KAMI LIMU

# ICT TRACK: DATA SCIENCE

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# Problem Background

In recent years, the proliferation of the Internet and technological advancements have revolutionized the transportation industry, leading to the rapid growth of ride-hailing platforms such as Uber, Bolt, and Little. This digital transformation has reshaped urban mobility, making ride-hailing services an integral part of daily life for many. In Nairobi, where 80% of residents have used ride-hailing services, with 78% citing safety as an important factor (Weru and Mugo, 2020), the industry faces significant challenges in addressing specific safety needs.

A major challenge lies in the routing algorithms these platforms use, which prioritize time and efficiency, often at the expense of safety (Carmody & Sowers, 2019). To find out the extent of this challenge among ride-hailing drivers in the Kenyan urban context, we conducted a pilot study among 10 e-hailing drivers who operate within Nairobi. According to the pilot study, seven out of ten e-hailing drivers indicate that the pressure to maximize profits can lead them to choose shorter, riskier routes over safer, longer alternatives. This issue is particularly concerning in areas with high crime rates or poor infrastructure, where the risks of accidents, harassment, or even violent crime are elevated. Although female drivers are at higher risk, this problem impacts all drivers who may be forced to navigate unsafe areas to meet the demands of efficiency-driven algorithms. For instance, Ivy Wanjiku, a driver who frequently works late into the night, often cancels trips requiring her to navigate dangerous roads. Conversely, Patrick Mwangi admits that despite being aware of the risks, he sometimes takes hazardous routes in pursuit of higher profits, illustrating the difficult trade-offs drivers face between safety and financial gain.

Addressing this challenge is crucial, not only for the safety and well-being of drivers and passengers but also for the sustainability and credibility of the ride-hailing industry. Integrating safety considerations into routing algorithms could significantly reduce the risks associated with ride-hailing, fostering a safer and more reliable transportation ecosystem in Nairobi and beyond

The research questions that this project will aim to address include:
- How might we design a predictive model that integrates safety considerations into routing algorithms without compromising efficiency?

- What types of data are most effective in predicting safety risks in the Kenyan context?
- Given the diversity in road infrastructure, crime rates, and emergency response systems, how can we ensure that the predictive model is adaptable to various regions and contexts within Kenya?

By answering these questions, we aim to develop a solution that not only addresses the current challenges but also sets a new standard for safety in routing algorithms, ultimately contributing to a safer and more secure transportation environment in Kenya.

## Market Opportunity

The two current solutions that exist in the market to solve the current issue we are experiencing include:

**Zello** is a popular push-to-talk (PTT) communication application widely used by cab drivers and fleet operators across Kenya. Zello facilitates real-time voice communication between drivers and dispatch centers by transforming smartphones into walkie-talkies. This immediate line of communication enhances coordination, allowing for quick responses to emergencies, traffic updates, and route changes. For instance, if a driver encounters a dangerous situation or needs assistance, they can instantly alert dispatchers and receive support, thereby improving overall safety. Additionally, Zello's ability to maintain constant communication helps monitor driver behavior and ensure adherence to safety protocols. However, while Zello excels in facilitating communication, it primarily serves a reactive role. The platform does not integrate predictive analytics into its communication framework, which means it cannot proactively identify or mitigate potential safety risks within routing algorithms. Consequently, while Zello enhances real-time responsiveness, it does not address the underlying issue of safety optimization in route planning. Also, with Zello, 7 out of 10 people we interviewed during our pilot study indicated they don't consider it as a reliable source of information as people usually mislead others.

**Emergency Services**, one of the leading ride-hailing platforms operating in Kenya, has implemented several safety features aimed at protecting both drivers and passengers. Bolt's and Uber's in-app emergency buttons allow users to quickly contact local authorities or support

teams in case of an emergency, providing an added layer of security. Ride tracking enables both drivers and passengers to share their trip details with trusted contacts, ensuring that someone is always aware of their whereabouts. Despite these measures, the approach remains largely centered on enhancing individual safety through direct interventions rather than integrating comprehensive safety metrics into their routing algorithms. This means that while they can respond to safety incidents effectively, it does not proactively prevent them by optimizing routes based on safety data. The reliance on manual reporting and reactive safety measures indicates a significant gap in utilizing predictive analytics to foresee and avoid potential hazards during route planning.

