T-TRIID PROJECT FINAL REPORT (FINAL)

Monitoring Devices and Information Transmission to Commuters: Promoting Safety in Urban Transport

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Document Control Sheet

Issue	Status	Author(s)	Reviewed By	IMC Approved By	Issue Date
1	Draft	Erin Kelley, Gregory Lane, Eddy Nguli, Boris Maguire and David Schönholzer	Holger Dalkmann		22/03/2019
2	Final	Erin Kelley, Gregory Lane, Eddy Nguli, Boris Maguire and David Schönholzer	Charlotte Maugham	Holger Dalkmann	17/04/2019
3	Final	Erin Kelley, Gregory Lane, Eddy Nguli, Boris Maguire and David Schönholzer	Holger Dalkmann	Holger Dalkman	03/06/2019

A. Executive Summary

African cities have experienced unprecedented growth in recent years. As the proportion of urban dwellers continues to grow, challenges surrounding infrastructure, and service provision more broadly have started to emerge. In this research we focus on a problem where the challenges of urban growth are particularly salient: the efficiency and safety of public transportation systems in Sub-Saharan Africa. Accidents in this industry are frequent and deadly. Bus drivers face incentives to drive recklessly in order to increase their take-home pay, which endangers passengers on board, as well as other vehicles on the road. These dangerous driving conditions disproportionately affect the poor, who rely heavily on public transportation to get to work. The goal of our work is to develop a system for tracking unsafe driving, and convey this information to passengers, who are the primarily stakeholders in the industry.

To this end, The University of California, Berkeley and Echo Mobile developed our own GPS tracking device that we designed specifically for the Kenyan minibus industry, which we fit to 60 medium-range minibuses traveling from Nairobi to Kisumu. This required forming close connections with companies operating on the route. We then monitored the safety performance of the vehicles each month and awarded a Top Safety Performer badge to the bus company with the best safety performance that particular month. We then informed hundreds of passengers about these safety ratings, and subsidized dozens of passengers to take safer rides. We did so by intercepting passengers as they entered the street and providing them with pamphlets about safe driving in general, or pamphlets that displaced the safety certificates we generated. Our research design allows us to determine a) the extent to which passengers value safety, b) whether their decisions about which bus to take are affected by information about safe driving.

Overall, we find that passengers react strongly to a small (10%) subsidy for the safest bus company. However, while money can move travelers towards safer choices, we find that the effect of information is much more complex: instead of taking the information at face value, travelers may reinterpret it in terms of persuasion attempts of competing public transport companies, especially when they are offered a subsidy for the company advertised as safe.

These finding sheds light on the importance of creating a trustworthy information environment for public information campaigns to succeed. We aim to address this in future work, by developing a mobile app that provides information about buses that have our GPS trackers (which we would develop in partnership with various partners). In general, individuals have more faith in apps than in solicitors on the street and the app will invite passengers to contribute information about their own experiences on particular buses, which will add legitimacy to the product.

B. Introduction

Road traffic accidents have dramatically risen among causes of death in developing countries around the world, rivaling causes such as malaria and civil conflict. Many of these accidents involve public transport buses, posing a growing challenge to policymakers in low- and middle-income countries. Various interventions by governments have so far failed to stave off a growing public health crisis taking place on their roads, taking thousands of lives of travelers on dangerous commutes every year.

In light of the urgent need for increasing public transport safety, our team of entrepreneurs, engineers, and social science researchers has engaged on a large-scale research initiative exploring new interventions to open up new avenues for safer public transport. In the course of this initiative, we have fit several hundred public transport buses in Kenya with tracking devices that are capable of collecting and conveying safety information to stakeholders in the context of several distinct projects. The devices collect information on the vehicles' forward, backward, lateral and vertical acceleration and feeds these measures into an algorithm that computes instances of speeding, over-acceleration, sharp-braking and sharp-turning. Using the information from these tracking devices, we then used state-of-the-art experimental methods to carefully evaluate the impact of various interventions designed to nudge stakeholders towards more safety.

Thanks to the generous support of the T-TRIID competition, we were able to study the role of one such stakeholder in the public transport industry in great detail: consumers of public transport services. In a free market the customer is king, and if he or she demands for service providers to change, industries can be transformed. However, the ability of consumers to demand services they care about critically depends on their ability to learn about the characteristics of these services. In the case of public transport, only well-informed travelers are able to steer public transport companies towards safer practices.

To investigate the opportunities that arise from informing travelers about the safety of their public transport options, we focused on one of the most dangerous bus routes in Kenya, connecting the capital of Nairobi with the regional hub in the West, Kisumu. We fit tracking devices to a total of 55 buses belonging to five companies and assessed their safety behavior (i.e. mainly their speeding behavior in the countryside, where most accidents take place). We then ran a series of innovative randomized experiments with travelers choosing between these five companies. We randomly exposed passengers to (a) information about the importance of safety, (b) information about the company performing best on our safety measures, and (c) a subsidy to take the safest company. As we discuss in more detail below, these experimental treatment conditions inform us about (a) how the salience of safety affects choice, (b) how passengers update their beliefs about the safety of public transport companies, and (c) their willingness to switch to another company.

Overall, this project offers the first rigorous assessment of the role of information and subsidies in public transport safety choice. Building on these findings, a number of new avenues open up for policymakers and private initiatives to approach public transport safety. First, even small price subsidies turn out to be very effective in changing traveler choices. On a large scale, this type of intervention is likely to shift behavior on the supply side: it provides strong incentives for competitors to catch up to the safety leader. Second, large-scale information campaigns need to be predicated on a trustworthy information environment. Combating misinformation means to elevate the provision of information above the playing field of competing interests.

The rest of the report is structured as follows. Section C provides some background on the problems in transportation industries, our solution concept, and our team structure. Section D details the project design, including the research concept, the technology we used, and how we implemented the research). Section E provides an overview of our preliminary results, while Section F concludes and highlights our next steps.

C. Background

a. Transport Problem

According to the WHO's World Report on Road Traffic Injury Prevention an estimated "1.2 million people are killed in road accidents each year and as many as 50 million are injured worldwide". Estimates suggest these numbers will increase by about 65% over the next 20 years unless significant investments are made in road safety. Unfortunately, only 28 countries, representing 449 million people (7% of the world's population), have implemented laws that address all five risk factors (speed, drink– driving, helmets, seat-belts and child restraints). Moreover, less than 35% of low- and middle-income countries have policies in place to protect road users, despite having the highest fatality rates in the world. In Kenya, for example, where this project takes place, approximately 3000 to 13000 people die annually as a result of reckless driving (WHO, 2013).

