

1. Problem Statement along with background and significance:

Project objective:

A way to address [lack of recyclable waste segregation at homes] in [localities of Karachi, with less Kabadiwalas] so [the overflow at landfills is minimized].

Project Background:

Arwa's Mother is a typical desi mother. She likes to make the most out of everything. Similar to how she attaches the old soap to the new one and reuses the Jam bottle to store the seasonal Achaars, she stores the recyclable waste or commonly known as Kabaad until she sells it to the kabaadiwala. Though the money earned is a small amount but its useful in hard times. The trade happens once in a while, when considerable amount is stored or there is a Dawat and she needs to get rid of all the excessive mess.

If it's a Dawat she has to send someone urgently out to bring the kabaadiwala or inform the chaukidaar (gate keeper) to send the kabaadiwala to her place if he sees him, a hassle and a never-ending wait with no reliability of him showing up. And if its late than 2 in the afternoon then she lost her chance completely. And so, the stored kabaad goes in the dustbin outside the house with all the other waste.

On the other hand, Batool's Father told her how the Kabaadiwala in their locality was very distraught because of the very less kabaad he collected and requested Batool's Father if he could give the kabaadiwala the kabaad of his place.

It seemed as if the locals wanted to sell the kabaad and the kabaadiwalas were in dire need of buying it but there was some gap in between that could not be met causing most of the recyclable waste going in the junk resulting in overflowing of the landfill sites. After doing interviews, other primary research and secondary research we saw that maximum people in Karachi segregate their waste for the kabaadiwala but still very less recyclable waste is recycled.

Our idea aims on how the path between the locals and the kabaadiwalas plus between the kabaadiwalas and the relevant industries could be strengthened so that this existing system could be standardized and made efficient.

Project Significance:

Up to 87 percent of the 16,500 tons of municipal waste generated daily in Karachi is recyclable [1][2], but not even 30% of it is actually recycled. Like other developing countries, Pakistan lacks waste management infrastructure, creating serious environmental problems. Most municipal waste is either burned, dumped, or buried on vacant lots, threatening the health and welfare of the general population. [2] All major cities of Pakistan face enormous challenges on how to manage urban waste. Bureaucratic hurdles, lack of urban planning, inadequate waste management equipment, and low public awareness contribute to the problem.

One of the major problems is the inefficient of the waste at the producer level. The separation of recyclable waste helps in processing because the major part of processing is waste segregation.

The lack of segregation of the waste at the source in Karachi leads to various problems, including roadside trash, blocking of sewage and gutter lines, incineration of waste on every other corner, overflow of the landfill sites and many more.

According to a study, around 80% of the people in Karachi from different financial backgrounds segregate their waste to sell the waste that can be recycled. Since decades, there exists a culture of selling the recyclable waste to a collector known as a Kabaadiwala who would then sell it to the relevant industries. However, the maximum of trash is not recycled. There can be various reasons for this problem like the lack of ease in selling the waste at the source, the collected waste not reaching the proper industries, the unawareness about what wastes can be recycled, the inefficiency of the complete chain etc.

The strengthening of this existing system can significantly lessen the burden on the waste processing at the landfill sites. Maximum waste can be recycled if delivered to the relevant industry. From the interviews conducted we found out that the industries that recycle from scrap in Karachi have a major chunk of their raw material imported from other countries. If the industries receive properly segregated waste locally their extensive cost in importing or segregating from the landfill sites can be saved. One of the interviewees agreed that if a direct connection with the households could be achieved, they would benefit significantly. Thus, our idea was to decentralize and build a D2C model to make this system efficient.

We want to standardize this complete chain by providing a digital ease to this existing system. Kabaarz is an app that connects the users to the nearest collector anytime, anywhere and at a click. In addition, it also informs the users on the type of waste that can be recycled and its market value. This will build awareness and encourage the locals to separate maximum waste for the Kabaarz.

Moreover, it also provides the collectors the information about the recycling industries. After interviewing one of the Kabaadiwala, it showed that they do not have much information about anything and they just buy the kabaad from the households and sell it to the dukaans, which are basically shops that buy the kabaad from the locals and kabaadiwalas and sell it to the industries. He said he earns very less and sometimes no money when he sells the kabaad to the dukaan. If these collectors are given information about the relevant industries they can earn more and can also be aware of the Kabaad that can be collected. Bringing the industries in the system completes the chain and eradicates the chance of breaking off of the chain.

2. Overview of Entire System and its decomposition into subsystems:

Functional Architecture:

Our design solution consists of the following subsystems, where each subsystem represents a different function independent of other functions:

1. Tracking System: To track location of nearest collectors and industries.
2. Navigation System: To provide collectors and throwers location.
3. Notification System: To provide users notification of waste collection.
4. Database System: To store user data securely.
5. Payment System: To manage payment to users.
6. Registration System: To sign up to use the app service.

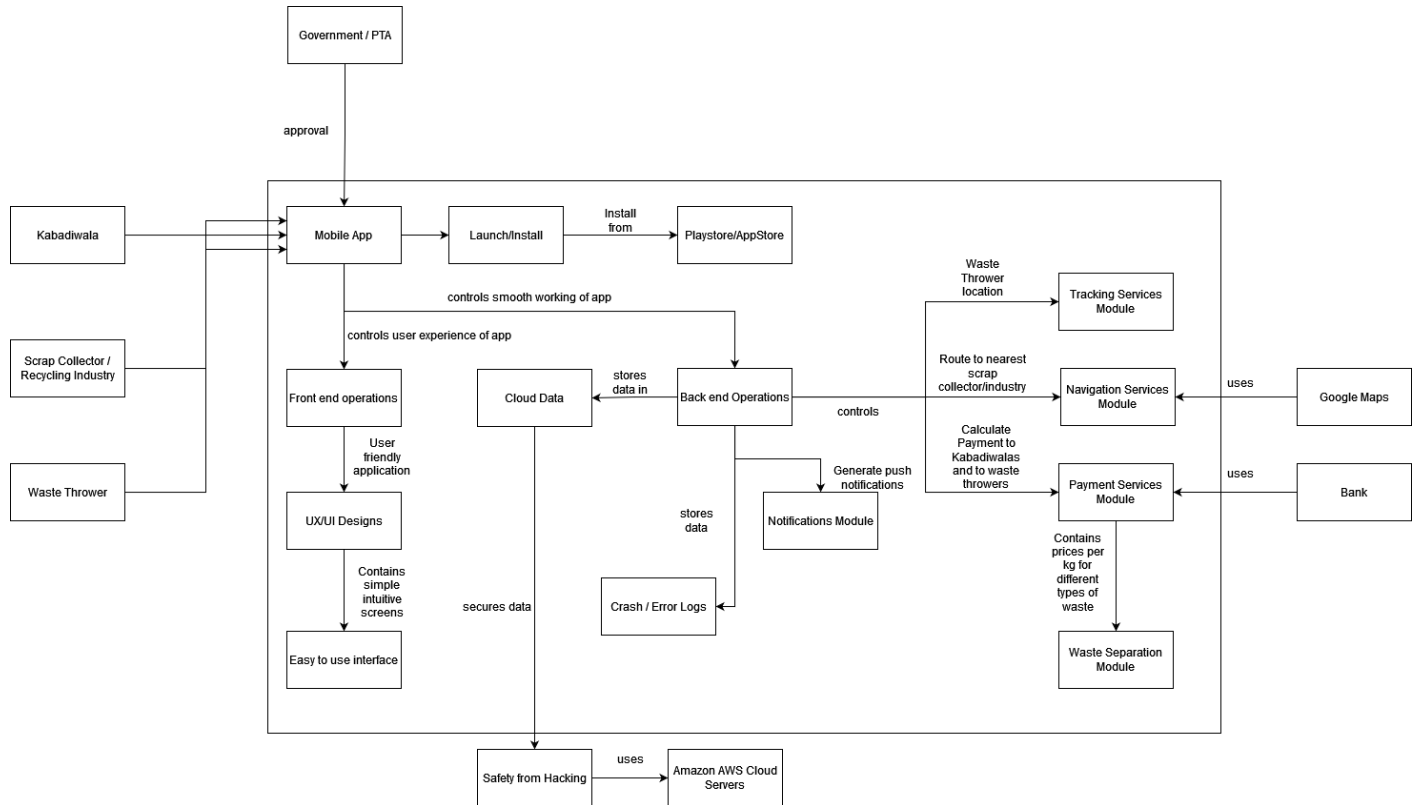
Further details with relevant input, output and interactions is summarized in the following functions table:

Function Name	Description	I/O	Interaction(s)
Tracking System	<ul style="list-style-type: none">• App should find the pickup location of thrower through tracking system• App shall find location of nearest scrap collectors/industries available	Location information	GPS, Location services
Navigation System	<ul style="list-style-type: none">• App should provide interface of maps and information of Kabadiwalas and industries	Data from Google Map servers	Location service
Notification System	<ul style="list-style-type: none">• App shall provide notification service of waste collection• Collector/industry shall receive notification of accepting• App shall send notification of	Push notifications, reminders, alarms	Sounds, ringtones

	accepted pickup session		
Cloud Database System	<ul style="list-style-type: none"> To store user information on cloud servers To keep track of all information in an organized manner 	Upload & Download data from servers Record & Extract information	Securely stores data Organizes data
Payment System	<ul style="list-style-type: none"> To decide amount of payment to users per kg of trash depending on the type of trash To decide amount of payment by industries and collectors to trash pick-up personnel Online payment or wallet transfer system 	Quantity & Type of waste provided by users to Kabadiwalas and Kabadiwalas to collectors and industries	Records and calculates payment information
Registration System	<ul style="list-style-type: none"> To sign up or login into the application 	Personal information such as Name, Contact info	Records personal information

Functional Overview:

The following flow chart diagram represents the functional architecture of our project. It illustrates the overall working of different modules of our system as a whole single entity. The flow diagram also shows how the user is connected with our project.

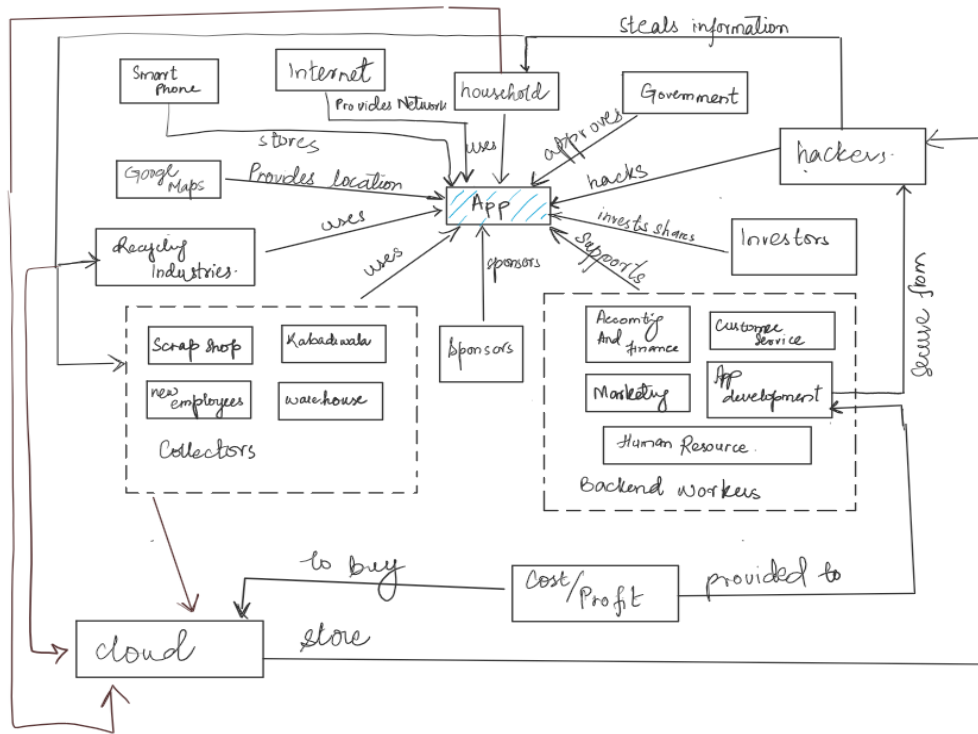


Actors and Stakeholders of the system:

The following table lists and defines the main actors and stakeholders of our system:

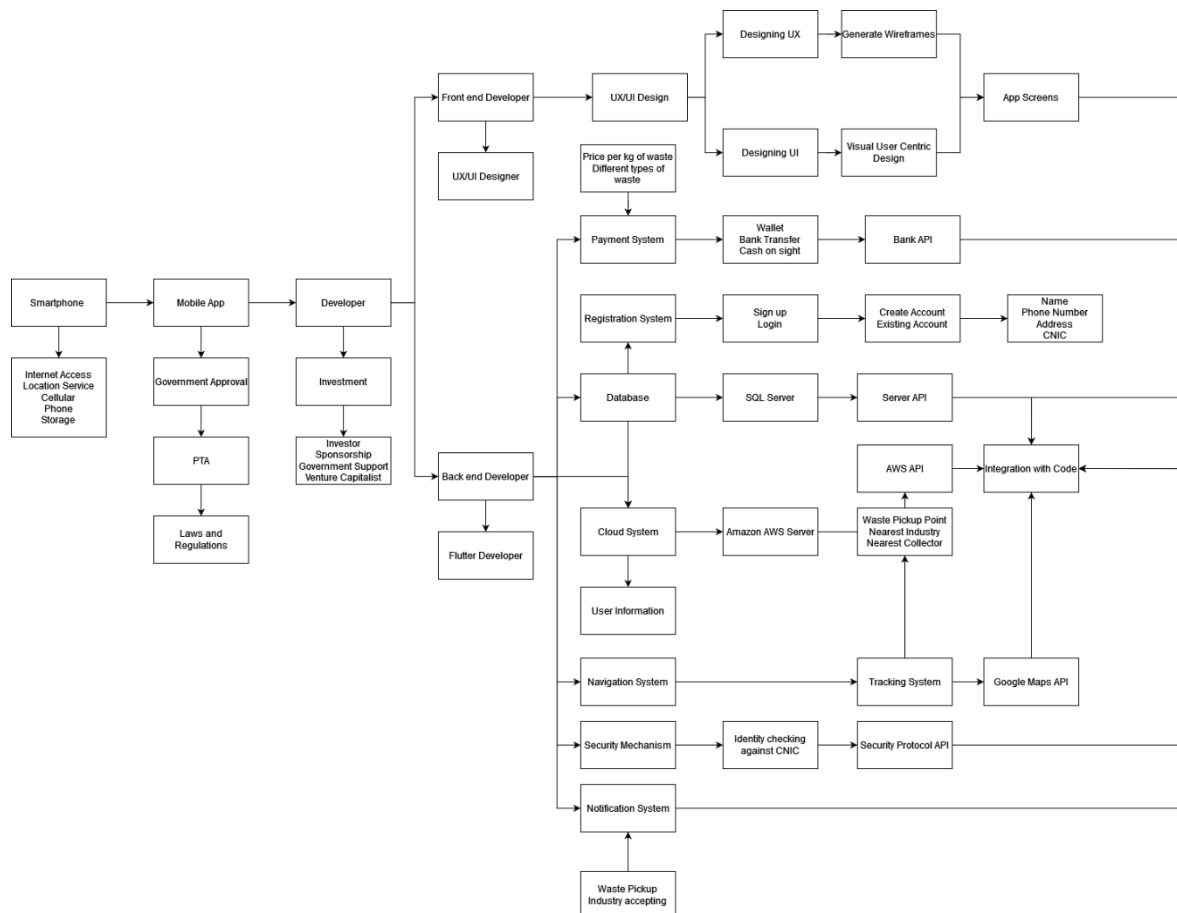
Actor	Definition
Smart Phone	It is used to access the Application and store it.
Internet	It provides network to the app for functioning and communication
Google Maps	It provides location and path to the industries and households
Recycling Industries	It uses the App to get the recyclable trash.
Collectors <ul style="list-style-type: none">KabadiwalaScrap ShopNew employeesWarehouse	Collectors uses the app to communicate with the households and industries and find their location and information.
Household	Household uses the app to call the collector
cloud	Stores the information of the users
Sponsors	It sponsors the app and the system
Cost/Profit	Required to run the application smoothly and sustain it
Government	It approves the Application
Hackers	Can hack the app and steal information of app and users
Investors	Invests shares and provide cost
Backend Workers	It helps and support the smooth functioning of the complete system
Accounting and Finance	Handles all the cost of the app and its flow
Customer Service	Communicates with the customers and listens to their feedback and concerns
Marketing	Helps to promote the app
App Development	Develops the app
Human Resource	Hires people and handles the staff