Both approaches have made commendable strides in improving safety within Kenya's cab industry by enhancing communication and implementing protective features. However, they fall short of addressing the core challenge of integrating safety into routing algorithms in a predictive manner. Zello offers robust real-time communication but cannot foresee and mitigate safety risks through data-driven route optimization. Similarly, Bolt and Uber's emergency features provide essential safety features that protect users during their journeys but do not incorporate predictive safety analytics to prevent incidents from occurring in the first place. These gaps highlight the need for a more sophisticated approach that not only reacts to safety issues but also proactively integrates safety considerations into the very fabric of routing algorithms. By developing a predictive model that leverages comprehensive data analytics, it is possible to create a routing system that balances efficiency with safety, ultimately fostering a safer transportation environment for all stakeholders in Kenya.

Ride-hailing services are a fast-growing sector with a global taxi market size estimated to be a total of 203.16 Billion and estimated to grow approximately 618.11 billion USD by 2031 (Staquest, 2024)  Africa only, the revenue is estimated to reach 2.01 Billion USD and the number of users is estimated to reach 268.02 users by 2029 (Statista, n.d.). Locally, the number of people using the e-hailing service is approximated to be 3 million users with Bolt accounting for 47% and Uber accounting for 41% (Owolabi, 2023) (Owolabi, 2023).  Our target audience is business people, everyday commuters, and tourists whereby in Nairobi 58% of the respondents indicate that they use the taxi-hailing services.  Taxi-hailing services not only contribute to direct revenue but also contribute to the reduction of congestion in traffic and offering affordable service. The

overall contribution to GDP is 1% and it is expected to rise with the rise in demand for digital services and urbanization.

## Solution Idea

*Target User*

**Who are the target users/customers?**

Our target users are e-hailing drivers, particularly those operating in high-risk areas, especially at night. These drivers often face dangerous situations where they must decide between canceling rides or risking their safety. Through our pilot study, we found that 7 out of 10 drivers lack trust in existing safety solutions, such as Zello and emergency services, which are perceived as ineffective or unreliable. This lack of trust leads to frequent ride cancellations, particularly when picking up clients in unsafe locations.

**How were these identified?**

We conducted a pilot study that revealed the safety concerns drivers face, especially in unsafe areas. Drivers are directly affected because they are the ones who encounter dangerous situations firsthand. The study allowed us to understand the disconnect between the existing safety solutions and the drivers' expectations, making it clear that current measures do not meet their needs.

**Why is this target group chosen for this project and not another one?**

We chose to focus on the drivers because they are the ones making real-time decisions about which routes to take and whether or not to accept rides. Their safety is paramount, as they are exposed to potential dangers more frequently than passengers. Additionally, by protecting the drivers, we indirectly ensure passenger safety since both parties share the same vehicle. However, drivers are more vulnerable as they must enter potentially dangerous areas to pick up passengers and complete rides. They are also incentivized to take risky trips to maximize their earnings, often at the expense of their safety.

**Is the problem only directly affecting your target user, or are there other users?**

While the problem primarily affects drivers, passengers are also indirectly impacted. If drivers feel safer and more confident in the security measures in place, they are less likely to cancel rides, resulting in a better experience for passengers. By addressing drivers' safety concerns, we are also contributing to passenger safety, as drivers will be more inclined to take secure routes, ensuring that both parties avoid dangerous situations. We focused on drivers as our primary users because they are the decision-makers when it comes to accepting rides and navigating routes. By solving their safety issues, we enhance the overall safety of the e-hailing ecosystem.

*Solution Prototype*

The proposed solution is a **predictive safety model** integrated into the routing algorithms used by cab services in Kenya. This model leverages machine learning and real-time data analytics to dynamically adjust routes based on safety considerations, ensuring that both drivers and passengers are guided through the safest possible paths without compromising on time efficiency.

## Process Flow of the Solution

The process of implementing the predictive safety model can be broken down into several key steps, as illustrated in the diagram below.

**Diagram Description:**

**User Input:**

Users provide start and end locations.