A significant share of road traffic accidents in developing countries involve semi-formal public transportation providers. Drivers often drive recklessly, endangering their passengers, other vehicles, and pedestrians. According to one study in Kenya, minibuses account for 11% of registered vehicles but 70.2% of casualties (Macharia et al., 2009). As a point of comparison, buses in the US account for 1% of registered vehicles but only 0.4% of casualties (BTS, 2016). This is not altogether surprising in light of the way the industry is organized, and the incentives drivers face on the road. The industry is dominated by thousands of small-scale entrepreneurs who own a few minibuses ("matatus") that run on designated routes. The owner specifies an amount of revenue that their driver must deliver by the end of the day, net of fuel expenses. According to the contract, the driver has to deliver the fixed rent ("target") amount and can keep anything they earn above it. As such, the driver is encouraged to earn as much as possible so they have more revenue to take home at the end of day. This creates a strong incentive to pick up as many passengers as possible - even if this means taking dangerous shortcuts and swerving on and off the road to pick people up.

In response to these trends, private institutions have directed additional funding, knowledge and technical assistance towards building new systems that reduce the number of traffic injuries and deaths worldwide. Our research team's ultimate aim is to contribute to these initiatives in the ways detailed below.

b. Solution Concept

i. Origins

This research investigates the hypothesis that passengers have the power to mitigate reckless driving in the informal transit industry. This idea came from observing how minibus owners and drivers operate, and the incentives they face, over multiple years. The researchers from UC Berkeley travelled to Kenya 5 years ago and were first struck by the unique structure of the minibus industry, and how unsafe it was. They spent the next few years working with engineers from Echo Mobile in Nairobi to develop a monitoring technology that could capture information about the efficiency and safety of the vehicle. Their first research project provided this information to minibus owners to see whether it could affect drivers' behavior and induce more efficient and safer driving. We found that minibus owners used the information to reduce behaviors that were not in the firm's best interest (e.g. under-reporting of revenue, low effort and reckless driving). However, we did not find that owners encouraged their drivers to behave more safely on the road. As a result, we began thinking about other stakeholders in the industry that might value information about safe driving more. That is when we decided to investigate the impact of providing information to passengers about safe driving. Passengers, after all, are the most negatively affected by unsafe driving and have the potential to reward safe driving through the choices they make.

ii. Objectives

Commuters have the potential to play an incredibly important role in making public transportation providers operate more safely on the roads. In theory, if commuters know which buses are safest, they can reward safer bus companies by opting for their services. This will exert pressure on competing public transportation providers to reform. This can move the industry as a whole towards safer practices and prevent accidents. Globally, we have seen that commuters have the power to affect dynamics within the transportation industry. Companies like Uber have risen to prominence because of passenger demand – passengers value the convenience and service provision by Uber and reward the company by taking their vehicles instead of standard taxis. These changes in the dynamics of the transportation industry rely on the fact that passengers have information about the various alternatives they can take (in the case of Uber, the quality of the driver is ranked by other passengers for examples). If commuters are not informed, or misinformed, about the vehicles they take, the power of commuters to affect change and improve public transport services will be limited. Unfortunately, most commuters in developing countries have no way of systematically learning about how safe their public transportation choices are, and in many cases, they may underestimate the power of taking their business elsewhere, or find it too burdensome to change their habits.

As researchers we want to test the hypothesis that passengers can improve safety standards in the public transportation industry through their choices. Specifically, our research objectives include:

1. Understanding how well-informed passengers are about safety in the Kenyan market.
2. Determining whether passengers have preferences for safe driving, and what their willingness to pay for safe driving is.
3. Assessing whether companies internalize these passenger preferences.

To this end, we have fit minibuses in Kenya with GPS trackers and provide safe driving information about these minibuses to as many passengers as possible. This provides commuters with the opportunity to make conscious decisions about their own safety, and change which buses they ultimately take. Image 1 provides a visual of the tracker we used and the types of minibuses ("matatus") we fit them in.

Image 1. Tracker and Minibus ("Matatus")

c. Team

The successful implementation of this research project required a combination of different skill-sets, including engineering capabilities, experts in research design, and experts in research implementation. To this end the collaboration between Echo Mobile and researchers from the University of California, Berkeley (UCB) was ideal. The lead company, Echo Mobile, is a Nairobi-based firm that builds and deploys mobile-first communication, interaction, research and management information tools. The team is comprised of dedicated engineers, user experience designers, M&E experts and project managers. Through their unique combination of experience designing products for emerging markets, training organizations in the latest technologies, and collaborating on content creation, Echo Mobile empowers organizations to make better, quicker decisions based on information instead of intuition.

For the purposes of this project, Echo worked alongside a team of PhD candidates in the Department of Agricultural and Resource Economics, and the Department of Economics from the University of California, Berkeley. Erin Kelley, Gregory Lane and David Schönholzer have extensive experience working on research projects in low income countries. Together they have projects in Bangladesh, Kenya, Chad and India.

D. Project Design

a. Research concept

To achieve our research objectives, we needed to know something about which buses were safest, what buses passengers were currently choosing, and whether we could influence this decision through information about safe driving or monetary incentives to choose the safest vehicle. A number of necessary steps were required to achieve these goals.

- First, we needed to fit minibus owners with GPS trackers so we could say something about which company operating on the Nairobi-Kisumu route was safest relative to others. Note we subsequently asked passengers to rate their overall experience on their selected bus so we could try and correlate their experience to the safety information we were gathering through the device.
- Second, we needed to provide information to passengers about safety. We were particularly interested in knowing whether making safety salient was sufficient, or whether we needed to highlight which particular company was the top safety performer on a particular route. We did so via the provision of pamphlets, where we varied the information contained on each pamphlet.
- Third, we needed to provide monetary incentives to passengers to see if we could induce them to switch towards the safer bus. Here we were also curious to measure whether passengers' willingness to accept a monetary incentive differed based on whether they had information about which bus was safest.
- Finally, we had to conduct surveys to determine passenger preferences. These surveys allow us to say something about the impact of the safety information we provided through the pamphlets, and the monetary incentives.