Context Diagram:



Physical Architecture:

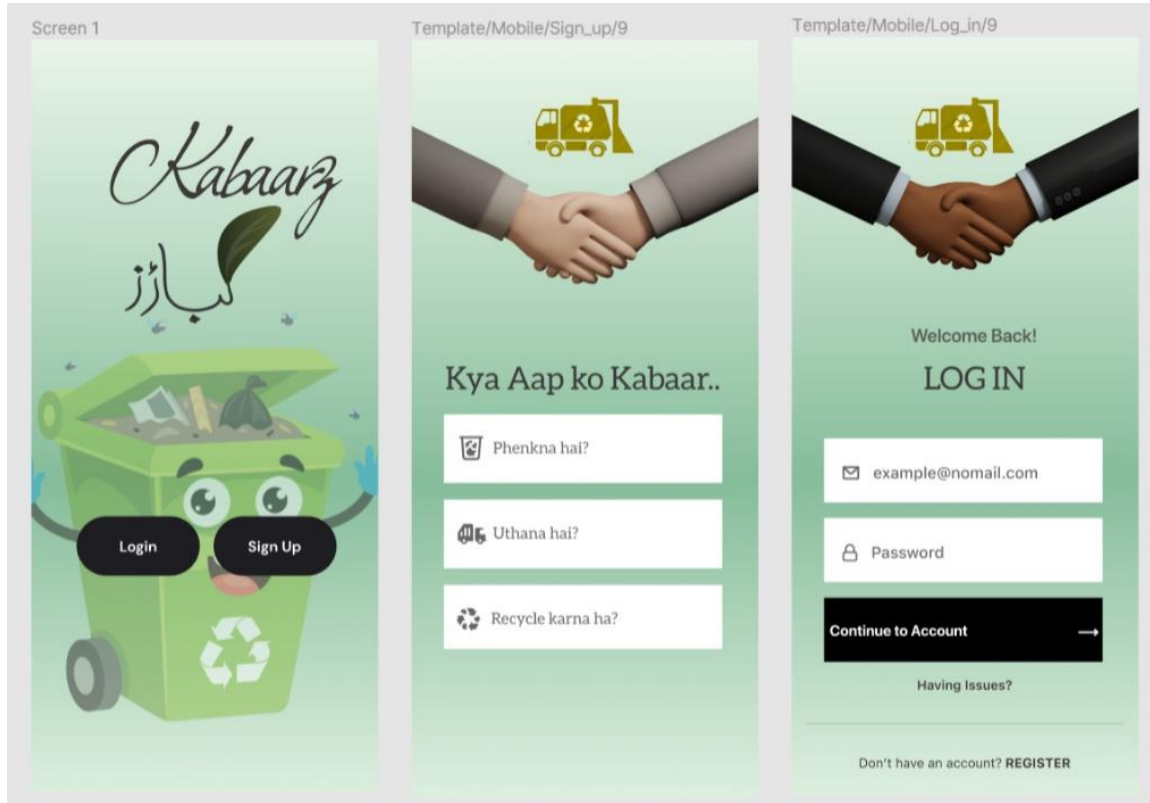
The following flow chart diagram illustrates the physical architecture of our design:



3. Design Details of each Subsystem and each function

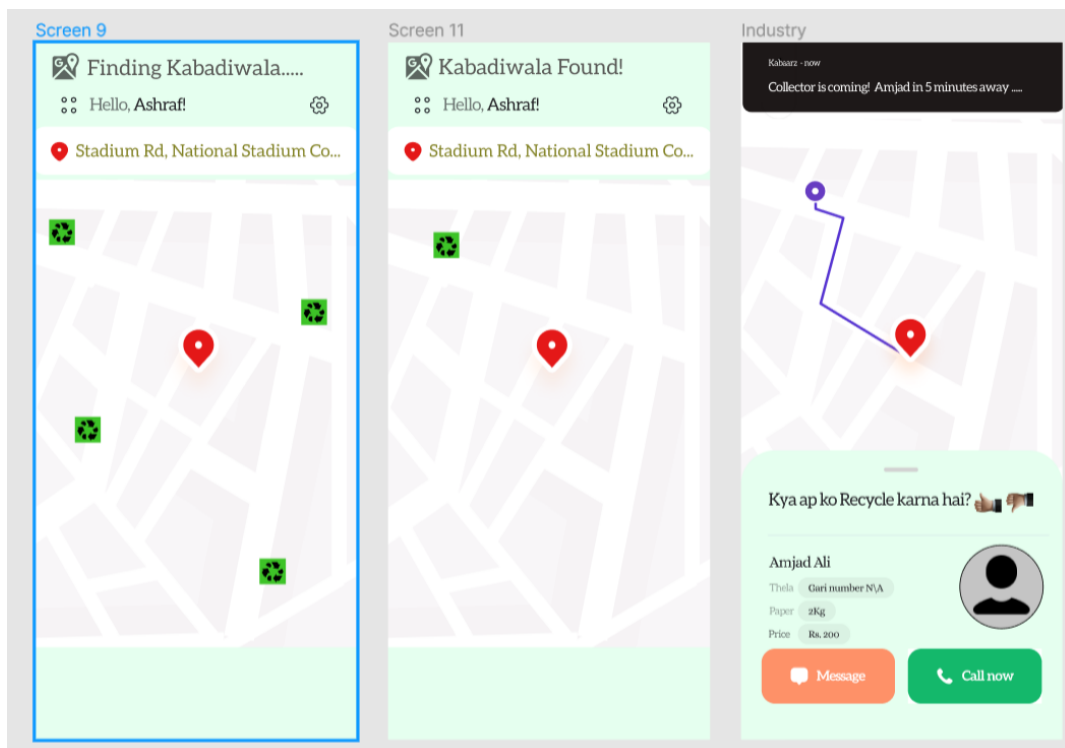
UX/UI and Important Interface Screens:

Signup Screens



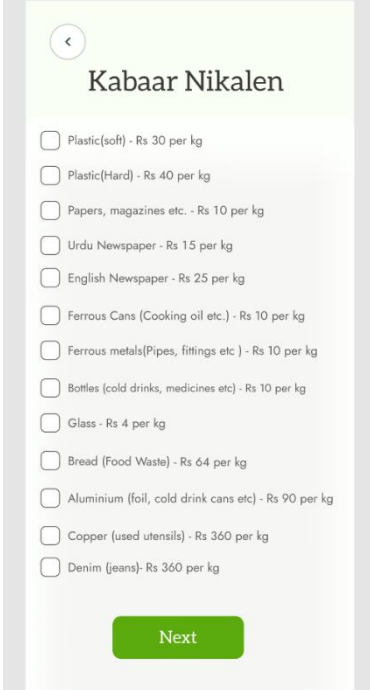
The above screen designs show interface for different users/stakeholders to sign up.

Tracking and Navigation:



The above screen shows tracking feature of our design.

Different Types of Trash Screen:



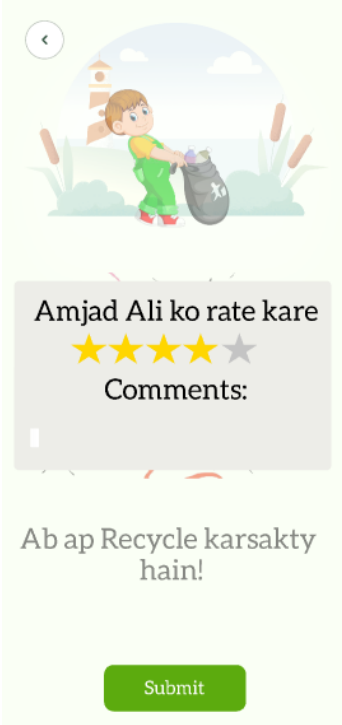
The screenshot shows a mobile application interface titled "Kabaar Nikalen". At the top left is a back arrow icon. Below the title is a list of 15 items, each with an unchecked checkbox and a price per kg:

- ☐ Plastic(soft) - Rs 30 per kg
- ☐ Plastic(hard) - Rs 40 per kg
- ☐ Papers, magazines etc. - Rs 10 per kg
- ☐ Urdu Newspaper - Rs 15 per kg
- ☐ English Newspaper - Rs 25 per kg
- ☐ Ferrous Cans (Cooking oil etc.) - Rs 10 per kg
- ☐ Ferrous metals(Pipes, fittings etc) - Rs 10 per kg
- ☐ Bottles (cold drinks, medicines etc) - Rs 10 per kg
- ☐ Glass - Rs 4 per kg
- ☐ Bread (Food Waste) - Rs 64 per kg
- ☐ Aluminium (foil, cold drink cans etc) - Rs 90 per kg
- ☐ Copper (used utensils) - Rs 360 per kg
- ☐ Denim (jeans)- Rs 360 per kg

At the bottom center is a green button labeled "Next".

The above screen design shows different types of trash that can be recycled.

Ratings Screen:



The screenshot shows a mobile application interface for ratings. At the top left is a back arrow icon. Below it is an illustration of a boy in green overalls holding a black trash bag, with a lighthouse in the background. The text "Amjad Ali ko rate kare" is displayed above a row of five stars, where the first four are yellow and the fifth is grey. Below the stars is the text "Comments:" followed by a text input field. At the bottom is a green button labeled "Submit".

Database Snippets:

Interfaces Kabaarz Database							
Thrower Registration Account							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Name	Contact	Email	Password	Short Description	Rating	+
1	Hamza Irfan	03414278279	hi05466@mail.com	lamarichguy	good experience	★★★★★	
2	Ashraf Bhai	03454268792	as15499@mail.com	kachralelo	nice service	★★★★★	
3							
+							

Interfaces Kabaarz Database							
Thrower Registration Account Collector Registration Account Industries Registration Account Waste Recycled by Thrower Waste Recycled by Thrower in 2022							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Name	Contact	Email	Password	Short Description	Rating	+
1	Junaid Ahmad Memon	03127896645	jamthebest@mail.com	controltheory	Timely service	★★★★★	
2	Amjad Ali	03243678987	aj05499@mail.com	kachradedo	Honest work	★★★★★	
+							

Interfaces Kabaarz Database							
Thrower Registration Account Collector Registration Account Industries Registration Account Waste Recycled by Thrower Waste Recycled by Thrower in 2022							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Name	Contact	Email	Password	Rating	+	
1	Muhammad Farhan	03127896357	computervision@mail.com	microcontrollers	3		
2	Hamza Brother's	03129634123	ri12345@mail.com	kachradoupaisaylou	5		
3	Hamza Brother's	03129634123	ri12345@mail.com	kachradoupaisaylou	5		
+							

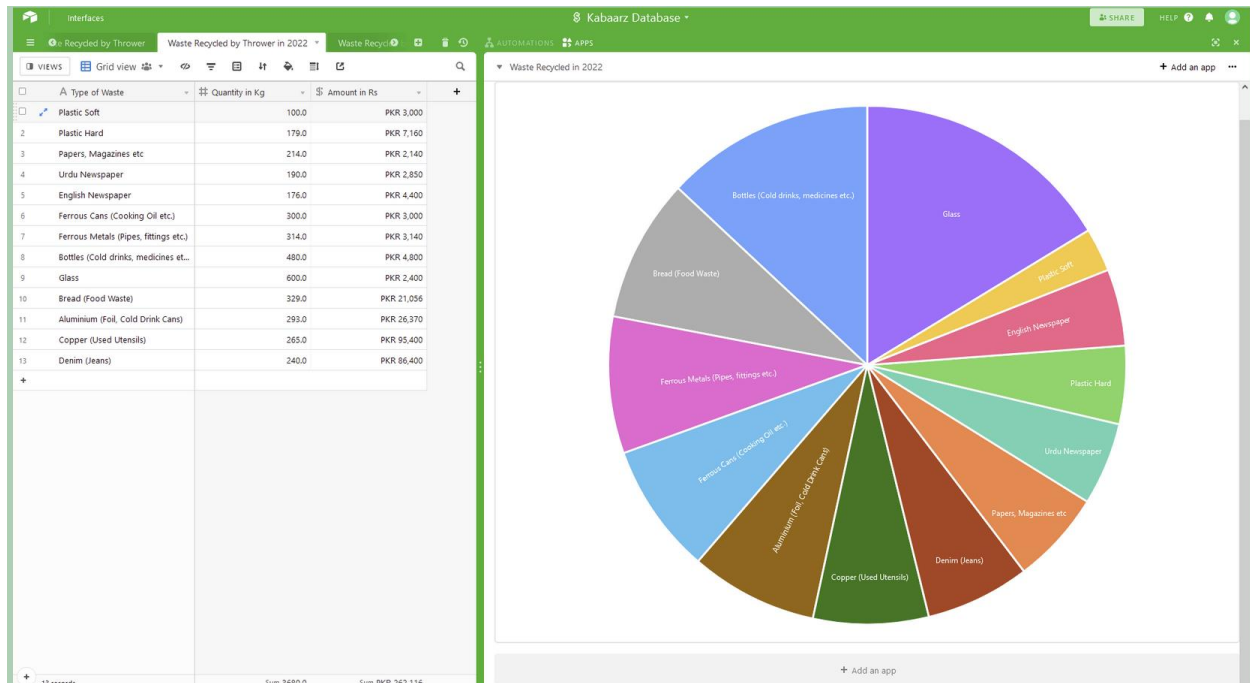
The above snippet shows different tables that store the user registration/sign up data in our app's database.

