# Concept

Our target is to create a sustainable platform where recyclable garbage is directed to the correct place, a problem rife in emerging markets.

Our Platform known as **Tau** aims to solve this by incentivising customers in developing countries to throw, segregate, and understand the ‘critical’ recyclable garbage. Our platform is a mobile app that enables a logistics ecosystem that enables collection of incentivising self-sorted recycling.

For an idea to be effective, it has to be scalable which is why our app aims to collaborate with already existing infrastructure to help them more effectively arrange, sort, and collect household waste. We collect a gold mine of data, which we will leverage effectively to drive the incentives, and thus power the recycling engines we envision, we call ‘self perpetuating recycling’.

Our platform also doubles down to educate individuals as the sorting is done by the said individuals. Once the app has a large enough user base, we will expand to encompass smart bins, which will seamlessly integrate to the system to facilitate a full two pronged attack to clean plastic and other waste.

### Why is it sustainable and why does it scale?

The incentives drive data, which drives more incentives. A self perpetuating circle.

It also doubles down as an education platform for users on what is and what's not recyclable.

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The bin is built upon the user base that stage 1 accomplishes. Its a two pronged, complete attack on solving any emerging markets issue.

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# Our Platform

Our platform can be subdivided into two part;

1. Stage 1: CityCollection is the scalable solution designed to address household sorting and education
2. Stage 2: CityBin will address all disposal of garbage by including automated sorting bins

Both systems will use our proprietary API platform Tau (under development).

### CityCollection

>> image CityCollection

### CityBin

>> image CityBin

### CityApp

-Booking for pickups

-See previous bookings

-See upcoming pickups/cancel upcoming pickups

-See nearby bins

-See previous disposals

-Authentication

-Prize redemption

-News/Advertising

### Dashboard

-Visualize the data

-Waste disposal patterns/habits of users

-Waste disposal patterns of areas/cities

### Image recognition

We have designed two models;

1. Custom Mobilenet model: a mobile friendly, image recognition model used for local waste segregation on type. Used in mobile android device on CB
2. Custom YOLO model: Specific, object detection model for identifying very narrow classes with high IOU, used for CC. It will be hosted on the cloud

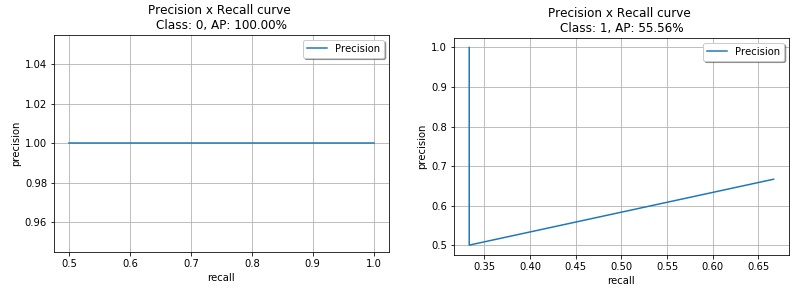
#### Custom Mobilenet model:

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#### Custom YOLO model:

Our specific model runs the latest YoloV3 object detection algorithm and we are currently training it to accomplish very high IOU’s with high confidence levels. Our results are below;

**Figure 1: mAP of our custom YOLO object detection model**



We achieved a mAP for both classes of 78% @IOU of 0.7. The IOU is a critical factor for us to accommodate multiple garbage items in one picture, for the ease of users.

We have currently trained on two classes, Coke and Knuckles PET bottles to illustrate the performance. This will be extrapolated to include over 400 classes as the data is extracted from the users for training. We are using a variety of image augmentation tools (including background augmentation).

### Data

-Data gathered so far from a local survey includes

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# How does it solve the problem?

To understand how our solution neatly addresses every problem in the challenge, either directly or indirectly, we have organised a Q&A session below.

## **Challenge 1 -** Improved Visibility of Plastic Waste Generation and Material Flows

* Southeast Asia’s existing systems are complex, often fragmented, and heavily reliant on the informal economy.
* Lack of visibility and transparency on plastic waste generation patterns as well as plastic waste material flows

Questions & Answers

1. How to better track and understand where plastic waste comes from and where does it go?

* The CC mobile app gathers information as to the houses that produce recyclables/non-recyclables via our QR code identification
* The dashboard tracks location, frequency, type, and even brand data via the image recognition portion of the app. The data is used to identify individual, community wise user patterns and behaviors to better focus collection efforts

1. Better understand waste generation based on its quality (type, cleanliness, etc) and source (urban/rural, commercial/household, community-level/country-level, etc)?

* CC & CB’s Image recognition to help identify the cleanliness and type of recyclability
* The app doubles down to track the brands that use plastics and other waste via the image recognition algorithm, which adds additional incentive rewards points (economics explained in the Our Platform section)
* Meanwhile, CB, our second iteration improves on the data collection procedure by going directly to the source of outdoor waste disposal (e.g. shopping malls, events) where CC influence is only indirect (home based solution that still incentivizes you to carry plastics home for recycling)

1. Predict the consumer attitudes and behaviors to identify potential channels of influence on plastics?

* As explained, the dashboard summarizes all of the relevant data to help identify individual and community wise user patterns. The app also has an ‘Awareness!’ section which displays weekly updates about plastic and waste related issues as heads up (not in a bothersome way!) This initiates public education of the responsible disposal of garbage