We provide more detail on each of these steps below.

b. Technologies

Over the past two years, Echo Mobile and UCB's research found that while a range of vehicle monitoring systems exist, they are not typically used in the semi-formal public transport sector in emerging markets. Where sensor devices are used, it is primarily to prevent theft, not monitor safe driving.

Echo Mobile and the UCB research team have since developed a technology suite that is designed explicitly for semi-formal public transport and substantially cheaper than existing solutions. The system uses a tracking device with GPS, accelerometer and GPRS, which records location, speed, and 3D-acceleration installed in a vehicle.

This information is sent wirelessly to Echo Sense, where it is processed and analyzed on Echo's open source sensor platform. From the platform, data is pushed to an Android application called SmartMatatu, built originally for matatu owners to track and assess the driving behavior of a single bus they own. It is also pushed to a large MySQL database for analysis by the UCB research team. This application was developed farther by Echo's Lead Project Engineer to enable long-range bus company managers to monitor multiple buses under their control at once.

c. Implementation

Next, we describe how we implemented the proposed research design in chronological order:

- **Recruitment -** In Kenya, matatus are operated under a registered company or a Savings and Credit Co-operative (SACCO). Each SACCO is permitted to run buses along predetermined routes, either within or outside of Nairobi. To recruit minibuses to our sample, we needed to visit these SACCOs, informing them about the research study and requesting access to a number of their matatus to fit with the tracking devices. This recruitment was conducted by the Echo Deployment Lead and two Field Managers. We restricted ourselves to companies operating out of Mfangano Lane in Nairobi that were managing buses headed to Kisumu. We were able to recruit 5 out of the 6 SACCOS that operated on Mfangano Lane. We spent approximately 1 month visiting various members of the SACCO's leadership to brief them on the project and bring them on board. It generally took a few meetings to make sure the leadership understood the parameters of the research and signed off. However, on the whole, they were very receptive and appreciated that we had been working in the industry for over 4 years. The one company that refused to participate stated that they already had trackers in their minibuses.

- **Installation -** For SACCOs that agreed to have a device fitted into one of their matatus, the Field Managers organized a meeting between the matatu driver and Echo's electrician at designated areas outside of the Central Business District. The electrician fit a tracking device under the dashboard of the matatu, and the Field Manager informed the Echo Deployment Lead who then uploaded the device ID onto Echo Sense. They would then verify that the device was sending data to the mySQL database.
    - Echo Mobile has managed to successfully install a total of 55 matatus where the target of installing 15 matatus per SACCO has been achieved on 2 of the four SACCOs. Based on the interest we have been able to generate so far, we are confident that we can achieve the 65-bus target we committed to in our original proposal by the middle of April. Additional fittings are continuously being scheduled with the remaining SACCOs. These installations are time-intensive as they require commitments from the managers to show up on time; and for the engineer and enumerators to be on site for the fittings and facilitate a smooth working process. Over the past few months, we have developed a very strong set of procedures for accomplishing this in the most effective way possible. We have faced some challenges ensuring that matatu managers show up on time for the installations, but we have worked with the managers closely to minimize these instances

- **Safety scoring -** Data from all the participating matatus is collected, stored and analyzed. The information is processed to generate various indicators of safe driving based on individual threshold values for speeding, over-acceleration, sharp-braking and sharp-turning. Finally, a relative score is assigned to each SACCO.

- **Safety certificates** - We award the title of "Top Safety Performer" to the company whose buses perform the safest overall relative to the other companies on the Kisumu route. The safety scoring is generated monthly in order to bring out different top performers monthly.

- **Pamphlets** - We design pamphlets with information about safety. These pamphlets are provided to passengers as they walk towards the bus terminal. There are two different pamphlets that we use. The first just makes information about safety salient, and contains the list of the all the SACCOs that travel on the Nairobi - Kisumu route. The second pamphlet highlights which of the companies listed is the top safety performer.
    - We piloted a number of different pamphlets by asking a few passengers what their eyes were drawn to on the pamphlet (to make sure safety was highlighted sufficiently well) and whether they found the pamphlet visually appealing. We found that the pamphlets visible in Image 2 were the most effective.

- **Baseline** - Enumerators intercept passengers on the busy street and collect their information through a survey that asks for their basic information (see below for more detail). The enumerators then inform the passengers about the project, hand over one of the pamphlets and explain its content. Finally, they explain that the passenger will be reimbursed for their time and choice of matatu when they show their bus ticket to another enumerator near the boarding point.
    - We have successfully completed 2327 passenger surveys. While this is slightly lower than we anticipated in our project proposal (4000), we are confident that we will be able to conduct rigorous analyses with the sample that we have. This is because the power calculation that we conducted to obtain our sample size assumed a minimum detectable effect that was much smaller than the one we actually found. Our strategy for intercepting passengers is streamlined, and our interception rates stand at about 30% - which is high relative to other studies (or phone surveys for that matter). The main reason people do not want to take the survey is because they are skeptical of the research's motivations (there are many scams in Kenya), or they do not want to dedicate the time to completing the survey. This is to be expected and we have made sure to develop scripts that re-assure passengers of the researcher's intentions and the limited time it will take. However, as with anything, not everyone is willing to participate but we are pleased with our response rates.
    - Please note in the baseline survey we collected information about age, education, frequency of travel, preferences for different vehicle attributes (e.g. safety, speed, comfort and style), and which SACCO they thought was safest, most comfortable and fastest.

- **Endline** - The passenger shows their ticket to another enumerator located close to where they will board the buses. The enumerator conducts a small survey, and generates a code that the passenger uses to redeem their incentive for participating in the study.

- We have completed 2227 endline surveys as well - as we always make sure we intercept the passenger we have baselined to record their choice of matatu.

- **Passenger Reimbursement -** Passengers, through an SMS code, trigger a one question survey that once completed, ensures they get an Mpesa (mobile money) reimbursement on their mobile phones for participating in the study.
    - So far, the research has managed to reimburse 2165 passengers that claimed their payout of KES 50 ($ 0.5). This totals 2300 pounds.