**Geocoding:**

Convert user-provided addresses into geographic coordinates (latitude, longitude).

**Retrieve Road Network Data:**

Extract road segments from the OpenStreetMap (OSM) or similar service.

Each road segment includes coordinates, lengths, and other properties.

**Crime Data Preprocessing**:

Load crime hotspot data.

Normalize crime severity using MinMaxScaler.

Calculate proximity to the road segments using the Haversine formula.

**Assign Crime Severity to Road Segments:**

Calculate the severity score for each road segment based on proximity to crime hotspots.

**Generate Routes:**

Use a routing algorithm (like A* or Dijkstra) to calculate possible routes:

- Shortest Route
- Fastest Route
- Safest Route (based on crime severity)

**Visualize Route on Map:**

Display the chosen route on an interactive map using Folium.

Save the map as an HTML file and render it in the web application.

**Output to User:**

Present the route on the map in the Flask web app.

Allow the user to select between different route types (shortest, fastest, safest)

This solution directly addresses the safety concerns identified in the initial problem description by proactively integrating safety considerations into the routing process. Unlike existing solutions that react to safety incidents, this predictive model anticipates potential risks based on comprehensive data analysis and adjusts routes accordingly. This ensures the drivers are guided away from high-risk areas, significantly reducing the likelihood of encountering unsafe situations. By embedding the predictive model into the core of the routing algorithms, the solution does not sacrifice efficiency for safety. Instead, it optimizes both, ensuring that cab services can continue to offer timely rides while also prioritizing the well-being of all users. This approach fills the gaps left by current solutions and sets a new standard for safety in the ride-hailing industry.

The model assumes that ride-hailing platforms in Kenya will be open to integrating this predictive safety model into their existing systems, recognizing the value it adds in enhancing user safety and potentially differentiating their service in a competitive market.

## Value proposition

Our value proposition is to provide e-hailing drivers with a reliable routing platform that offers them the safest route possible while still considering traffic and the shortest route ensuring their safety while enhancing their confidence in operating in high-risk areas. By prioritizing driver

safety, we also indirectly protect passengers, creating a safer ride-hailing experience for everyone.

## Designed Solution

*Technologies Used*

The project utilized several key technologies:

Python- the core programming language used to build the backend logic.

Flask- a lightweight web framework for creating web applications and serving route visualization.

Pandas- for data manipulation and processing of the crime data.

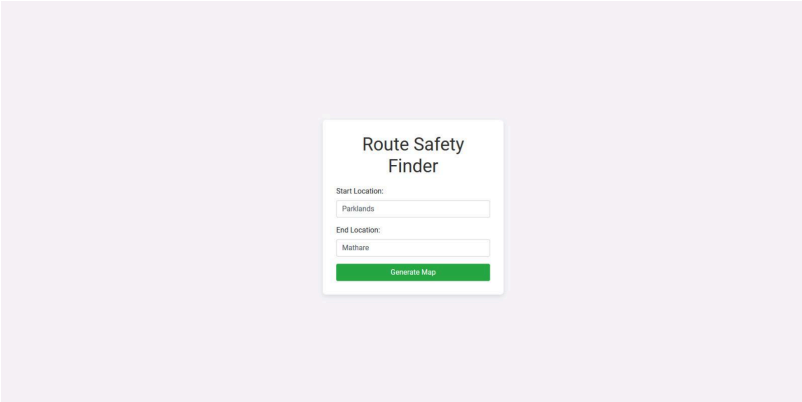
Folium- to generate interactive maps and visualize the routes and crime hotspots.

Geopy- for geocoding, converting addresses into latitude and longitude coordinates.

