System Design Document

IS / HCC 636: Structured Systems Analysis and Design

Recycling Plastics

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1. Introduction

While people expected technology to drive and change businesses, not a lot of people expected the changes would be so abrupt. The plastics industry is an industry that has seen enormous growth over the past few years. However, as it continues to grow, the vast number of plastics entering landfills and their related processes have not yet been addressed properly to try and reduce this concern.

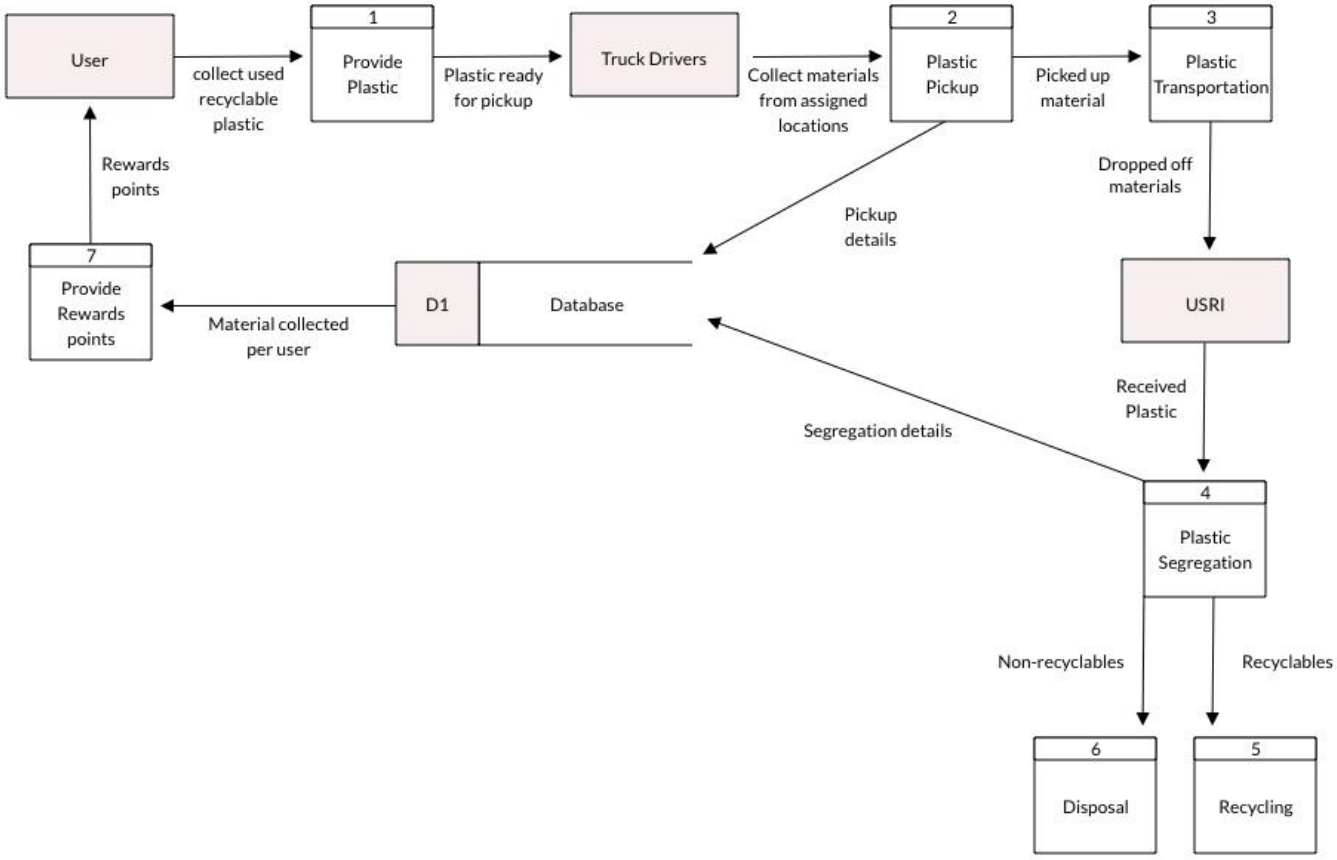
The process of recycling plastics requires a detailed system design. This system design document includes Data Flow Diagrams to illustrate and explain all the different processes involved in recycling plastics, as well as an Entity Relationship Diagram to show the data the system manipulates and the relationships between the data. We've also included a Use Case Analysis to illustrate the narration of the users' activities at specific points in time, and a Sequence Diagram to identify the sequence of events taking place from start to finish. This system design document also contains a section discussing Coupling and Cohesion, which are each important in a process-driven system like the recycling of plastics. Lastly, we've included an Interface Structure Diagram, which will explain many components in the interface and how they will work.

After analyzing the requirements for this work thoroughly, we drew conclusions on the myriad of items that will affect the implementation phase. The modules that have a tight coupling will be difficult to implement while the increased number of modules will also increase the time span of implementation. Because we intend to follow the Iterative Incremental Development Model for the implementation of our software, we need good documentation for the design phase, as we intend to distinguish both the Design and Implementation phases. While working on the design, a major thing to keep in mind is the user experience. A poor user experience can cause your users to stop using your product because they cannot see or gain value from it. This can give your product a bad reputation and may even cause users to prefer your competitors.

The goal of this system design document is to provide an understanding of the various parts of the system to be implemented by Generic Solutions. This system will address the recycling of plastics and in turn, decrease the number of plastics reaching landfills. We expect this document to be very useful and highly referenced during the implementation phase of the software development process.

2. Data Flow Diagrams

Level 0 Data Flow Diagram



As mentioned before in our Problem Analysis and Requirements Document, and more specifically in our Context Diagram, there are three key external entities that come into play as part of the Generic Solutions system to be developed in order to address the current problems in recycling plastic. As you can see, those same external entities are present in our Data Flow Diagram (abbv: DFD). The first process in our DFD is the process of Providing Plastic, where the input is the users used recyclable plastic and the output is the plastic being ready for pickup. Without this process, the rest of the processes cannot take place, as we need the users to initially provide the plastic, in order to be able to obtain the material for recycling.