Interfaces Kabaarz Database							
Thrower Registration Account Collector Registration Account Industries Registration Account Waste Recycled by Thrower Waste Recycled by Thrower in 2022							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Type of Waste	Quantity in Kg	Amount in Rs	+			
	Plastic Soft	1.0	PKR 30				
	Plastic Hard	1.0	PKR 40				
	Papers, Magazines etc	1.0	PKR 10				
	Urdu Newspaper	1.0	PKR 15				
	English Newspaper	1.0	PKR 25				
	Ferrous Cans (Cooking Oil etc)	1.0	PKR 10				
	Ferrous Metals (Pipes, fittings etc)	1.0	PKR 10				
	Bottles (Cold drinks, medicines etc)	1.0	PKR 10				
	Glass	1.0	PKR 4				
	Bread (Food Waste)	1.0	PKR 64				
	Aluminium (Foil, Cold Drink Cans)	1.0	PKR 90				
	Copper (Used Utensils)	1.0	PKR 360				
	Denim (Jeans)	1.0	PKR 360				

Interfaces Kabaarz Database							
Thrower Registration Account Collector Registration Account Industries Registration Account Waste Recycled by Thrower Waste Recycled by Thrower in 2022							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Type of Waste	Quantity in Kg	Amount in Rs	+			
1	Plastic Soft	1.0	PKR 30				
2	Plastic Hard	2.0	PKR 80				
3	Papers, Magazines etc	1.0	PKR 10				
4	Urdu Newspaper	1.0	PKR 15				
5	English Newspaper	1.0	PKR 25				
6	Ferrous Cans (Cooking Oil etc)	1.0	PKR 10				
7	Ferrous Metals (Pipes, fittings etc)	1.0	PKR 10				
8	Bottles (Cold drinks, medicines etc)	1.0	PKR 10				
9	Glass	1.0	PKR 4				
10	Bread (Food Waste)	1.0	PKR 64				
11	Aluminium (Foil, Cold Drink Cans)	1.0	PKR 90				
12	Copper (Used Utensils)	1.0	PKR 360				
13	Denim (Jeans)	1.0	PKR 360				

Interfaces Kabaarz Database							
Thrower in 2021 Waste Recycled by Collector Waste Recycled by Collector in 2022 Waste Recycled by Industry							
Views Grid view Hide fields Filter Group Sort Color Share view							
<input type="checkbox"/>	A Type of Waste	Quantity in Kg	Amount in Rs	+			
1	Plastic Soft	1.0	PKR 30				
2	Plastic Hard	2.0	PKR 80				
3	Papers, Magazines etc	1.0	PKR 10				
4	Urdu Newspaper	1.0	PKR 15				
5	English Newspaper	1.0	PKR 25				
6	Ferrous Cans (Cooking Oil etc)	1.0	PKR 10				
7	Ferrous Metals (Pipes, fittings etc)	1.0	PKR 10				
8	Bottles (Cold drinks, medicines etc)	1.0	PKR 10				
9	Glass	1.0	PKR 4				
10	Bread (Food Waste)	1.0	PKR 64				
11	Aluminium (Foil, Cold Drink Cans)	1.0	PKR 90				
12	Copper (Used Utensils)	1.0	PKR 360				
13	Denim (Jeans)	1.0	PKR 360				

The above snippet shows different tables that store waste recycling and payment information in our app's database.



The above snippet shows the data analysis provided by the database we use.

For the prototyping we only designed screens that represented the key features of our application, these were part of the front end of our design and were given high priority because they represent the prototype.

For the backend of our prototype, we only developed the database which stores all information of the app and user, the database is integrated with our front-end design, however this is the only thing we worked on in our backend, other backend features were given low priority because they required extensive development and time, and they were not relevant for prototyping stage.

The statistical analysis from waste recycled data from our database tells us about the efficacy of our prototype, using graphs we can determine how much waste has been recycled every year and get a visual representation of data we obtain from our application.

4. Testing and Assessment of our Design:

Goal and Ideal Metrics:

In order to create a perfectly user centric design that fulfills the user requirements, we decided to establish different metrics which will assist us in testing our goals and features of our prototype, this was an important phase of our design research because it enabled us to refine our objectives as per user needs. The ideal and approximate metrics test the validity of our prototype features and the data collection methods we are going to employ are all summed up in the table below:

Objective	Question	Ideal Metric	Approximate Metric	Data Collection Method
User-friendly interface	How to make the app user-friendly?	Using icons along less text	-	Survey and feedback
Payment collection through app	How do users pay?	Through digital wallet in the app	Cash in hand	Clicking "Paid" option once transaction is completed
Trash Identification provided by App	How does it identify the type	Adding picture of Kabaar and detecting the type on its own through digital image processing	Selecting the type from drop down menu	Users confirming the added type
App should be responsive	What causes lag?	Heavy memory usage and slow internet	-	User Feedback
	How to increase responsiveness?	Utilizing as low memory as possible. Keeping app basic and simple	-	Information of cache used, memory usage.
Performance	How to ensure app is functioning smoothly?	No lag between transitions	-	Response time after selecting an option
Security in app	What can harm the app and how?	Hackers can steal information	If the password is known to another person related to a user and they can misuse it.	-

	How to keep the app secure?	Using anti-theft software's like affiniti, securiti.ai	-	Information kept safe in the cloud
Regular Updates required for the app	Why to update?	To add new features and bug fixing	Making the app more efficient	User feedback and rating
Personalization in app	Why is personalization essential?	To give ease to users e.g., dark mode, changing the view of information	-	What users suggest to be personalized through a survey
Analytics provided in the app	How to show analytics	A tab to see all analytics including thrown Kabaar, money paid or received etc. in the form of a dashboard.	Present whenever the app is opened	Through inspection of what users prefer

Technical Architecture:

Code	Requirements	Actor/block s	Inputs/outputs	Function	Verified by
K1	<p>Government shall approve app</p> <ul style="list-style-type: none"> The app should be given patent The app should be given approval on all the features it provides In accordance with PTA guidelines for example follow MDM regulations about application use for 18+ age individuals Follow federal terms and conditions Registered with Federal Mobile Apps directory 	<p>Government</p> <ul style="list-style-type: none"> -Representative -Departments 	<p>I: Request of approval</p> <p>O: Approval</p>	Approve	PTA Regulations
K2	<p>Backend Workers shall work on designing and smooth working of app</p> <ul style="list-style-type: none"> The app should provide 	<ul style="list-style-type: none"> -Back-end workers -users 	<p>I: interfacing and app designing</p> <p>O: user experience</p>	Backend working for App designing	Checking through rigorous testing/beta