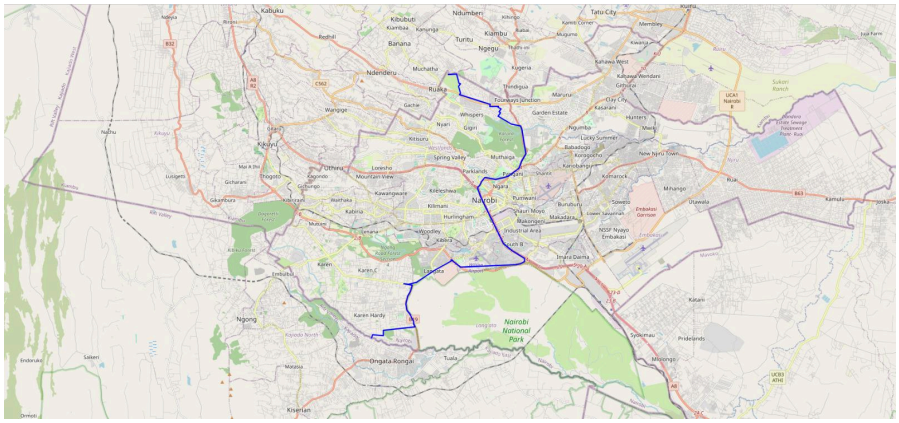
Machine Learning (MinMaxScaler)- for normalizing crime severity scores.

HTML- for creating the front end (map.html) to visualize the route.

*Screenshots of Main Modules*




This prompts the user to input the start location and destination. In our case, we prompted the model to give us the safest route from Parklands to Mathare.




Above is the output.

*Link to the project*

https://github.com/JoyNyayieka/SafeWay.git

# Business Model

To ensure financial sustainability, we plan to implement a profit model that generates revenue while delivering value to e-hailing drivers and enhancing their safety. Here's how we intend to make money and ensure long-term sustainability:

## 1. Subscription Model

**Target Group:** E-hailing drivers

**Revenue Stream:** We will offer a premium subscription service that gives drivers access to advanced safety features. These features include real-time GPS tracking, priority emergency response services, and enhanced driver-passenger verification systems.

**Subscription Plans:**

**i) Basic Plan:** Free with limited access (e.g., basic emergency alert system and standard GPS tracking).

**ii) Premium Plan:** Paid monthly/annually (e.g., enhanced emergency services integration, direct contact with security, and accident reporting).

**Pricing:** We will conduct further market research to determine an affordable price point for drivers. Initial estimates could be around 300-500 KES per month.

## 2. Partnerships with E-hailing Platforms

**Target Group:** E-hailing platforms (like Uber, Bolt, Faras, or Little Cab)

**Revenue Stream:** We will form strategic partnerships with e-hailing companies, offering our platform as a safety feature they can integrate into their driver app. This will enhance the appeal of their platform to both drivers and passengers.

**Partnership Model:**

i) E-hailing platforms can either pay a licensing fee to use the software or a revenue-share model based on the number of drivers using the platform.

ii) Negotiating a partnership where drivers' safety data can also improve the platforms' internal safety ratings and reduce insurance risks.

### 3. Driver Insurance and Security Services

**Target Group:** Insurance companies and private security firms

**Revenue Stream:** We will collaborate with insurance companies and security firms to offer discounted services to drivers using our platform. For instance:

**i) Driver Insurance Packages:** Insurance companies could offer specialized plans based on the platform's safety data (e.g., safe driving routes, and emergency alert activation).

ii) **Referral Fees:** We will earn a referral fee for every driver who signs up for such packages through our platform.

### 4. Advertising and Sponsorship

**Target Group:** Local businesses, car accessories, fuel companies

**Revenue Stream:** Once the user base grows, we will introduce targeted advertising within the platform. For example:

i) Local businesses and car accessory brands could advertise their products to drivers.

ii) Fuel companies could sponsor in-app services, offering discounts for drivers at specific petrol stations.

**Sponsorship Packages:** We can also offer sponsorship opportunities for companies looking to brand certain features of the platform (e.g., a fuel company's name tied to an emergency alert feature).

## Financial Sustainability

To ensure financial sustainability, we will adopt the following strategies:

- **Diversified Revenue Streams:** By combining subscription models, partnerships, insurance collaboration, and advertising, we ensure multiple income sources to avoid dependency on any one revenue stream.
- **Scalable Growth:** The platform is designed to scale easily across cities and regions. Initially, we will focus on high-risk areas where the safety features will be highly valued. As adoption grows, the marginal cost of adding new users decreases, enhancing profitability.
- **User Retention Focus:** Our value proposition directly targets drivers' safety concerns, meaning once drivers experience the benefits, they are likely to remain subscribed. Additionally, safety is a growing concern, so the demand for such services is expected to increase over time.
- **Partnership Expansion:** Long-term partnerships with e-hailing companies, insurance providers, and security firms will create a steady stream of income through licensing, commission fees, and potentially long-term contracts.
- **Continuous Innovation:** We will continuously enhance the platform with new safety features and data analytics to ensure we stay competitive and valuable to users, ensuring subscription renewals and positive partnerships.