Once the plastic materials are ready for pickup, independent truck drivers can then collect them from each assigned location as part of the Plastic Pickup process, which is one of our system's requirements; to make the whole recycling process as easy and frictionless for the user as possible. One of the outputs of this process that our system produces is the pickup details, such as the weight of the materials per location, which is sent to the Central Database by both the use

of radio-frequency identification (abbv: RFID[1]) and through the drivers' manual input. We require this information to be able to accurately track materials and provide user rewards points. The more we can automate the transfer of information to the database with RFID technologies, the more accurate our tracking information will be because drivers might forget to input details sometimes, or the input information can be miscalculated or inaccurate, which would decrease the effectiveness of the system. However, the implementation of RFID hardware might prove to be very cumbersome as we are dealing with large quantities of material. This is why we need to hire or consult RFID experts. If this technology is implemented incorrectly, it might become very difficult to distinguish between which users provided which amount of material per location, for example. The other output of the Plastic Pickup process is picked up material, which then initiates the Plastic Transportation process where truck drivers transport plastic from their assigned pick up locations to the United States Recycling, Inc. (abbv : USRI[2]) location where they drop off picked up material. All pickup details should be recorded as soon as the pickup is complete per location, before transportation begins, to ensure the information is as accurate as possible.

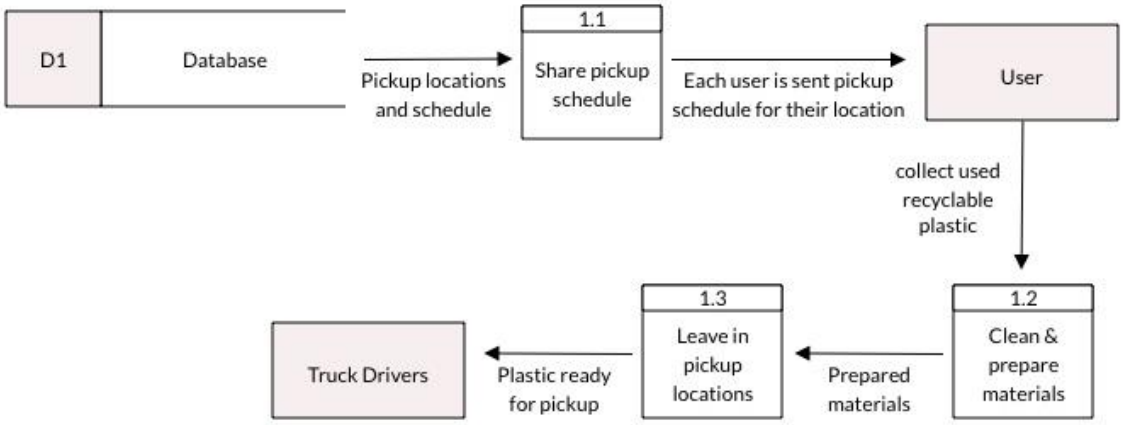
USRI then takes the received plastic and begins the process of Plastic Segregation, where all the plastic received from the pickup is examined and divided into non-recyclable materials and recyclable materials. All recyclable plastic then goes into the process of being recycled and non-recyclable materials go into the process of being properly disposed of. This information is documented and sent to the Central Database for us to keep track of the amount of material from each pickup that is successfully recycled. We need this information to measure how efficient and effective our system is in reducing the amount of plastic ending up in landfills.

Lastly, the plastic pickup details entered into the Database allow us to calculate the material collected per user, which is an input into the Provide Rewards Points process. As a result of this process, our system then produces rewards points for each contributing user as an incentive to make use of the system and recycle, which is one of our software requirements. It's important to implement this process in a way that the user feels rewarded for each round of provided plastic soon after they've contributed it, that the rewards are things the user actually is interested in and appreciates, and that redeeming the rewards is simple for this aspect of the business to be successful.

[1] "What Is RFID and How Does RFID Work? - AB&R®." AB&R, 11 Sept. 1970, www.abr.com/what-is-rfid-how-does-rfid-work/.

[2] "USRI." *USRI*, www.unitedstatesrecycling.com/.

Child Diagram: Provide Plastic Process

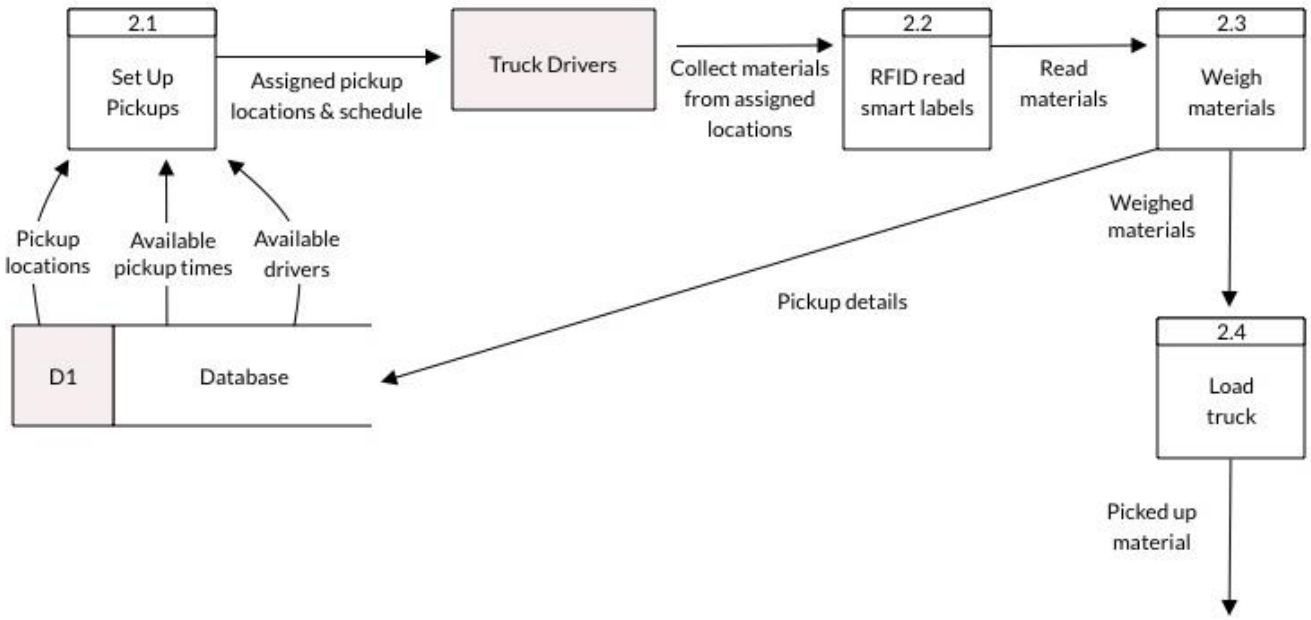


When exploding the first process of Providing Plastic from the Level 0 DFD, three sub-processes can be identified. Initially, in order for the users to be able to collect and have their used recyclable plastic ready for pickup in time, the pickup schedule needs to be shared with them. The inputs into this Share Pickup Schedule process are the pickup locations and schedules produced by the system and provided by the Central Database. Then, as a result of this process, each user is sent the pickup schedule for their location. Users can then collect their used recyclable plastic, which goes into the process of Cleaning and Preparing the materials.