- **Passenger Experience Surveys** - We introduced a passenger experience survey that allows us to capture human-validated safety performance reports for individual vehicles in real time. Passengers are able to submit any instance of unsafe driving they detect during the ride. They can also rank the overall safety of their journey at the end of the trip. In an effort to ensure we get high response rates, we follow up with passengers again the following day of their trip. We invite them to submit their feedback about the trip they took the previous day via SMS. This ensures that we capture the feedback of passengers who may have forgotten to complete the initial experience survey. A small incentive of KES 50 ($ 0.5) is offered to the passengers after completion to encourage them to submit their reports. This data will be matched with the tracker data to attempt to correlate the tracker reports with passengers' subjective experiences.
    - Since we introduced the passenger experience survey, we have managed to get feedback from 300 passengers.

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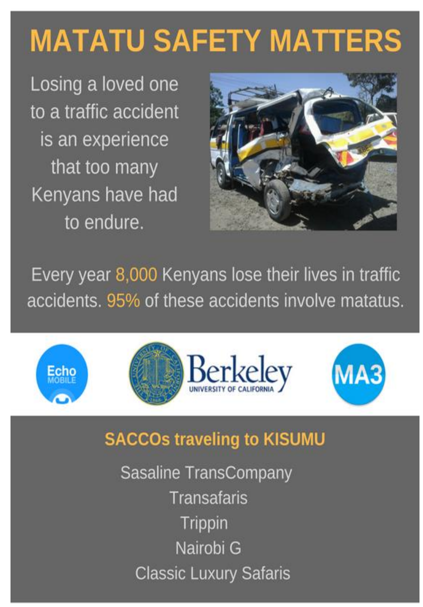


KEY: #####

Image 2. Sample pamphlets

d. Assumptions

Our research seeks to test the hypothesis that passengers care about safety. We implicitly assume this is the case, but our research intends to demonstrate it rigorously - and seeks to actually estimate the monetary value passengers place on safety.

e. Limitations

We have faced a few minor challenges in the research process (intercepting enough passengers, ensuring matatu managers show up on time for the fittings). They have been addressed as effectively as possible.

1. **Matatu Recruitment**: Echo Mobile and the UCB team have been making efforts to build relationships with SACCO managers to ensure device installations take place on time. However, the managers can be hard to pin down when the actual time comes. As a result, we created a monetary incentive scheme for the managers, which encouraged them to provide their vehicles in a timely fashion.
2. **Passenger interceptions**: We have faced some challenges intercepting passengers for surveys. Some commuters say they do not have the time, while others are skeptical of why we want to conduct a survey in the first place (the concept of research surveys is not yet well established in Kenya). Nevertheless, we have developed strategies to reduce individuals' skepticism: the enumerators have badges with ECHO and UCB logos on them so they can show passengers. Our interception rate is well in line (maybe even above) what you might expect in most countries.

E. Results

a. Analytical Framework

The table below summarizes the research design we discussed above. As a reminder, we overlay two interventions so we can say something about the power of offering passengers subsidies for choosing a safer bus, when they do (or don't) have information about which bus is actually safest.

		Information treatment		
		Control	*Salience*	*Safety*
Subsidy treatment	*No*	G1	G2	G3
	Yes	G4	G5	G6

Information Treatment

1. **Control group:** does not receive any information about safety.
2. **Salience treatment:** receives a pamphlet about the importance of safety in public transportation, thereby making safety a salient feature of the commuter's choice.
3. **Safety treatment:** receives the same pamphlet as the salience group, except the bus that received the "Top Safety Performer" certificate is clearly highlighted on the form.

Subsidy Treatment

1. **No group**: Does not receive a subsidy for taking the safest bus.
2. **Yes group:** Receives a subsidy of KES 100 ($ 1.00) for taking the safest bus. Buses will normally charge KES 1000 ($10) per ticket making the subsidy 10% of the total cost of a ticket. Please note that when the subsidy is offered we do not actually reveal to passengers that it is for the safest bus company, we simply say it's for company X.

Once we have all of the data, we will be running regressions that implicitly compare the following groups. First, we will compare the control group (yellow) to the salience group (green) so we can say something about whether making safety salient affects passengers' choice about which bus to take.

		Information treatment		
		Control	*Salience*	*Safety*
Subsidy treatment	*No*	G1	G2	G3
	Yes	G4	G5	G6

Control versus Salience: Does salience change choice?

Next, we will compare the salience group (green) to the safety group (orange) so we can say something about whether providing information about which bus is safest affects passengers' choice about which bus to take. We hypothesize that this effect will be larger than the "salience" effect, because we are explicitly identifying a bus that is safest for the passenger. As a consumer (in this case passenger), I may know that something like safety is important but I may not be able to do anything about it unless I know which product (in this case "bus") is actually safest.

		Information treatment		
		Control	*Salience*	*Safety*
Subsidy treatment	*No*	G1	G2	G3
	Yes	G4	G5	G6

Salience versus Safety: Does safety knowledge change choice?

Next, we will use the subsidy treatment to say something about a passenger's willingness to switch buses for a small monetary payment. We compare subsidy recipients (blue) to non-recipients (pink). With this comparison we want to say something about how strong passengers' preferences are for a particular bus. In other words, we want to establish whether a small financial incentive is sufficient to change a passenger's choice of bus. We call this their "switching cost". This is important to benchmark the next comparison we make below, where we determine whether the information we provide about safety affects this "switching cost".

		Information treatment		
		Control	*Salience*	*Safety*
Subsidy treatment	*No*	G1	G2	G3
	Yes	G4	G5	G6

No subsidy versus Subsidy: How high is switching cost?

Finally, we will compare the impact of providing the subsidy without the information treatment to the impact of providing the information with the information treatment. In other words, we want to determine whether a passenger's "switching cost" is affected when they know about the safety of the bus. For example, absent information about which product (in this case bus) is safest, I may be willing to accept 2 dollars to switch to another product. However, once I have information about which bus is safest, I might be willing to accept just 1 dollar to switch.

		Information treatment		
		Control	*Salience*	*Safety*
Subsidy treatment	*No*	G1	G2	G3
	Yes	G4	G5	G6

Subsidy × Safety: Differential switching cost by knowledge?