By focusing on multiple streams of revenue, cost-effective scaling, and retaining users through continuous innovation, we will establish a financially sustainable business model.

# Responsible Computing

We aim to achieve in achieving response computing through the following approach:

To describe how the solution aligns with the principles of responsible computing, we can refer to the framework shown in the image and address each aspect in detail:

1. **Inclusion**

The solution is designed to include all e-hailing drivers, regardless of gender, location, or economic background, ensuring that safety measures are available to everyone. There will be no exclusion based on the nature of the rides they take or the area they operate in.

We will work with driver unions, e-hailing companies, and security bodies to ensure that marginalized drivers also have access to the platform and its safety services.

2. **Accountability**

Accountability refers to ensuring that all actors responsible for data collection, processing, and responding to emergency services are accountable and transparent in their processes. The solution ensures that each stage of the implementation, from data collection to emergency response, is monitored by accountable stakeholders such as e-hailing platforms, security services, and government bodies. Clear records of data use and emergency service actions will be maintained.

3. **Privacy and Security**

Protecting users' data is crucial, especially in sensitive cases like emergencies and safety protocols.

The platform will use encrypted data storage for users' personal and location data, ensuring only authorized personnel can access it. Emergency response systems will have a secure method to use driver data in real-time for immediate actions but will not exploit it for non-emergency purposes.

4. **Cultural Sensitivity**

It’s important to ensure that the solution respects the cultural backgrounds of the drivers and the areas they work in. Cultural sensitivities, such as the treatment of certain locations as "safe" or "unsafe," will be addressed by collaborating with local stakeholders who understand these dynamics. Features such as voice alerts or support language options will be adapted to different cultural contexts.

5. **Accessibility**

The solution should be accessible to drivers from all walks of life, ensuring that even those with limited tech knowledge can use the app easily.  We will build a user-friendly interface with support for multiple languages, including Kiswahili, and provide offline functionality for areas with poor network coverage. Support and training materials will be available in various formats (videos, FAQs).

6. **Biasness**

Assumptions in the design should not lead to bias against certain drivers or areas. The system will be designed with neutral algorithms to ensure that all areas and drivers are treated equally. Continuous audits will be conducted to prevent any algorithmic bias based on location, client background, or economic status.

# Traction

During our pilot study, we spoke with 10 e-hailing drivers to better understand their challenges and experiences. Notably, we engaged with two drivers, Ivy and Patrick, who provided valuable insights. Both drivers emphasized the need for a reliable safety solution that could provide real-time security without compromising their livelihood. Ivy's experience highlights the hesitation that some drivers face, while Patrick's situation underscores the risks some are willing to take without considering their safety.


*Patrick, who, despite the risks, continues to take night rides to maximize his earnings*

*Ivy frequently cancels rides at night due to safety concerns in high-risk areas.*

## Funding

For the initial implementation of the model, we will need the following financial aid:

a) Software development- That includes hiring the developers ( ML scientists, developers, project managers) and integrating the API's for emergency services. We need to build a UX/UI that is ideal for everyone.

b) Testing and Quality Assurance - Covers the setting and testing of the environment and hiring of the Quality Assurance engineers that ensure that the app has no issues at any given time and that the app is secure from hacking.

