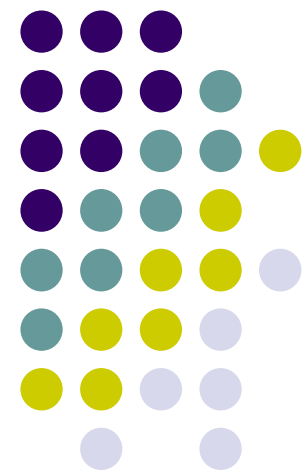


Ubiquitous and Mobile Computing

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



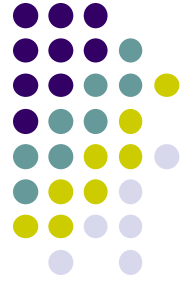
- To create an app that will use crowdsourcing to monitor road hazards
 - Prototype for documenting Nairobi's road conditions
- Users would be able to report a hazard on the go by taking picture and entering relevant information
- Speeds up the reporting process for citizens of the city
- Goal to create 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





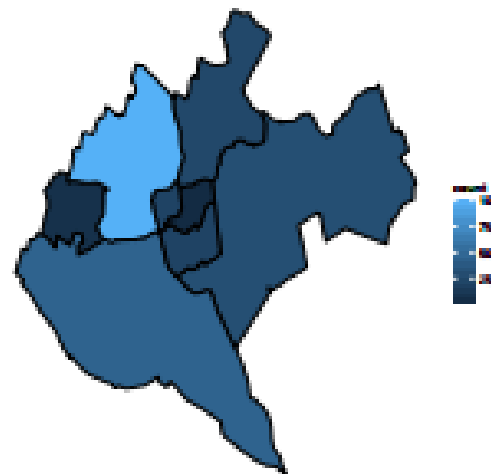
Related Works – Existing Systems

- 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

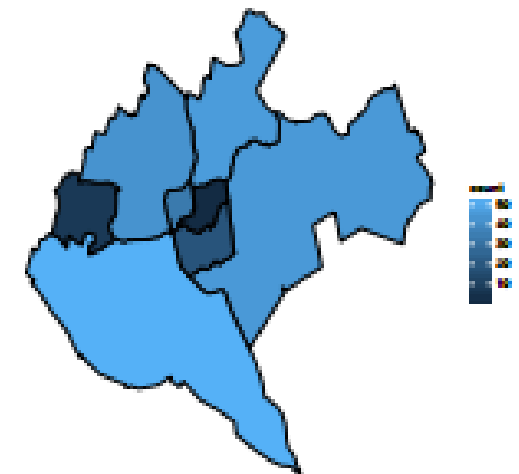
Methodology – Initial Survey



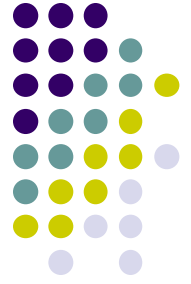
- Goal was to understand the citizens' opinion on the road quality in Nairobi
- Also used to gauge interest in reporting hazards
- Two survey methods used
 - Online survey with Google Forms
 - SMS-based survey



(a)

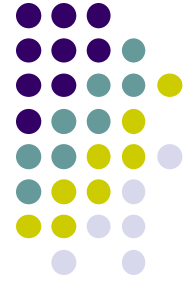


(b)