	<p>information about the materials (cost and type)</p> <ul style="list-style-type: none"> • Server response time should not exceed 200 milliseconds • Screen transition time should not exceed 100 microseconds • The app should provide maps and location within 50 milliseconds • The app should provide info about the industries within 100 milliseconds • The app should provide a rating facility to build a secure network • The app should be safe for customer information, use end to end 256k encryption • The app should be user friendly • The app should have minimum steps in selling the waste 	- flutter developers		and modification	testing
K3	<p>Google maps shall allow their integration in app</p> <ul style="list-style-type: none"> • The app should be able to integrate with the app • The google map should provide location and shortest paths • Connection to Google Maps server within 2 to 3 seconds. 	-Maps server	<p>I: Request to integrate</p> <p>O: API incorporated in app</p>	Integrate	Google terms and conditions
K4	<p>Cloud shall store all user related and app data</p> <ul style="list-style-type: none"> • The cloud should be bought with a continuous subscription of \$5/ month for 5 GB data size per user for regular package. • The cloud should store history of users and ratings of customers • The app should have algorithms to take the 	<p>-Cloud</p> <p>-App consumers</p>	<p>I: User information of contact, location and the trash they collect, throw, recycle</p> <p>O: Securing data</p>	Storage	Amazon AWS Authorization and Registration

	average of the ratings and build a trust quotient				
K5	<p>Internet shall allow app installation and functioning</p> <ul style="list-style-type: none"> Internet should be at least 2G for proper app functioning The app should be no more than 100MB Bandwidth should be at least 25 MHz 	-Internet	<p>I: Searched app of Kabaarz</p> <p>O: Installed app</p>	Install	-in app permission
K6	<p>Smart phones shall be able to load the app for usage</p> <ul style="list-style-type: none"> The app should be no more than 100MB The app should be on play store of both IOS and android versions 	<p>-Smart phones</p> <p>-Play store/ Appstore</p>	<p>I: Searching the app and checking compatibility</p> <p>O: Allowance of installation and saving app in memory</p>	Store	Google play store, apple app store regulations
K7	<p>Investors shall invest in the app development</p> <ul style="list-style-type: none"> The investors should invest according to the valuation set by the company, initially it would cost around \$ 500 for the first basic working prototype. 	<p>-Investors</p> <p>-Finance</p> <p>-Money</p> <p>-Employees and workers in app development</p>	<p>I: Investing through proper contract</p> <p>O: Allocation of money for app updating and salaries</p>	Invest	Legal accounting firm
K8	<p>Sponsors shall sponsor and market the product/app</p> <ul style="list-style-type: none"> \$100 to \$500 sponsorship packages which include in app ads and promotion etc. 	<p>-Sponsors</p> <p>-Finance</p> <p>-Money</p> <p>-Employees and workers in app development</p>	<p>I: Sponsorship provided through proper contract</p> <p>O: Allocation of money for app updating and salaries</p>	Sponsor	Legal accounting firm
K9	<p>Users shall sign in</p> <ul style="list-style-type: none"> The sign in should be easy to access and understand with minimum steps The app should have algorithm to not let same username or email ID to have multiple accounts 	<p>-User</p> <p>-User data</p> <p>-Cloud</p>	<p>I: Registering to the app by providing relevant information</p> <p>O: Registered for lifetime and data saved on cloud</p>	Sign in	OTP, email verification

	<ul style="list-style-type: none"> The sign in process must take contact number of the user for easy communication 				
K10	<p>Hackers can steal the information</p> <ul style="list-style-type: none"> The app should have proper security to prevent hacking The app should have end to end encryption for the users 256K encryption of data 	<ul style="list-style-type: none"> -User data -Hacker -Backend worker -Authenticator app 	<p>I: Hacking Algorithms</p> <p>O: Information stolen</p>	Steal	Safety authenticator, OTP
K11	<p>Types of trash shall be specified in app</p> <ul style="list-style-type: none"> All the types of recyclable items that are bought in Karachi must be mentioned in the app The materials must also have their prices mentioned per kg. Paper is 10 Rs/kg Glass is 20 Rs/kg Metal is 50 Rs/kg Plastic is 40 Rs/kg Organic Waste is 30 Rs/kg 	<ul style="list-style-type: none"> -Trash -Users (thrower, collector, recycler) 	<p>I: Type of trash</p> <p>O: Saved in database for the case of collectors and recyclers. For thrower, it redirects to relevant collectors or industries for specific type of trash</p>	Specify	Searching algorithm of trash name written from database
K12	<p>Scrap thrower/collector selects the type with the information of price per kg</p> <ul style="list-style-type: none"> The app must ask approval of the user sent by the buyer with the offered amount 2 FA authentication The materials must also have their prices mentioned per kg. Paper is 15 Rs/kg Glass is 25 Rs/kg Metal is 55 Rs/kg Plastic is 45 Rs/kg Organic Waste is 35 Rs/kg 	<ul style="list-style-type: none"> - Thrower - collector - trash 	<p>I: Selection of type of role in the chain (throw, collect, recycle)</p> <p>O: Interface of which type trash to select given by database in cloud</p>	Select	Confirmation interface for selection
K13	App should find the pickup location of thrower through tracking system	- tracking system	<p>I: Location</p> <p>O: for trash-money</p>	find	Check of permission for current or

	<ul style="list-style-type: none"> GPS integration Algorithms to find shortest path and provided time to reach Response time should not exceed 200 milliseconds 	<ul style="list-style-type: none"> - Thrower - trash - money 	exchange		typed location
K14	<p>App shall find location of nearest scrap collectors/industries available</p> <ul style="list-style-type: none"> GPS integration Algorithms to find shortest path and provided time to reach Response time should not exceed 200 milliseconds 	<ul style="list-style-type: none"> - tracking system - collectors - industries - trash - money 	<p>I: Location</p> <p>O: for trash-money exchange</p>	find	Check of permission for current or typed location
K15	<p>App shall provide interface of maps and information of Kabadiwalas and industries</p> <ul style="list-style-type: none"> GPS integration Algorithms to find shortest path and provided time to reach Response time should not exceed 200 milliseconds 	<ul style="list-style-type: none"> -Maps -Cloud -User data - Users 	<p>I: map API integrated and displaying map with relevant options</p> <p>O: Users can see the information they are trying to get contact in</p>	Interface	Google maps
K16	<p>Person/collector shall select a Kabadiwala/industry depending on pickup time and charges</p> <ul style="list-style-type: none"> GPS integration Algorithms to find shortest path and provided time to reach The app must ask approval of the user sent by the buyer with the offered amount 	<ul style="list-style-type: none"> -Thrower -collector - industry - Money - trash 	<p>I: Options of relevant Collectors/ industries with their information displayed</p> <p>O: Depending on the prices, location, the option selected and notified too other</p>	select	Confirmation interface for selection
K17	<p>App shall provide notification service of waste collection</p> <ul style="list-style-type: none"> The app must ask approval of the user sent by the buyer with the offered amount 	<ul style="list-style-type: none"> - smart phone - internet - notifier <u>thrower</u> (to collector) and <u>collector</u> (to recycler) - notified 	<p>I: Selection of the next person in chain to trade with</p> <p>O: Receival of notification to the next person in chain</p>	Notify	Allow push notification of system