We provide some analysis of the data, and preliminary results below. Please note we will be continuing our analysis over the next 6 months in order to produce an academic paper, which we will submit to general interest journals (i.e. American Economic Review, Journal of Political Economy) and field journals (Journal of Development Economics).

b. Preliminary Results

Table 1 investigates whether or not passengers choose the safest bus. Column 1 shows the effect of offering the subsidy to take the safe bus. The coefficient of 0.31 indicates that the subsidy increases the probability that passengers take the safest bus by 31 percentage points. This effect is statistically significant at the 1% level. This represents a 200% increase in the probability that passengers choose the safest bus, demonstrating that passengers can be incentivized to take safer buses in this industry.

Column 2 shows how passenger choice responds to 1) the saliency treatment and 2) the safety information treatment. Beginning with the salience treatment: the first coefficient demonstrates how making safety salient affects passengers' choice of bus. As expected, this coefficient is small and insignificant. Simply telling passengers the industry is unsafe, thereby making safety salient, is not enough to change their decisions. Indeed, if the passenger does not know which bus is safest, they will not be inclined to change their choice of bus.

Moving to the safety treatment: the second coefficient in Table 1 Column 2 demonstrates the impact of informing passengers which bus is safest on the route. Here we find the coefficient is unexpectedly negative and statistically significant at the 10% level (-0.05). This suggests that passengers were five percentage points (a 31% decrease) *less* likely to take the safety certified bus after learning about this information. The direction of this effect is surprising, and suggests that there may have be some sort of "backfire effect" from the safety certification information we provided. In the next few months we will conduct some qualitative interviews to try and find out why passengers reacted in this way. We are relying on these qualitative interviews because there has been very little research in Kenya along similar lines to what we've done here (and context maters immensely). Our working hypothesis builds on an observation we made when we were trying to intercept passengers on the road: many Kenyans were concerned that we were running a scam and hence would not stop to talk to us. Those passengers that did stop may have interpreted the fact that we were providing information about a particular bus as an attempt to promote that bus company, and reacted negatively by choosing a different bus.

Finally, Column 3 builds on Column 2 by demonstrating the impact of interacting the subsidy with the safety and salience treatment. The advantage of this regression specification is that it allows us to determine whether the effect of the salience or safety information treatments we detailed just above differ based on the presence of the subsidy. The coefficients in the second and third row of Column 3 show the effect of the two treatments without the subsidy. We see that the salience treatment has a negative and statistically significant effect (at the 10% level) on the probability of taking the safest bus. Again, this is not unexpected because passengers do not know which bus is objectively safe. The coefficient for the safety treatment is also negative, but not statistically different from zero.

The coefficients in the fourth and fifth row of Column 3, capture the differential effect of the salience and safety treatments when passengers are offered the subsidy to take the safest bus. Beginning with the salience treatment: the results show that the subsidy does not move the needle significantly for passengers who we primed about the importance of safety relative to those we did not. This is not altogether surprising as passengers still do not know which bus is safest, and hence may not be inclined to change their choice of bus. Moving to the safety treatment: we find that offering a subsidy to passengers who already know which bus is safest leads increases the probability they move away from that bus relative to passengers who did not know about which bus was safest. In other words, the "backfire" effect we detailed above is even stronger when we reveal which bus is safe *and* offer to subsidy passengers' tickets to take that same bus. The coefficient demonstrates that passengers were 6.8 percentage points (a 35% decrease) *less* likely to take the safety certified bus after receiving the information about the safest bus, and the subsidy offer. This is a surprising effect and therefore we attempt to understand what may be occurring later in the analysis.

Table 1

Choice of Safety Certified Bus

	(1) Chose Safe Bus	(2) Chose Safe Bus	(3) Chose Safe Bus
Subsidy	0.311***		0.299***
	(0.018)		(0.029)
Salience		-0.017	-0.052*
		(0.022)	(0.030)
Safety		-0.049*	-0.021
		(0.026)	(0.035)
Salience X Subsidy			0.064
			(0.042)
Safety X Subsidy			-0.048
			(0.047)
Controls	Yes	Yes	Yes
Mean in Control	0.16	0.16	0.16
p-value Salience + Salience X Subsidy			0.674
p-value Safety + Safety X Subsidy			0.042
Observations	2202	2227	2202

Notes: The outcomes is an indicator for the respondent buying a ticket for the safest bus company as measured by the tracking devices. "Subsidy" is the subsidy treatment where passengers were given a 100 Ksh discount to take the safest bus. "Salience" is an indicator for passengers receiving a pamphlet that increases the salience of safety on matatus. "Safety" is an indicator for passengers receiving a pamphlet that indicates which bus has been "safety certified". * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2 investigates whether passengers continue to choose the bus that they *previously* believed to be the safest (as reported to the enumerator before being shown any pamphlet). Column 1 shows that providing a subsidy to passengers reduces the probability that they opt for the bus they believed to be the safest in the past by 10 percentage point (23%). Column 2 shows the impact of the salience and safety information treatments. In contrast to Table 1, here we might expect the salience treatment to encourage passengers to take the bus they previously thought was safest. This is because if I have some prior about which bus is safest, and someone makes safety salient to me, I may become even more inclined to take that bus. Conversely, we might expect the impact of the safety information treatment to be zero - if people *are not* convinced our assessment of which bus is safe is correct - or negative - if people *are* convinced that they were misinformed about their original choice. Surprisingly, we see that the salience treatment does not encourage passengers to take the bus they perceived to be the safest more often. However, the safety information does not change the probability that passengers choose the bus they perceive to be safest. Finally, Column 3 examines whether the safety and salience treatments had differential effects based on the presence of the subsidy. It appears the subsidy does not cause any changes in the probability that the passenger chooses the bus they perceived as safest in the safety and salience treatment arms relative to control.