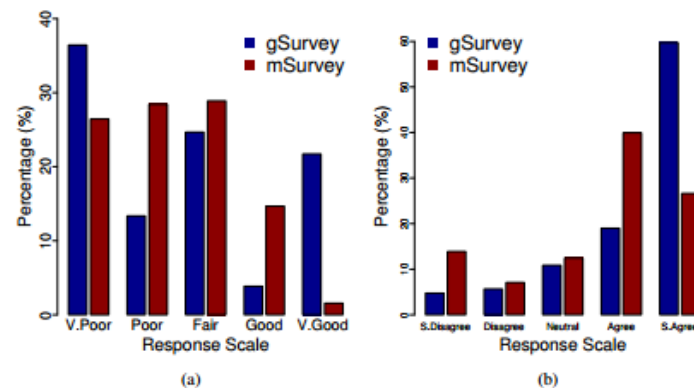
Methodology – Survey Results

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



Methodology – Survey Results

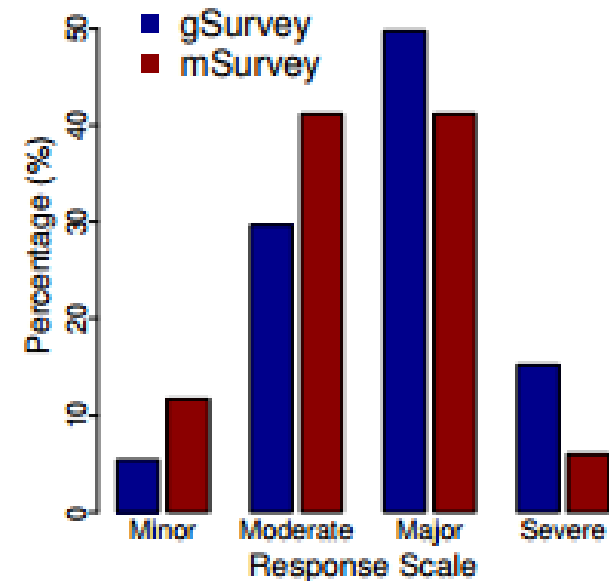
- Status quo on road quality
 - Web survey
 - 45% indicated that road conditions in Nairobi were poor
 - 79% agreed that potholes are a major road nuisance
 - SMS survey
 - 30% indicated that road conditions in Nairobi were poor
 - 67% agreed that potholes are a major road nuisance



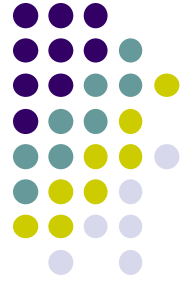


Methodology – Survey Results

- 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



New Report LOG OUT

Create New Report

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

Submit

New Report LOG OUT

Pothole Description

Size of Pothole

Small Medium Large

Type of road

Tarmac Murram Earth

Rate pothole

Comments (Optional)