		collector and recycler			
K18	<p>Collector/industry shall receive notification of accepting</p> <ul style="list-style-type: none"> The app must ask approval of the user sent by the buyer with the offered amount 	<ul style="list-style-type: none"> - smart phone - internet - collector - industry 	<p>I: Receival of notification</p> <p>O: Accepting or rejecting the offer of trash trade</p>	Notify	Allow push notification of system
K19	<p>App shall send notification of accepted pickup session</p> <ul style="list-style-type: none"> The app should have notification system At least 3 notifications 	<ul style="list-style-type: none"> - smart phone - internet - User - Trash - money 	<p>I: Receival of notification</p> <p>O: Keeping the exchanged source ready and meeting</p>	Accept	Allow push notification of system
K20	<p>Trash shall be weighted</p> <ul style="list-style-type: none"> The app should have the section for collector to enter the weight and the amount he would pay for that weight Minimum weight is 10 kg. 	<ul style="list-style-type: none"> -Users -trash -weighing machine -money 	<p>I: trash</p> <p>O: weight of trash</p>	Weigh	Instrument test for accuracy compared to a standard weighing machine
K21	<p>Collector/Industry shall pay Person who throws/collector</p> <ul style="list-style-type: none"> The app should have an approval system to ensure the payment is made The rating system should ensure any discrepancy made in the rating The customer service should make sure to address any such issues The materials must also have their prices mentioned per kg. Paper is 20 Rs/kg Glass is 30 Rs/kg Metal is 60 Rs/kg Plastic is 50 Rs/kg Organic Waste is 40 Rs/kg 	<ul style="list-style-type: none"> -money - users 	<p>I: weighted trash and set prices</p> <p>O: money paid and exchanged with trash upon consensus</p>	Pay	Payment receipt (Digital)

5. Connecting the results to project objectives obtained through stakeholder's interviews:

Features of Our System:

Following tables sum up the features (in context to the subsystems and the prototypes discussed above) according to our design, the ranks are assigned according to the relative priority assigned to each feature/objective which is decided by keeping the stakeholder assessment in mind.

Objective	Relative Priority	Rank	Stakeholder
The registration system is simple and gets necessary information	0.02	8	Throwers, Collectors, Recycling Industries, front end developer
The tracking system is accurate and responsive	0.01	9	Thrower, Collector, backend developer
The payment calculation and online transfer system is smooth and secure	0.14	3	Throwers, Collectors, Recycling Industries, backend developer
The navigation system is accurate and update to date	0.03	7	Thrower, Collector, backend developer
Security system ensures data safety through encryption	0.15	2	Throwers, Collectors, Recycling Industries, backend developer
User Interface is intuitive and user friendly	0.12	4	Throwers, Collectors, Recycling Industries, front end developer
App is functioning smoothly	0.31	1	Throwers, Collectors, Recycling Industries, backend developer
App is very Responsive	0.10	5	Throwers, Collectors, Recycling Industries, backend developer
The app accurately identifies	0.09	6	Thrower, Collector, backend developer, front end developer

The weighted scores provide a further detailed overview of our prototype features and their relative priority according to the user.

Attribute Name	Weights
User Interface	10%
Payment Collection	15%
Trash Identification	8%
Responsiveness	17%
Performance	10%
Security	15%
Regular Updates	5%
Personalization	5%
Analytics	5%
Social Media Integration	10%

Attribute Name	Front end	Back end	Integration
User Interface	5	2	4
Payment Collection	4	4	5
Trash Identification	4	4	3
Responsiveness	3	5	4
Performance	3	5	4
Security	2	5	4
Regular Updates	1	4	3
Personalization	5	3	4
Analytics	3	3	4
Social Media Integration	2	3	2

Attribute Name	Weights	Front End		Back End		Integration	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
User Interface	10%	5	0.5	2	0.2	4	0.4
Payment Collection	15%	4	0.6	4	0.6	5	0.75
Trash Identification	8%	4	0.32	4	0.32	3	0.24
Responsiveness	17%	3	0.51	5	0.85	4	0.68
Performance	10%	3	0.3	5	0.5	4	0.4
Security	15%	2	0.3	5	0.75	4	0.6
Regular Updates	5%	1	0.05	4	0.2	3	0.15
Personalization	5%	5	0.25	3	0.15	4	0.2
Analytics	5%	3	0.15	3	0.15	4	0.2
Social Media Integration	10%	2	0.2	3	0.3	2	0.2
Total	100%	32.00	3.18	38.00	4.02	37.00	3.82

Stakeholder`s Interviews and Our Journey:

Interviews:

Interviewer: Arwa Hasnain

Interviewee: Manager of Scrap Metal Traders (Industry)

Questions	Answers
Are you talking from the Scrap Metal traders?	Yes
Where do you get your raw material from?	We majorly import it.
Do you collect wastes from landfill sites	yes
You would have to process that waste and that would cost?	Yes it does
We are planning to build a system that gets the kabaad from the locals to the Recycling Industries. Do you think that would help you	Yes it would definitely help us as that would be much cheaper for us. But that would be not enough amount
Do you buy kabaad from households?	Yes we do, the raddipaper wala/ kabaadiwala buys from households sells to nearest dukaans they sell to the wholesalers and they sell to our warehouses.
Do you think many people in the middle of the chain decreases the profit margin	Yes, a direct connection to the households would decrease the cost.

After this interviewe we decided to add the industries in the app as well. So that the collectors have a direct connection with the industries and there is only one person in between resulting in maximum profit. Moreover, we decide to add the feature that also informs the collector about what wastes each industry will collect and what money are they ready to pay for it so that the industries get the maximum pay as every kabadiwala will know the type of waste they need.

To cater the problem of the waste collected being less we planned to add the types of waste that can be recycled and its price on the household end so that knowing what wastes can actually be recycled maximum waste is recycled and the estimate of the amount earned will motivate the locals to call the kabadiwala.

Interviewer: Arwa Hasnain

Interviewee: Local Kabaadiwala (Collector)

Questions	Answers
Do you get kabaad everyday	Sometimes we get it sometimes we don't
Do you collect from shops or only homes?	Only homes
How much do you earn	6000 per week on average
Where do you sell?	A shop nearby
What is the pricing system	We set amount according to kilos
If people can call you through mobile phone will that be more beneficial	yes , more connection. But can only go through calls and not through msg because not literate
If people teach you to run an app that will help you get orders will you go for it.	Call would be great
If direct industries location is provided would you go? Even if its far	Yes I would as dukaam waale pay sometimes and sometimes dont.

To cater the problem that the dukaans dont pay enough to the kabadiwalas the feature of providing information about the industry would motivate the kabadiwalas to join the app. The feature of calling the kabadiwala would incorporate the local kabaadiwalas who are not literate. The dual language interface is a feature to incorporate this difficulty as well. The feature of userfriendly interface after this interview was a must.

Interviewer: Arwa Hasnain

Interviewee:

According to Arwa's mother it is easy to call whenever we forget, referring that it is necessary that the interface should be simple and relevant so that the users (even those who are not good at using technologies) can use it.