c) Server Infrastructure - Cloud hosting (i.e Google Cloud) and server setup

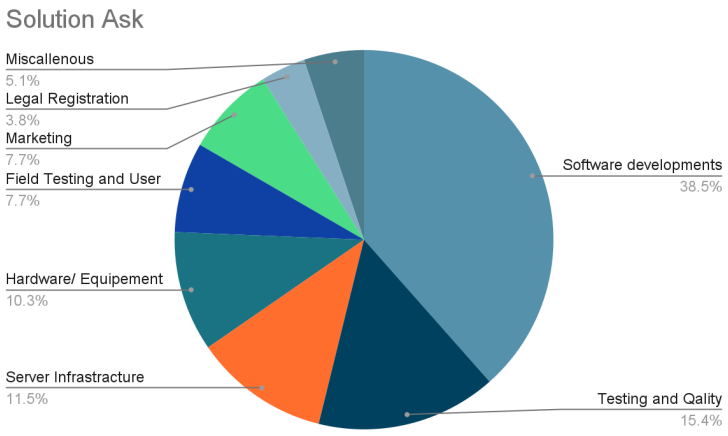
d) Hardware/Equipment- Ensuring that we have the right tools to test our model.

e) Field Testing and User research - Involves compensating the drivers that will be used for the test run, and catering for testing and logistics. This will enable us to know how the product will work in real life if it meets the drivers' needs.

f) Marketing - This accounts for advertising and collaborating with organizations to bring awareness.

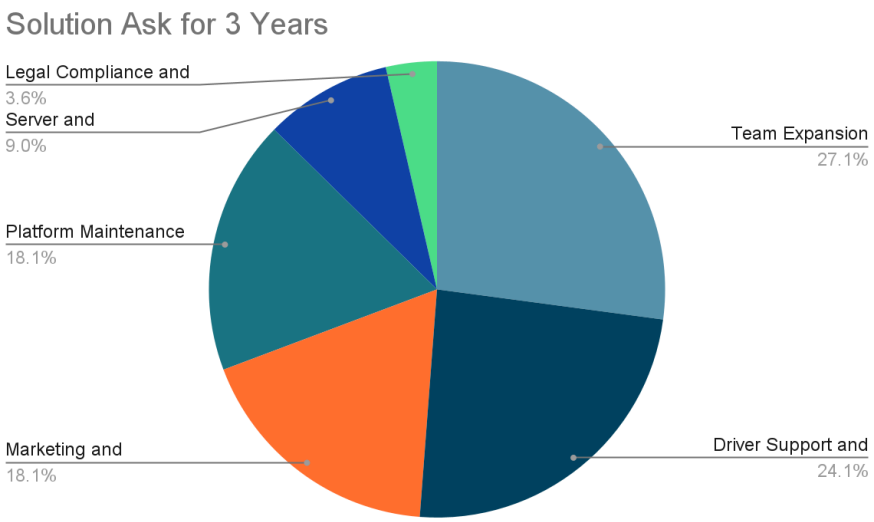
g) Legal Registration - Ensures that we have all the legal complaints documents from insurance to contracts to agreements which will ensure the business runs smoothly

h) Miscellaneous - Managing unforeseen costs to ensure that the project doesn't stop or meet unexpected hitches that can't be handled.



Past the pilot study, for the next 3 years, we will require funding to ensure that our project runs smoothly and for scalability. Here is a breakdown of the financial ask for the next 3 years after the pilot year:

1. Team expansion - As the system grows and gets adopted by many users we will require an additional developer to help us scale with growth.
2. Driver's Support and Training - Ensuring that drivers are well-trained to use the app and get the support needed.
3. Marketing and Customer acquisition - Expanding to new areas and attracting more customers through continuous advertising and partnerships.
4. Platform maintenance and feedback- ensuring that the platform is maintained and evolves with feedback while still adding some features.
5. Legal, Compliance and Data Security- Ongoing compliance with new regulations and ensuring data security.
6. Server and Infrastructure upgrades- Enhanced server capacity to support larger user bases and increased traffic.



# Our team

*(From left to right)Joy Nyayieka, Simon Kiragu and Joy Kendi*

Skills:

Python Programming. Proficient in using Python for back-end logic and handling data operations.

Flask Development. Experience in building web applications using Flask for handling routes and rendering HTML templates.

Geospatial Processing. Capable of working with geospatial data using libraries like Folium, for route visualization, and Geopy, for geocoding.

Data Manipulation. Skilled in using Pandas for data processing, loading, and transformation.

API Integration. Knowledgeable about working with APIs, although opting for a more simplified approach for this project.