When providing materials to be recycled, some preparation has to go into them before in order for the items to be recyclable and the whole process to be more efficient. In the case of recycling plastics, for example, users need to rinse the cans and bottles with water to clean any residue. Bottle and jar lids, as well as metal parts, should be removed because they are not recyclable, and users can choose to also crush their plastic items in order to reduce the space they take up and make more room for other items in their recycling containers[3]. After the user has done all this with their plastic, the results are the prepared materials, which then go into the Leave in Pickup Locations process. So once the user has finished preparing their materials for recycling, they can then leave them in their assigned pickup location in time for the pickup, according to the schedule, and the result is that the plastic is then ready for pickup.

Child Diagram: Plastic Pickup Process

[3] "Your Guide to Recycling." *EverydayHealth.com*, 3 Sept. 2009, www.everydayhealth.com/green-health/daily-living/recycling-guide.aspx.

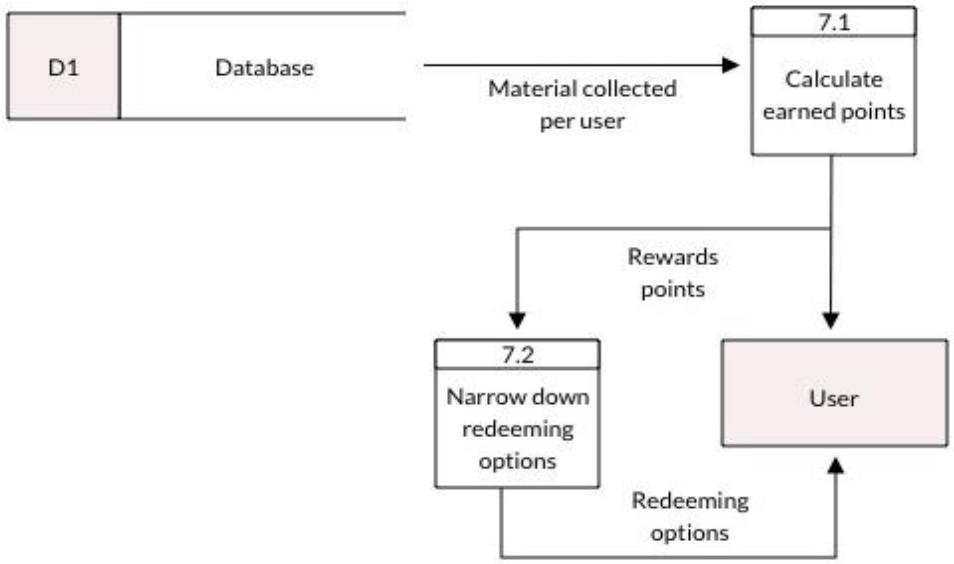


When exploding the process of Plastic Pickup from the Level 0 DFD, on the other hand, four sub-processes can be explored. First is the process of Setting Up Pickups. Pickup locations, available pickup times and available drivers are inputted to this process from the Central Database. Drivers are then matched to specific pickup locations and a pickup schedule is determined for each. Truck drivers are then notified of their assigned pickup locations and schedule so they can go to each location according to the appointed dates and times, and collect the plastic materials for recycling. It's critical to set up pickups and properly communicate assignments to the drivers with enough time in advance in case there are conflicts and changes that need to be made. This will ensure organization and coordination so that everyone is on the same page.

The collected materials become inputs for the process of using RFID technologies to read smart labels, which is one of our software requirements. So as drivers collect materials, the smart labels from the locations or recycling containers are read, and it's critical for the implementation of this technology to be completed appropriately, to ensure proper tracking is being done. The outputs of this process are the read materials that become inputs into the Weighing Materials process, which is the best and most efficient way to measure the materials collected per location. This information is sent to the Central Database because it's needed to later calculate the material collected per user.

Lastly, the weighted materials go into the process of Loading the Truck. To make sure everything's being tracked appropriately, it's very important to ensure the materials per location are read and weighed before being loaded into the truck, where the material from all the locations are combined. The output of this process is the material being successfully picked up according to protocol.