Table 2

Choice of Perceived Safe Bus

	(1) Perceived Safe Bus	(2) Perceived Safe Bus	(3) Perceived Safe Bus
Subsidy	-0.105***		-0.115***
	(0.023)		(0.038)
Salience		0.022	-0.006
		(0.027)	(0.039)
Safety		-0.012	0.008
		(0.032)	(0.044)
Salience X Subsidy			0.056
			(0.054)
Safety X Subsidy			-0.046
			(0.060)
Controls	Yes	Yes	Yes
Mean in Control	0.44	0.44	0.44
p-value Salience + Salience X Subsidy			0.182
p-value Safety + Safety X Subsidy			0.382
Observations	1774	1796	1774

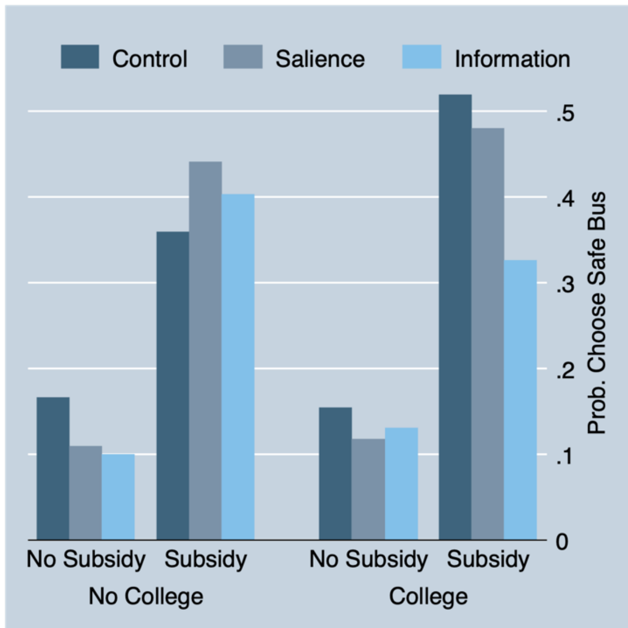
Notes: The outcomes is an indicator for the respondent buying a ticket for the bus company they previously believe was safest. 'Subsidy" is the subsidy treatment where passengers were given a 100 Ksh discount to take the safest bus. "Salience" is an indicator for passengers receiving a pamphlet that increases the salience of safety on matatus. "Safety" is an indicator for passengers receiving a pamphlet that indicates which bus has been "safety certified". * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Heterogeneous Effects

In order to understand these effects more deeply, we examine how different sub-groups within the population respond to each treatment separately. Of primary importance is understanding what attributes may be driving the "backfire effect" we observed in the full sample (where the "backfire effect" refers to the reduction in the probability of taking the safest bus when offered safety information and a subsidy).

Figure 1 below graphs the probability that a passenger chooses the safest bus based on their level of education (either post-secondary education (college) or not). The figure demonstrates that the "backfire effect" only exists among the college educated group. This suggests that the "backfire effect" may be entirely driven by the educated audience's skepticism of our intervention. This may be because their education has trained them to be more skeptical of claims or information sources in general. In particular, they may interpret the fact that we are providing information and money to take a particular bus as some sort of scam. Providing money (without strings attached) is not common practice in Kenya.

Figure 1



To further test this hypothesis, we examine the difference in responses between passengers who express a strong pre-existing preference for one bus company. We say that a passenger has a strong preference for a bus if they reported a bus company as being the "best" along all measurable attributes. We hypothesize that passengers with strong pre-existing opinions might be more skeptical about interventions that offer information that contrary to their beliefs. Figure 2 shows that we observe the same strong "backfire" among this sample as well. Therefore, this suggests that the "backfire" effect occurs among groups that are predisposed to be skeptical of the information intervention. When the information is coupled with a subsidy offer, passengers become even more wary and respond by avoiding the bus company we recommended.

Figure 2

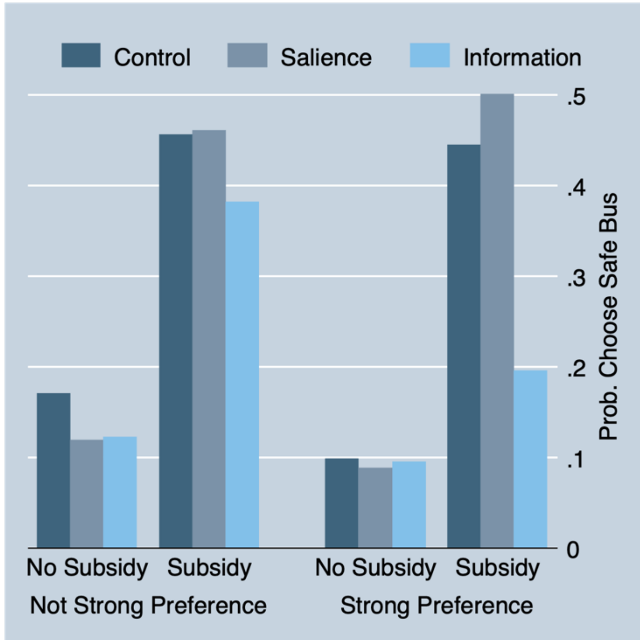


Table 3: Next, we examine whether passengers responded differently to the treatments based on whether or not they reported "safety" as being the most important attribute when choosing a bus. Table 3 shows how the probability of passengers choosing the bus they perceived to be safest is affected by the salience and safety treatments. We further split these results by whether or not they care about safety. Column 1 limits the sample to passengers that reported safety as their top priority, while Column 2 limits the sample to those who listed another attribute first. Finally, Column 3 pools both groups together and adds interaction terms in order to run statistical tests on these differences.

Overall, we can see that there are clear differences in the response to the saliency treatment among these two groups. The passengers who value safety highest are 8 percentage points more likely to take the bus they think is safest when they are primed to think about road safety. This effect is 10 percentage points larger and statistically different from the group that does not value safety as highly. This result suggests that a least a subset of passengers care about safety and are willing to change their choice of bus when prompted to think about accidents.