Enter your comment

Submit

Location of Road Hazard

Done

Magadi Rd, National Park

Kingdom
Life
hur

Is the position of the Pothole correct on the map? Click on the right spot

Google

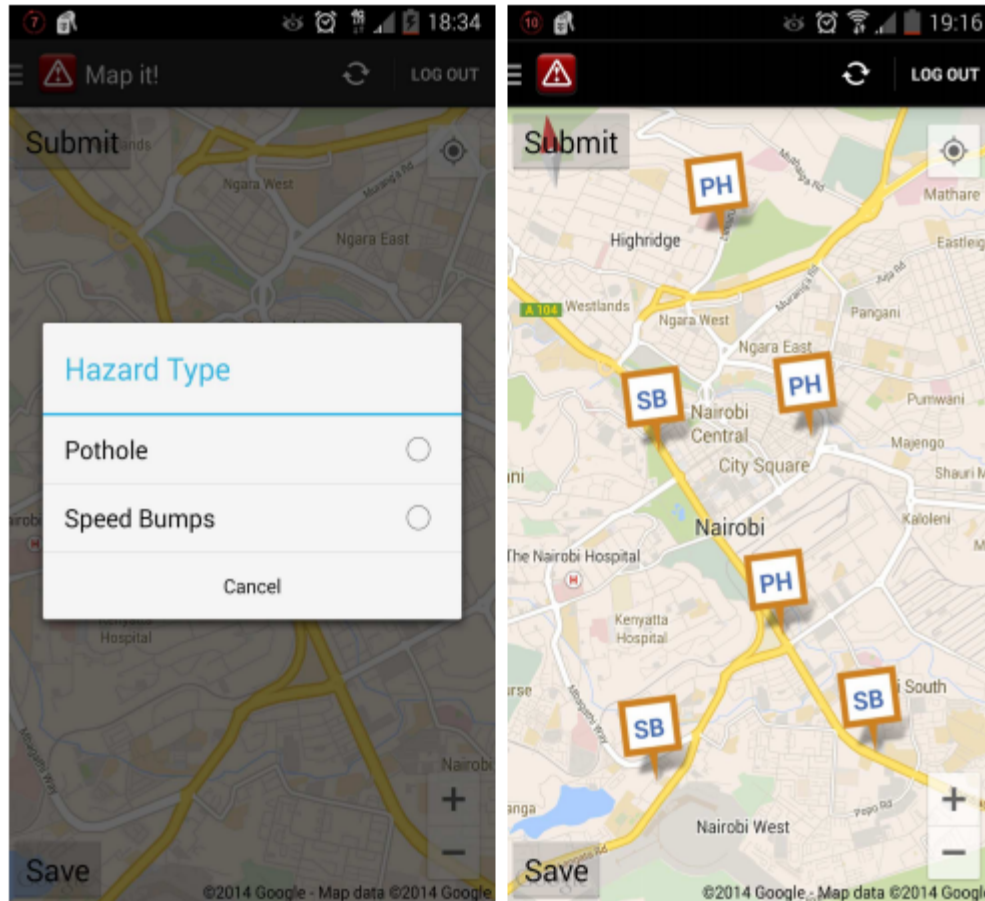
©2014 Google - Map data ©2014 Google

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

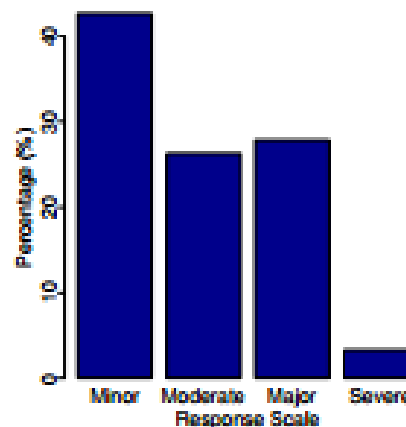
Methodology – Implementation



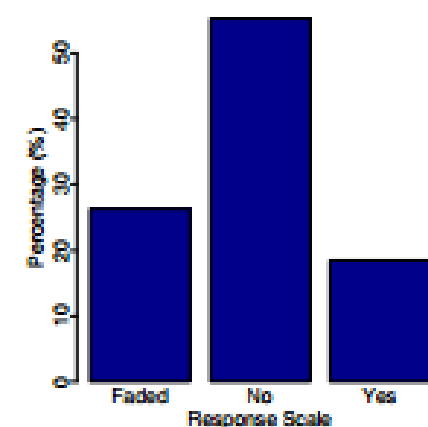
Results – *CommuniSense* Field Test



- 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



(a)

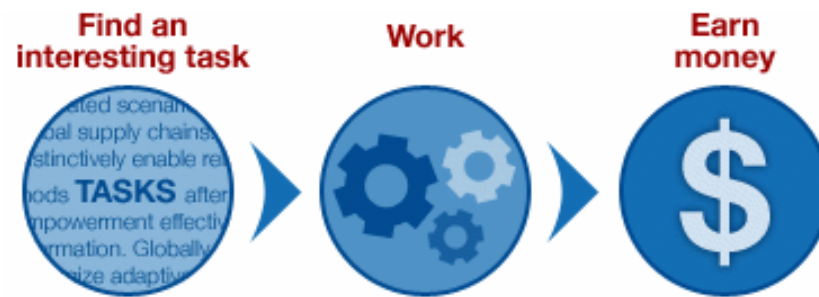


(b)



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

- *CommuniSense: Crowdsourcing Road Hazards in Nairobi*, <http://arxiv.org/pdf/1506.07327.pdf>
- *OpenDataKit*, <https://opendatakit.org/>
- *Nokia Data Gathering*,
<http://www.wp7connect.com/2012/07/21/nokia-publishes-nokia-data-gathering-app-to-the-marketplace/>
- *Amazon Mechanical Turk*,
<https://www.mturk.com/mturk/welcome>

Questions?