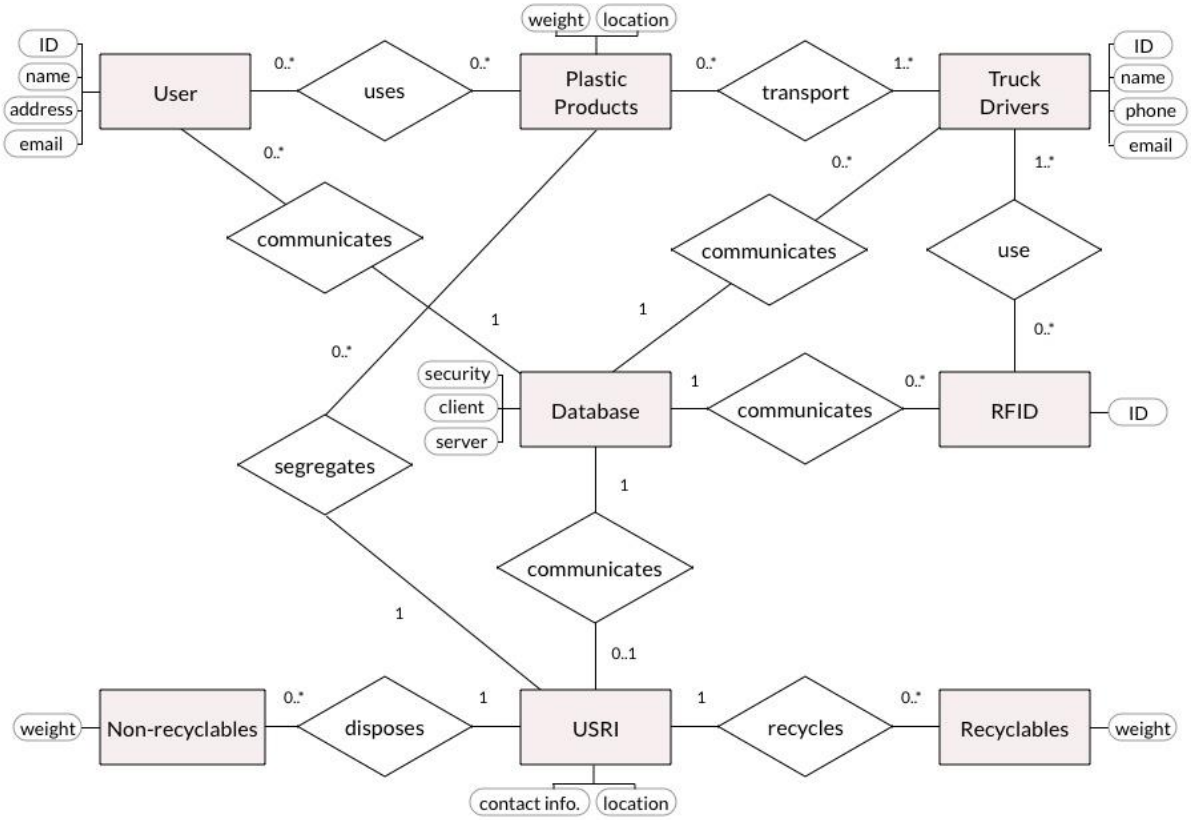
Child Diagram: Provide Rewards Points Process



Lastly, exploding the Providing Rewards Points process leads to two sub-processes. We first have the subprocess of Calculating Earned Points, where the inputs are the materials collected per user which are provided from the Database. With this information, we're able to calculate how many rewards points each user has earned. The rewards points produced per user are then inputs towards the process of Narrowing Down Redeeming options.

In this process, redeeming options are selected depending on how many rewards points each user has accumulated, and those redeeming options are then presented back to the user for them to make their selection and get their reward, which is one of our software requirements to maintain our users incentivized. This requires having partnerships with different companies and stores which will be providing our rewards.

3. Entity Relationship Diagrams



For our entity relationship diagram (abbv: ERD), we have identified eight different entities that best help represent the structure of data in our software system. Those entities are the User, the Truck Drivers, our business partner USRI, as well as Plastic Products, Recyclables, Non-recyclables, the Database, and RFID technologies. Note that all these entities are also data elements in our DFD's and that three of them are the external entities in our context diagram and DFD's. The rest of the entities identified are other key components that are being used in our system that receive, share, or produce data. Next, we will explain the relationships between these entities and discuss the data attributes that they each have.

Starting with the User, some of the data attributes shared across all users which the system will make use of are the ID which the system will use for tracking, the email to be able to communicate with the user and send them the pickup schedule, for example, the name which we'll use to personalize emails among other things, and the address, which will be used to be able to better determine pickup locations. The User has a *uses* relationship with Plastic Products, as many users can use many plastic products or none. This is the fundamental relationship of our system, being that it's already happening and even if our system didn't exist, people would still continue to use plastic products on a daily basis. One of the data attributes shared across all plastic products which the system will make use of is weight, which as we've mentioned above in our DFD's, is the way we're going to measure the materials collected per location. Therefore, another

data attribute for Plastic Products is location because we need to keep track of each location Plastic Products are being collected from and how much each location and each individual user is contributing. The User also has a *communicates* relationship with the Database, as the database will communicate to all of the system's users by sending them emails to inform them of upcoming pickup schedules for instance, and likewise, users will also be able to communicate with the database to request urgent pickups, for example. The data attributes that the Database entity has are a client and a server as part of its architecture, and a security protocol to ensure the systems information and all customer information is secure and there are no security breaches.

The entity of Truck Drivers, on the other hand, contains data attributes such as ID, which again, the system will make use of for tracking purposes, and name in order to be able to have a more personal relationship with the drivers and be able to address them by name in our communications. Truck Drivers also share the data attributes of a phone and email to make sure we're able to reach them at all times. Truck Drivers have a *transport* relationship with Plastic Products, as many drivers will be transporting many plastic products from pickup locations to a drop-off USRI location for recycling, as represented by the Plastic Transportation process in our DFD. Truck Drivers also have a *communicates* relationship with the Database, as many drivers will be inputting pickup and transportation details such as the weight of materials through their app into the database for tracking purposes.

Likewise, the database will communicate with them before transport even takes place to let them know what their assigned locations and schedules are for each plastic pickup. Based on our established requirements, Truck Drivers also have a *use* relationship with RFID technologies, as their trucks will contain the hardware to read smart labels through radio-frequency identification, which means that many drivers will use many RFID devices, which share a data attribute of an ID. As a result, the entity of RFID also has a *communicates* relationship with the Database, as many RFID readers will be sending their collected information to the Database for tracking.