Table 3

Choice of Perceived Safe Bus by Safety Importance

	(1) Perceived Safe Bus	(2) Perceived Safe Bus	(3) Perceived Safe Bus
Salience	0.078**	-0.034	-0.031
	(0.039)	(0.039)	(0.038)
Safety	0.021	-0.045	-0.042
	(0.046)	(0.045)	(0.043)
Salience X Care Safety			0.103*
			(0.054)
Safety X Care Safety			0.060
			(0.060)
Safety Most Important			-0.034
			(0.038)
Controls	Yes	Yes	Yes
Mean in Control	0.42	0.46	0.44
p-value Salience + Salience X Care			0.055
p-value Safety + Safety X Care			0.668
Observations	920	876	1796

Notes: The outcomes is an indicator for the respondent buying a ticket for the bus company they previously believe was safest. "Care Safety" is an indicator for passengers who rated safety as their top criteria for taking a bus. "Salience" is an indicator for passengers receiving a pamphlet that increases the salience of safety on matatus. "Safety" is an indicator for passengers receiving a pamphlet that indicates which bus has been "safety certified". Column 1 limits the sample only to passengers who rated safety as their highest priority. Column 2 limits the sample to passengers who listed some other attribute as their highest priority. Column 3 includes the entire sample. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Finally, Table 4 suggests that changing passengers' beliefs about which bus is safest is extremely difficult. This table is the same as Table 3, but with the outcome being whether or not the passenger chooses the safest bus as measured by the tracking system. Here, we can see the same "backfire" effect from the safety information. Perhaps even more surprisingly, we see that this effect is highly concentrated among passengers who rate safety as their highest priority. However, as with highly educated passengers or passengers with strong beliefs about the best bus company, passengers who care most about safety may be the most skeptical about scams.

Table 4

Choice of Safety Certified Bus by Safety Importance

	(1) Chose Safe Bus	(2) Chose Safe Bus	(3) Chose Safe Bus
Salience	-0.008	-0.024	-0.032
	(0.030)	(0.034)	(0.033)
Safety	-0.064*	-0.019	-0.020
	(0.036)	(0.040)	(0.038)
Salience X Care Safety			0.028
			(0.045)
Safety X Care Safety			-0.041
			(0.051)
Safety Most Important			-0.008
			(0.031)
Controls	Yes	Yes	Yes
Mean in Control	0.17	0.14	0.16
p-value Salience + Salience X Care			0.897
p-value Safety + Safety X Care			0.085
Observations	1213	1014	2227

Notes: The outcomes is an indicator for the respondent buying a ticket for the bus company they previously believe was safest. "Care Safety" is an indicator for passengers who rated safety as their top criteria for taking a bus. "Salience" is an indicator for passengers receiving a pamphlet that increases the salience of safety on matatus. "Safety" is an indicator for passengers receiving a pamphlet that indicates which bus has been "safety certified". Column 1 limits the sample only to passengers who rated safety as their highest priority. Column 2 limits the sample to passengers who listed some other attribute as their highest priority. Column 3 includes the entire sample. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F. Conclusions and Next Steps

a. Conclusions

In recent years, international institutions have provided funding, knowledge and technical assistance to build systems aimed at reducing the number of traffic injuries and deaths worldwide (World Bank, 2014). These efforts are typically difficult to evaluate because the investments are multi-faceted and typically rolled out across an entire city. One exception is a program that was launched in Kenya, which placed stickers inside Nairobi's matatus to encourage passengers to complain to their drivers about unsafe driving (Habyarimana and Jack, 2015). Our intervention complements their approach by asking whether providing information to passengers about safe driving can change their choice of minibus, which will eventually put pressure on companies to improve. To this end, we implement a research design that allows us to rigorously test this hypothesis. This required forming close connections with SACCOs operating on the Nairobi - Kisumu route and fitting GPS trackers into their vehicles. We then tracked the company's performance over the course of a month to understand which company on the route was safest overall. Finally, we provided this information to passengers via pamphlets.

In preliminary results, we have generated a number of novel insights that inform policymakers and private initiatives in the public transport sector. First, we show that travelers react strongly to a small (10%) subsidy for the safest bus company: the share of travelers taking the safest company triples, nudging hundreds of travelers towards a safer public transport experience. The size of this effect is remarkable, especially given the low cost of the intervention (the subsidy only cost 1 USD per traveler, which was 10% of the travel cost). Second, we show that while money can move travelers towards safer choices, the effect of information is much more complex: instead of taking the information at face value, travelers may reinterpret it in terms of persuasion attempts of competing public transport companies, especially when they are offered a subsidy for the company advertised as safe. This finding sheds light on the importance of creating a trustworthy information environment for public information campaigns to succeed. This can often be achieved by ensuring that information campaigns are highly visible (i.e. online and easily accessible to all), and invite user feedback (please see final section of this report where we propose to build on the efforts of a company, Ma3 route, that did just that). Third, our preliminary findings suggest that highlighting safety as an important dimension of public transport services nudges travelers to fall back on their prior beliefs about which company is safest. This result underlines the role of designing public information campaigns on the basis of travelers' (potentially uninformed) prior beliefs about the safety of their public transport options.

Building on these findings, we are now in the process of designing an information environment in which travelers can expect the safety information to be publicly known, as opposed to the private information shared with individual travelers so far. In this way, we seek to shift expectations towards an understanding that the safe choice is public knowledge. This is in line with a number of recent studies that have shown how behavior shifts when it is publicly observed (Habyarimana and Jack, 2015).

Moving forward, we would like to be able to provide this information through a USSD shortcode or a mobile application (a short code is short digit sequences, significantly shorter than telephone numbers, that are used to address messages in the Multimedia Messaging System and short message service systems of mobile network operators). We detail this approach, and the assumptions behind it further below. In doing so, this project represents a significant step towards empowering the most important stakeholder in the public transit industry: passengers. When government institutions are weak, this often represents the most promising avenue forward.

b. Further testing and implementation

Next Objective: Our research represents an important step towards providing information to passengers about safe driving. In an ideal world, however, we would fit every bus of each company with a GPS tracker (not only a subsample), and provide this information to all passengers (not simply a subset). Indeed, every passenger should be able to access up-to-date safety information about any minibus they might want to take before making a final decision.

The most accessible way to do this is to allow passengers to search for a minibus' registration number and observe their most recent performance on the road. This approach has the potential to completely change passengers' expectations about public transport, empower them to make informed choices as passengers, and induce industry reform towards more safety.

Product: We intend to develop a service that allows passengers to learn about the safety of any minibus they might board and provide feedback about their own experience on a particular bus. To this end, we envision developing a mobile app (for smartphones) and a USSD-response system (for regular phones) that would convey important safety information about minibuses to any passengers who logged on. We have reason to believe that Kenyans are much more comfortable with information available on apps and shortcodes because it is less common to find scams run through these types of platforms. The app would also elicit information from passengers themselves. We believe that we can motivate passengers to submit these reports by highlighting that they will benefit from others doing the same (a similar approach to Uber and Lyft that asks for driver ratings at the end of each trip). We also believe that crowd-sourcing passengers' feedback on their trips will add additional legitimacy to the information we are providing via the tracker. Indeed, Kenyans are accustomed to using Twitter and a serviced called Ma3 route to report unsafe driving.