**Example solutions**

* Crowdsourcing data collection tool to map local plastic waste flows and stakeholders
* Data visualization tool to provide insights and forecasting on plastic waste flows
* A photo-sharing app that gathers location information on waste generation, aggregation centers, and markets
* A sensor technology that collects data on community-level waste disposal volumes and/or directional flows
* Image recognition technology that verifies waste volumes through photo capture
* Waste-shed modeling tools
* Data collection software and hardware that measures real-time community-level plastic waste generation
* Data analysis and visualization of product-specific data (including packaging materials) from brands, FMCG companies, and distribution networks to accurately capture plastic sources
* Data analysis which links retail consumption and producer’s plastic generation data with plastic waste disposal data to understand behavioral aspects and identify opportunities for intervention
* An innovative labelling technology (ex, QR code) that improve waste collection and recycling

## **Challenge 2** - Optimization of Circular Supply Chains for Plastics

* Collected-for-recycling rate of PET just ~26%, yet they import a large quantity
* Insufficient pricing of post-consumer materials/lack of visibility of post-consumer materials pricing for informal sector waste collection
* Lack of value creation mechanisms in the local supply chains
* Poor and short-term plastic waste collection efforts resulting in insufficient supply of quality, clean plastic feedstock
* Lack of new delivery models to eradicate usage of plastics

Questions & Answers

1. How might we incentivize responsible for plastic use and waste management?

* As mentioned, our CC system relies on two stage basis of incentification, 1. Recycler based incentives, 2. Image recognition drives marketing based incentives.
* Success rate of recycling is a direct function of the value of our incentive scheme. Our surveys across the regions of Colombo indicate that a range of LKR 150-400 per month is enough to get users to actively engage in collecting, and sorting their recyclable waste
* Subsequently, the payout from the recyclers requires and efficient operating base, one with already well established logistics infrastructure. We are currently exploring partnerships with a couple of private, waste collection entities regarding our solution to leverage their more efficient cost base and transfer maximum margin to users

1. How might we enhance the visibility, connectivity, and efficiency of informal sector waste collectors and aggregators?

* Answered above

1. How might we improve the visibility of pricing?

* Our platform shows the reward points for each type of item collected, helping users recognize the pricing of garbage. Furthermore, our system incentivizes the use of clean plastics, as the app penalizes unclean/incorrectly sorted waste.
* This method deeply embeds habitual recycling, which works even in places where there are no incentives

1. How might we better track and improve value generation across the supply chain?

* No plans for this yet. However, our state-of-the art Image recognition and object detection algorithms, have a wealth of (proprietary) image data at their disposal which we will use as training to perform multilayered, segregation into increasingly more specific classes (e.g. reusable vs. reusable yoghourt cups packets). This enables more efficient industrial scale sorting reducing the requirement for manual labor. Please see object detection algorithm figure XXX

1. How might we best identify and improve awareness of existing gender and power dynamics across the value chain?

* No plans for this yet, but a requirement for gender at login will help us understand any dynamics here

Ex**ample solutions**

* A data solution that allows informal waste pickers to access market data in exchange for sale information
* Predictive analytics on plastics pricing data that leverage a mix of local and global market datasets
* A mobile alert system to inform informal waste pickers and aggregators of local market information and pricing changes related to specific resin types
* A data solution that allows decision-makers to see if/how gender impacts variables along the value chain like pricing, and the interplay between gender and power
* Analytics that help identify and/or demonstrate correlations between gendered issues (e.g. gender-based violence), risk and returns
* Machine-learning and/or sensory hardware to measure and capture real-time data on plastic flows by the quantity and resin types
* An application that awards incentives for responsible disposal, recycling or reuse of plastics

## **Challenge 3** - Identification & Prevention of Plastic Waste Leakage

* 80% of ocean plastics come from land-based sources
* Assessment of contributions to ocean pollution from inland populations through riverine systems has been less frequent.
* Explore advanced data solutions to better map, monitor, understand, and forecast plastic leakage into the environment

Questions & Answers

1. How might we map and monitor plastic leakage entering waterways?

* This is an extension of the dashboard app in which we will layer the water bodies, including rivers and lakes nearest to the heat map for high activity locations.
* This allows for targeted collection and education in these critical zones.

1. How might we better understand and address how plastic leakage relates to external factors (landfill location, waste storage, socioeconomic factors, etc)?

* The sample user volume and location data is used to predict the fill rate of local landfills. It can even be used to predict collection capacities and requirements ahead of large beach events etc, and deploy resources effectively

**Example solutions**

* Data analysis which heat maps leakage points by layering various datasets
* Prediction systems to correlate weather patterns and plastic flows, and identify priority intervention spots
* RFID-based sample tracking and mapping of plastic waste across the watershed
* Aerial drone mapping of plastic debris density along riverways and coastal areas

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# Appendix + Planning

*How do we visualize the* ***data****?*

***Dashboard***

*Ajmal + Raneesh*

*- Truck routing information based on the fullness of a CityBin*

*- Based on the disposals or the collections of users, map which areas are recycling more and which areas aren’t as recycling as much. (Heatmap of where recycling is happening)*

*- Which types of recyclables are being disposed of in areas? (Heatmap)*

*- Timeline based recycling habits of consumers*

*- We can see if a particular pro-recycling advertising is working.*

* *Redemption handling*

**Mobile App**

Avinath

-Booking for pickups

-See previous bookings

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-Authentication

-Prize redemption

-News/Advertising

**CityBin App + Arduino**

Avinath

**Validator**

**Models**

2 - models

1 - Generic

-Exists on the device

1 - Specific **10 items of the most popular recyclable items (Anything trained with ImageNet)**

-Milo Milk Packet

-Knuckles Water Bottles

-Coca Cola Glass

-Coca Cola Plast

-Kotmale Peach Flavored Drinking Yogurt

-Elephant House Peach Iced Tea