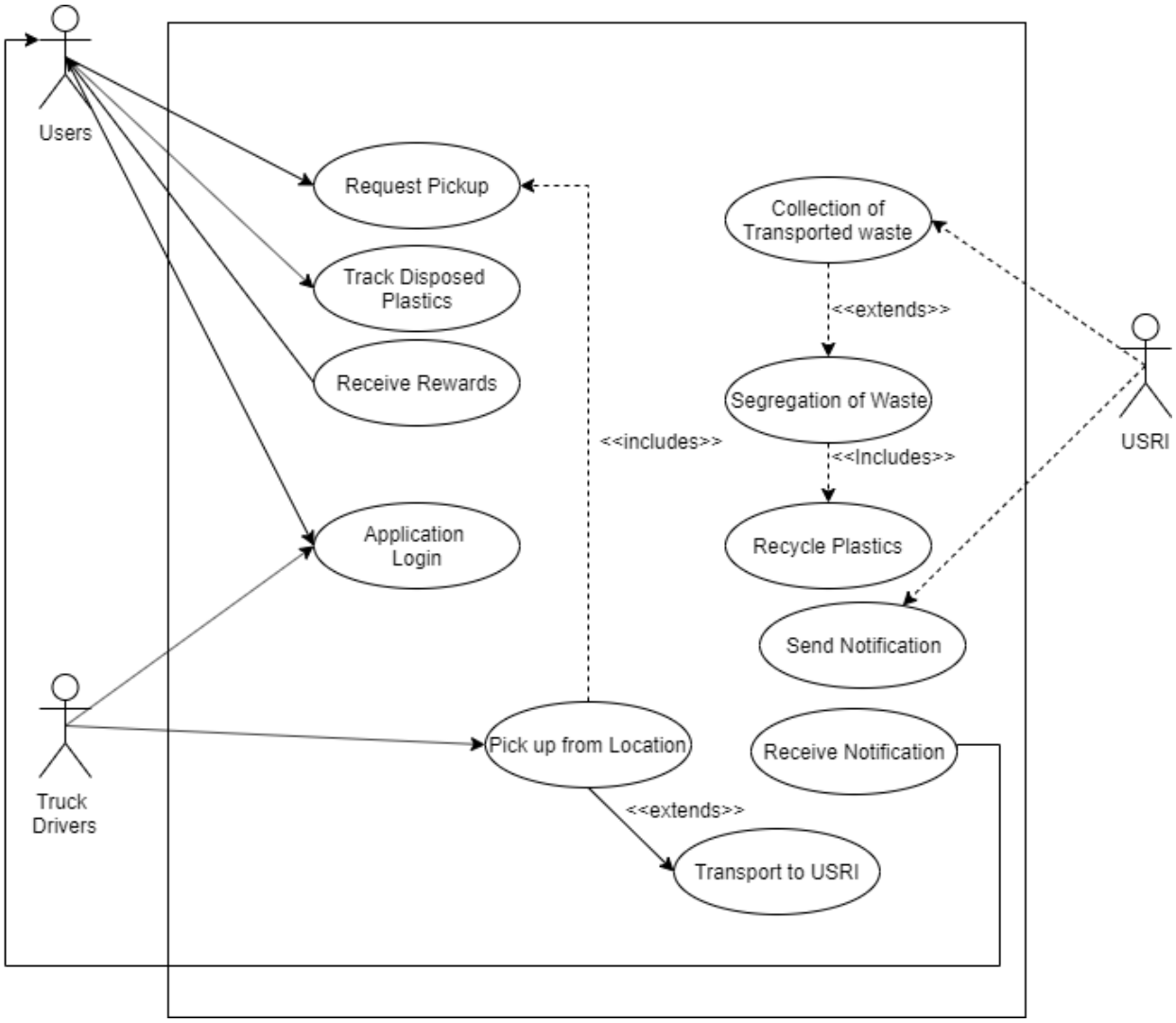
As previously mentioned, Truck Drivers will transport Plastic Products to a USRI drop-off location for recycling, so in turn, USRI has a *segregates* relationship with Plastic Products. Our business relationship states that USRI oversees examining and dividing all the materials they receive from the various drop-offs from the truck drivers into Recyclable materials and Non-recyclable materials. This is consistent with the Plastic Segregation process in our DFD. The data attributes for USRI that the system will make use of are their location, which will be shared will all of our Truck Drivers to make sure they are dropping off picked up materials in the right location, and also their contact information to be able to reach them when needed and have clear and constant communication, which is essential in any partnership.

Next, we have our two last entities, which are Recyclables and Non-recyclables, which both share the data attributes of weight, which is how these two sets of materials will be measured. We mentioned before how USRI will segregate all their received Plastic Products into Recyclables and Non-recyclables, however, after doing so, USRI will also be in charge of recycling all their selected recyclable products and properly disposing of all the non-recyclable plastic products

separately. This is why USRI has a *recycles* relationship with Recyclables, and a disposes relationship with Non-recyclables, as they will be both recycling and disposing of many plastic products, which is also represented with the Recycling and Disposal processes in our DFD.

In addition, after the segregation, recycling and disposal processes take place for each drop-off, per our requirements, USRI is also in charge of writing a full report including the updated amounts of recyclable material vs. non-recyclable material to share with Generic Solutions. The amounts of each will again be calculated by weighing them, but this time weighing Recyclables and Non-recyclable materials separately to know how much they have of each. They will also generate payment reports and submit payment to Generic Solutions, as well as notifying them upon receiving plastic materials for recycling. This is why USRI also has a one to one *communicates* relationship with the Database, which is a shared database between both USRI and Generic solutions, in order to properly store and make all this information accessible to both parties.

4. Use Case Analysis



Use Case	Pickup plastic from users
ID	1

Actors	Truck drivers
Priority	Essential
Pre-conditions	Drivers are logged into their application and RFID hardware is set up in their trucks.
Post-conditions	Drivers input pickup details for each location on time.
Event Flow	● Drivers get pickup information (schedule and location) from the Generic Solution system. ● Drivers reach assigned locations and pick up the materials. ● Information such as the weight of collected material for each location is input to the database. ● Pickup details are made available to USRI and Generic Solutions through the database. ● Drivers transport collected materials to USRI.
Alternate Flow(s)	● Generic Solutions can assign drivers for emergency pickups. ● After emergency pickup, information is made available through the database.
Functional Requirements	● Organizational agents will specify pick up and drop off locations for the collection and disposal of material from end-users. ● Drivers will have access to a separate section in the application to keep track of the pickup locations and to facilitate the entry of additional information such as the weight of collected material for each location. ● Drivers have a feature to provide confirmation of pickup and drop-off.

For the use case above of picking up plastic products, the truck drivers are the actor responsible for picking up the plastic materials from user locations. Locations are assigned to drivers by Generic Solutions, and after drivers receive their appointed schedule, they go to each location to load materials into their trucks and access the system through their application to both confirm pickup and provide weight and other pickup details per location. Drivers then transport collected materials to USRI and confirm drop-off.