The passenger would be able to search for a particular bus by entering the minibus' registration number and company name. The passenger could then see two important pieces of information. First, they would see a safety rating (on a 5-point scale) generated from the raw data collected by the GPS tracking device over the last 30 days. Second, they would see a safety rating generated from previous passenger reports of their safety experience on that particular bus.

These reports ask passengers to 1) rank the overall safety of their ride on a scale from 1 to 5; 2) flag any instances of unsafe driving they experienced during their ride; and 3) provide a compliment to drivers if appropriate. The mobile application layout would build on an application we previously designed for minibus owners. The SMS response system would build on a system we used to elicit feedback from drivers during a previous project.

Roll-out: We intend to provide GPS trackers to minibuses operating on all of the major mid-range bus routes located throughout the country (of which there are approximately 15,000 (Mutongi, 2017)). Logistically, it will be easiest to proceed with this process on a route-by-route basis, focusing on one particular route at a time. We intend to start with the busiest and most dangerous routes first. Note that while there are no official statistics we can use, Kenyan travelers have a sense of which routes are busiest and most dangerous. This will involve contacting each company on the route and offering them the chance to fit as many of their buses as possible with the trackers (we are aiming for full saturation of these "treatment" routes). The provision of the initial GPS trackers will either be subsidized at 50% (at a cost of 60 USD per device) or provided for free, depending on what the budget permits. As momentum grows, the subsidies will be removed.

In a previous project, we built a large network of bus networks in Nairobi and fitted more than 300 commuter buses with tracking devices. In parallel we will run a marketing campaign along the route to encourage passengers to consult the application or SMS-response system, and submit their own feedback. Here we will try to partner with existing companies in the field to add legitimacy to our system. Namely, we will look to partner with companies like Ma3 route that have name-recognition. We can then track the safety performance (from trackers and passenger experience feedback) of each bus before and after the GPS trackers are rolled out. We will also conduct surveys to determine how the prices that companies charge change over time.

Business model components

The system will be fully developed and operated by engineers and project managers at Echo Mobile. *The team of engineers* will be in charge of 1) ensuring each tracker that is fitted in a minibus is communicating data to the server; 2) developing the smartphone and SMS-response system; 3) maintaining data processing on the server; and 4) ensuring the app/SMS-response system is providing up-to-date information to passengers. *The team of project* managers will be in charge of 1) ensuring the timely roll-out of GPS trackers, and 2) the engagement of passengers along treated routes.

A third-party investor will be contacted to share some of the financial risk involved in scaling up this endeavor. Because of the information acquisition value in passenger contacts (phone numbers), and minibus behavior/safety, we have no doubt that this will be feasible. We have reached out to some of the following potential investors and intend to continue these efforts over the coming months.

- Safaricom: Safaricom is the largest cell-phone provider in Kenya. They have expressed interest in developing new products that cater to the Kenyan market, including GPS technologies.
- BRIK technologies: is a company comprised of software developers, engineers and technologists in Nairobi, that build the tools to ensure connectivity. They have demonstrated a strong

commitment to developing new products that use the internet to provide information to various stakeholders.

- Atma Connect: is a company that creates solutions to empower users to make informed decisions. They would be interested in partnering with an endeavor that is doing something similar for road safety.
- Ushahidi: is a technology company that aims to change the way information flows in the world. They build tools to help people raise their voice. They would be interested in partnering with an endeavor that helps passengers raise their voices.
- Data Integrated: is a Kenyan ICT company that offers financial solutions to small and medium scale enterprises (SME's) in Africa. They have ventured in the world of trackers and would be interested in collaborating on an endeavor that builds solutions for passengers as well as minibus owners.
- Ma3 route: Ma3Route is a mobile/web/SMS platform that crowd-sources for transport data and provides users with information on traffic, matatu directions and driving reports. They are currently experiencing some changes in their internal management but we have been in contact with them to discuss how to integrate our two approaches.

This *team of investors* will be in charge of managing the financial costs and revenues generated by the platform. To the best of our knowledge, there are three ways to generate revenue streams from this endeavor.

- First, the investors can create means for advertisers to feature their products on the platform
- Second, they can offer matatus to pay to have their buses fitted so they can feature on the platform.
- Third, they can offer premium services on the platform that passengers would have to pay for.

As detailed in the next section, we can also investigate the possibility of working with the government to facilitate this scale-up.

c. Sustainability and Applications to the National Transport System

Currently, the NTSA (National Transport Safety Authority) is struggling to enforce safe driving standards. The industry is dominated by thousands of private companies, and road traffic officers are notoriously corrupt. As a result, the NTSA is supportive of different approaches that can result in safer driving and fewer road accidents. This includes involving the industry's largest stakeholders: passengers. The idea of encouraging customers to put pressure on businesses is not unique: consumers are often the drivers of change in the private sector. The transport industry, when operated by individual minibus owners, should not be any different. In fact, the rise of cab companies like Uber (relative to traditional cabs) demonstrates the power of passenger demand. Moreover, bus companies like Easy Coach have gained prominence in Kenya specifically because of the professional services, and safer driving, they provide. For these reasons, we anticipate that our current approach, and our scale-up, will provide a unique opportunity to induce safer driving in an environment where top-down approaches have been less successful. This will appeal to any entity in the country that is concerned with safe driving, which includes the National Transportation Safety Authority.

The National Transport Safety Authority will see value in a crowd-sourcing application that uses information from passengers and GPS technologies to assess minibus safety. One key advantage of working closely with the NTSA, is their ability to mandate that every public service vehicle has to have a GPS tracker (we would have to convince companies to sign up if NTSA were not to back us, which we could do by providing access to the software we developed, which we know minibus owners value). This is not unheard of: the Indian government recently mandated that every commercial vehicle will need to have a real-time GPS tracking system with emergency request buttons (panic/SOS buzzer). This means that all public transportation vehicles could be tracked and searched through the mobile application. A similar regulation could be implemented in the long term in Kenya as well. The disadvantage of relying on the government for this, is the time it might take to enforce such a measure.