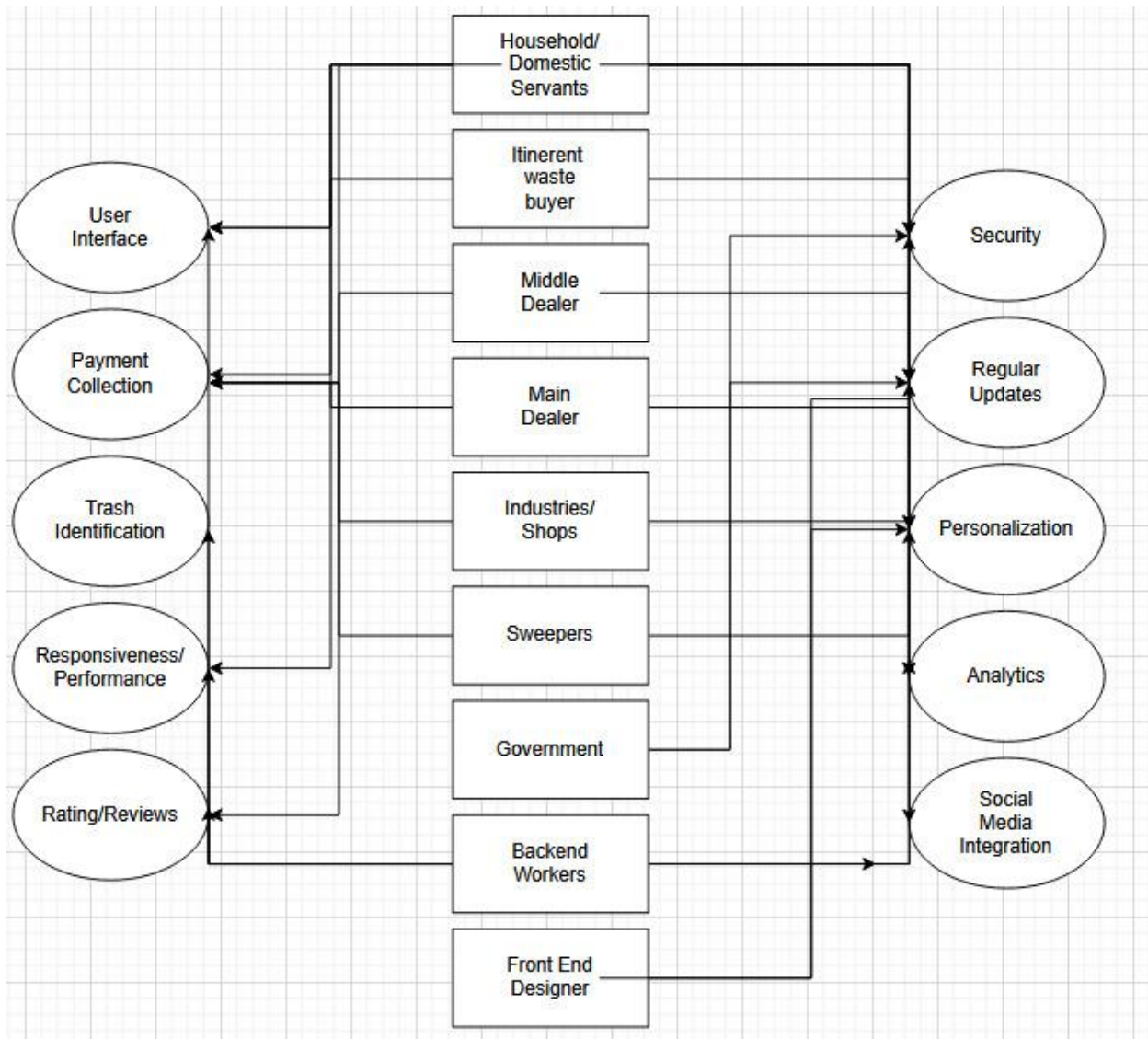
The analytics help in tracking their previous record, motivating them to use the app and be part of the recycling process as much as they can according to the interviews of Habib University Students.

Additionally, since everyone is not an English reader or speaker, priorly discussed many of them are old too, the dual language interface gives them an option to read and go around the app in Urdu Medium. Those who can not understand much Urdu, the icons should be well enough to convey the message and image detection of trash can make things easier for collectors too.

As people are not always comfortable with sharing their personal information and call the Kabadiwalas, usually they know, the data security feature is a must. And, the reviews of kabadiwala will help people to gain credibility over who they are calling. Plus, we can give bonuses to them as they don't earn a lot

Originating Requirements of Our System:

The figure below shows the stakeholders and features mapping for our project. The selection of these features is based on careful analysis of the interviews we conducted with the relevant stakeholder of our project:



The elements on the left-hand side of the figure indicate desirable characteristics of our project, while the features on the right-hand side represent mandatory characteristics of our project. As can be observed, our project's must-have features align with the originating requirements listed in the originating requirements table. As can be observed from the above graphic, the must-have characteristics of the device correspond to the highest-priority features in the preceding section's last table, and these priorities were determined by considering the influence that these features might have on stakeholders and what they truly desire.

Now, let us associate these characteristics with the actual characteristics of our prototype. The prototype was created with great care, taking into account the diverse requirements of stakeholders and the insights gleaned from the interviews. The following table contains a summary of all the characteristics of our device, along with a discussion of how each functionality is implemented in our prototype.

Features	How the prototype supports the feature?
Sign Up	By clicking the sign-up button, you are navigated to the screen where you have to define the type of user (thrower, collector, or industry or 2 nd hand shop).
Log in	Simply add email and password and the system will decide itself your category and navigate you to the relevant screen.
Data Saving	On Cloud, through Bravo studio, in the form of tables – separate for each user. They include registration and recyclables and cash exchange information according to the weights.
Shortest path	It is not actually implemented in the Prototype but an algorithm, e.g., Dijkstra, will find the shortest path for the nearest Kabadiwalas e.g., in Thrower6.
Dual Language Interface	Not implemented due to issues in integrating Urdu Text
Maps, tracking and navigation	GPS and API are to be integrated and their sample can be seen in the prototype in Thrower6, Thrower7, Thrower8, Collector5, Industry5 and Industry9 screens
Payment	Still online payment is optional to integrate yet the price calculated through the selected recyclables and reusable and their quantity e.g., in thrower 9 in details. On payment, the users click the “Paid” button to close the pending request.
Rating	Reviews of Collectors are shown in detail upon clicking one of the nearest Kabadiwala to improve his and app’s efficiency and reliability.

6. Conclusion and Future work:

We started our journey by investigating problems in waste recycling management department followed by research over the sources of waste in Karachi, then we conducted interviews with the relevant stakeholders such as the waste collectors, recycling industries and waste throwers to understand the depth of problem and gain a user perspective of the problem. We then came up with a simple D2C model for our solution which connects the waster throwers, collectors and recycling industry through a digital platform which provides them incentives for waste recycling and also creates a digital infrastructure for earning livelihood. We drew insights from existing D2C applications to gain inspiration, combined with analysis of our stake holder interviews we developed features for our prototype. Each feature was assigned a set of functions which that would assist us in achieving our goal while keeping the stakeholder in mind. The results of our prototype are positive and fulfill the requirements of relevant stake holders. We made sure that our design incorporated all the features that fulfilled the requirements put forward by the stakeholders during initial phase of our design.

Overall, it was a great experience working on this problem, to work on a user centric design problem. This is not the end of our journey because we are taking this problem towards the Tech Infusion challenge as well.