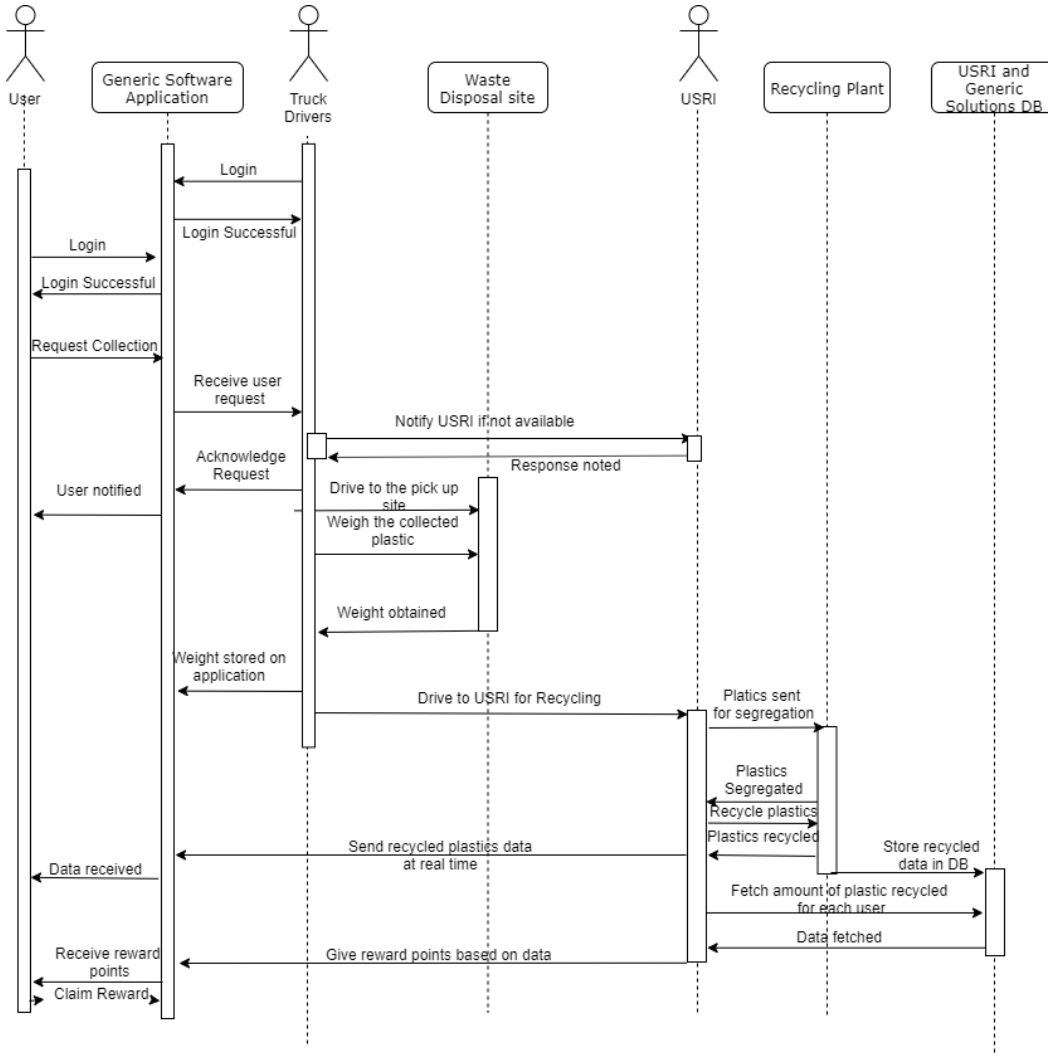
Use Case	Pickup Plastic request
ID	2
Actors	User
Priority	Essential
Pre-conditions	1. The user is registered with the Generic Solutions Recycling program. 2. If not, the user creates an account with all the necessary information.
Post-conditions	The users' login ID is accepted by the system.
Event Flow	1. The user logs in to the Generic Solution system through the application or web portal. 2. The user requests a pickup. 3. The user receives the pickup schedule from Generic Solutions.
Alternate Flow(s)	1. Users track their material after pickup. 2. After the material is recycled, the user is rewarded with points to redeem.
Functional Requirements	1. Users must be able to log into the application or portal. 2. User information will be validated when creating an account and every time they log in. 3. If an error occurs, the system should ask for validation.
Non- Functional Requirements	Users are able to track the material they provided through the Generic Solutions system.

For the use case above of a pickup plastic request, the user is an active actor who is responsible for logging into the system, requesting the pickup, tracking their materials, etc. After the material is recycled, the user is rewarded with points to redeem, and they are connected to the other actors through the system when they receive the pickup schedule or access the plastic tracking feature, etc.

Use Case	Recycling operation
ID	3
Actors	USRI
Priority	Essential
Pre-conditions	USRI receives plastic for recycling.
Post-conditions	USRI will store updated final reports of both non-recyclable plastic and recycled plastic in the shared database.
Event Flow	● USRI's internal System will notify Generic Solutions upon receiving plastic materials for recycling. ● USRI's internal team will divide plastic material collected into recyclable and non-recyclable. ● USRI will enter the amount and type of plastic into a mutually shared database between Generic Solutions & USRI. ● Waste will be sent to the landfill and recyclable plastic will be sent to the recycling unit in the company.
Functional Requirements	Based on collection reports, USRI will generate payment reports and submit payments to Generic Solutions.
Non Functional Requirements	Weekly Plastic Collection Reports will be sent to USRI in order to calculate the plastic sent by Generic Solutions.

For the use case above of the recycling operation, USRI is the actor in charge of actually recycling the plastic materials collected from users. To do this, USRI first segregates materials received into recyclable and non-recyclable and updates the database with the details. They then appropriately dispose of non-recyclables and recycle recyclables. USRI is also in charge of creating updated final reports of received materials and making them accessible through the shared database. Throughout this use case, USRI collaboratively works with other actors through the Generic Solutions system.

5. Sequence Diagram



The entire process of recycling plastics is based on sequential requests and responses through the software. The process starts with the user undergoing the normal authentication process. Once the user is logged in, the user requests for the collection of plastic waste disposed at a local disposal unit through the application or web portal created by Generic Solutions. Requests are processed through the database, where Generic Solutions then assigns truck drivers to specific locations and creates pickup schedules.

Drivers are appointed according to their location and availability. Drivers that are in the area of requested pickups and may have some availability are sent the corresponding pickup requests, which they receive through their separate driver UI and which also needs proper authentication. Drivers then either accept or deny requests, depending on their availability. If the driver denies the request, another driver is appointed, and once the request is accepted, the pickup is confirmed

to the user and the plastic is collected. The pickup schedule for that day is shared with the user. Once again, users are notified to ensure they're up to date at every step and to ensure there is proper communication in all stages. For example, for them to know that there are not any available truck drivers for the pickup and how it will be addressed. When drivers arrive at collection sites, on the other hand, they weight the plastic collected and share pertinent information through the application for tracking purposes and so the user can view the data in real-time. Then the driver transports the collected waste to the USRI plant.

Inside the USRI plant, there is a separate process for the segregation of plastics into biodegradable and non-biodegradable materials. USRI's internal System will notify Generic Solutions upon receiving plastic materials for recycling so that Generic Solutions can keep track of the process. Once the material is segregated, the recycling of plastics takes place and the non-biodegradable plastics are sent to landfills. One thing to note is the fact that relaying the data for each user consumes a lot of time. Hence, generated waste data and segregation data are combined for all the users within a specific community and reported back to the users in that community. This information can help reduce the amount of non-biodegradable plastic used and given by the community and therefore individual plastic consumption can reduce greatly.

Once the recycling process is complete, the information about the plastics is stored in the database shared between USRI and Generic Solutions. To promote more user activity and enhance customer retention, a rewards point system is in place. Once the process is complete, users earn rewards points based on the number of recyclable plastics that they provide. The higher the number of recyclable plastics, the greater the rewards points. The user can then use these rewards points to redeem coupons or gift cards from partner companies. In terms of the complex actions, the process of understanding the real-time data generated through the application may be complex for an average user, which is why this part needs special consideration from the UX team. The feature to request a pickup, on the other hand, can be easily understood by our user base. The goal is to make all the processes in the sequence of events that both users and drivers interact with as intuitive and easy to understand as possible to reduce effort and mistakes and make the interaction with our system a friendly and positive one.

6. Discussion of Coupling and Cohesion

When large software is divided into modules, these modules can operate in sequence or parallel and each module will have a dedicated process. This is called modularization. Modules are a set of instructions that are put together to achieve a task, where one or more modules are executing a task. Coupling and Cohesion are the measures through which the quality of the design of the modules and the interaction among these modules can be measured. The software system which Generic Solutions and USRI will be using on a daily basis in an automated flow is based on

breaking the software into separate functions or processes which would be integrated in the end to create one final software. In our system, every single function is divided into separate modules as we have tried to maximize cohesion and minimize coupling in our software design.

Most of our functions are proposed to be developed using cohesion techniques and using a minimum of coupling techniques.

Cohesion: When there is high intra dependency of the intra elements which are present inside a module.

- When a customer wants to redeem a gift card or coupon from the points they have received after providing plastic under their customer account, the redemption request is sent to a third-party vendor to generate a gift card or coupon. The result is then shared with Generic Solutions and the details are stored in the database. (This function or process has **coincidental cohesion**).

- When multiple processes are running through one application and the database is queried multiple times at a single timestamp, logs with timestamps should be generated and stored for activities like login to backend servers. Processes should not be locked out and there should not be any kind of lag while these processes are processed. (This function or process has **temporal cohesion**).

- When the truck driver submits pickup details for collected plastic, it will be marked with a unique barcode using RFID. This barcode will be then used to track the processing stage of the collected plastic. (This function or process has **logical cohesion**).

- The USRI team will segregate the collected plastic into recyclable and non-recyclable plastic. New reports will be generated for this activity and stored in the central database so it can be accessed by Generic Solutions employees to verify the USRI generated report. (This function or process has **procedural cohesion**).

- When a driver is on duty, a table in the database will get updated or inserted, and whenever a driver is assigned a pickup route for the collection of used plastics, another table in the same database will be updated to store that information. (This function or process has **communicational cohesion**).

- Drivers will input pickup details using their application, and that information will be stored in the central database from where USRI and other government agencies can access it. (This function or process has **sequential cohesion**).

- The application designed specifically for drivers will perform important functions like tracking the pickup trucks and their locations, tracking collected plastic details and driver attendance. This data will be processed and stored in the central database. (This function or process has **functional cohesion**).

Coupling: When one module is dependent on one or more modules.

- When a new user is signing up for the Generic Solutions system, the user will be required to fill all mandatory inputs and all input data along with logs will be stored in the database against that user ID. (This function or process has **content coupling)**

- The central database processes all the USRI processes and will store the same processed information (This function or process has **common coupling**).

- For auditing purposes, third party applications will be allowed to integrate with the Generic Solutions system for access data which would be fetched from the central database. (This function or process has **external coupling**).

- In case a truck driver does not accept or rejects a pickup request, the request will be assigned to the next available driver. If no one accepts it, the request will not be processed and all other modules or functions will not be processed (This function or process has **control coupling**).

- Only selected tables or files can be read or updated by USRI employees as most of the database and its structures are owned by Generic Solutions. USRI generated payment invoices will be shared with the bank to process the payment and with Generic Solutions. (This function or process has **stamp coupling**).

The central database will be responsible for more than 70% of the tasks or functions which will be preprocessed or processed depending on the different types of inputs from the user, drivers, Generic Solutions employees or USRI internal employees. We have kept most of our processes under Cohesion as these functions revolve around the central database and its functioning.

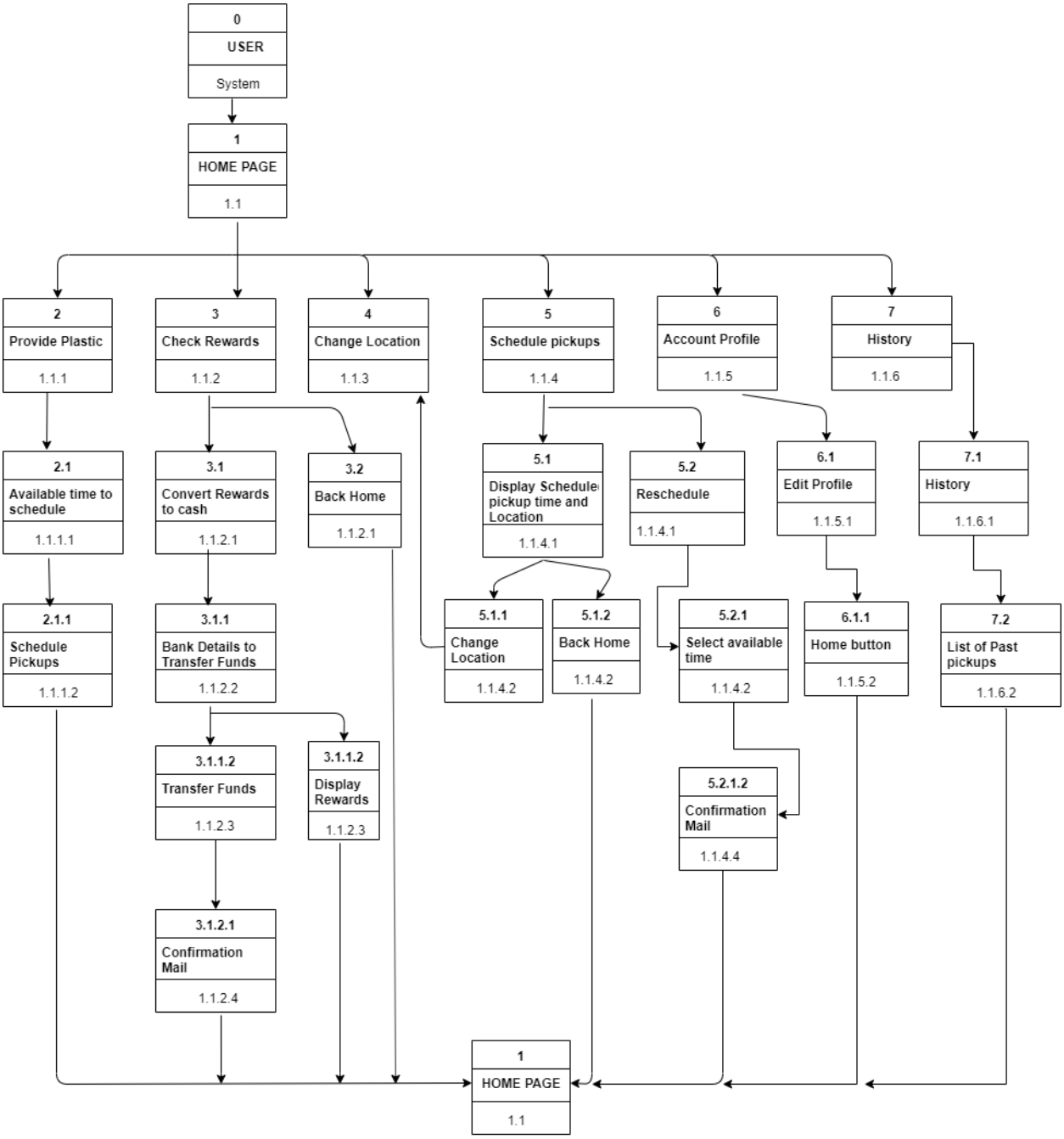
The drivers' application and the separate users' application will be hosted over a mutually shared application server (i.e. base machine), and the data from both applications will be stored on the central database. The inputs from the drivers' application will trigger many further internal functions like the generation of user rewards points, user notifications, etc.

Customer data will be stored in different tables in the central database and Generic Solutions will own those tables. The payment and segregation data table, on the other hand, will be owned by USRI.

To maintain strict access of the database tables to only specific employees, separate database groups with unique group IDs will be created in the database for both Generic Solutions and USRI separately. Employees will be added to their specific groups in the database and permissions for table access will be given to the respective employees. All tables will be backed up every Friday at midnight and will be uploaded onto a cloud network. Third-party agencies can integrate their system to specific paths on the Generic Solutions application server from where they can pull or request different types of reports for auditing, which would have been decided at the time of the

integration agreement with the application server. Reports can also be customized according to government or audit firm demands.

7. Interface Structure Diagram



Interface Structure Diagrams are used to model the users' interactions with the software or system and it also provides a high-level view of the system. In this case, we focused on predicting what users might do and ensuring that the interface has elements that are easy to access, understand and use to reduce user effort. In order to do this, we followed the principles of layout, awareness, aesthetics, being user-focused, consistency and efficiency. For our business, we have decided to design a different UI for both users and truck drivers.

Starting with the interface for the user, we have considered a home page which includes options such as Provide Plastic, Rewards, Change Location, Scheduled Pickups, Account Profile and History, each with an accompanying icon. Firstly, users will go through a verification process while they enter their personal information such as Name, Email (where verification is sent to the given mail ID for confirmation), Address (which will be automatically added to the users' pickup location), Contact information, and a photo of the user which will be optional. All this data will be stored in our central database. Once the user confirms their email, the database tries to match the information with the current information and it allows the user to access the home page.

If a user wants to provide plastic, they can go to the option where they select a pickup location and available pickup time. The available pickup times are accessed from the database. Available truck drivers are then also accessed from the database and matched to specific pickup locations and a pickup schedule is determined for each. After pickup is confirmed, the user will be emailed with all the details about the pickup for confirmation (Driver details, location, time, truck number, etc.). This information can also be accessed via the application or web portal.

Users always have the option to change their location for every pickup in the change location section. However, we will always use the users' last pickup location stored in the database as the default pickup location and ask the user to confirm before every pickup is scheduled. There is a section where the users can see their upcoming pickups and all their details. If the user wants to reschedule the pickup time of any of their confirmed pickups, they can do that using the reschedule CTA, and then the system will display the other available times for the specific location, depending on driver availability. In the account profile section, on the other hand, users will be able to edit or change any provided information, and they can also see all their past pickup details in the history section.

Users can check the rewards points that they have earned for their contributions by going into the Rewards section. Rewards points are based on the collected data regarding the weight of the plastic materials provided per pickup and per user, which is stored in the central database. This data is recorded by the truck drivers, but we hope to make this process automated in the future to reduce inaccuracies and miscalculations. A minimum number of reward points is needed to redeem rewards points, and if the user does not have enough points to redeem, then the software will only display the points that the user has earned so far, not enabling the option to redeem. If users do exceed the minimum number of rewards points to redeem, then they have the option to transfer their funds to their respective bank accounts, for which they need to provide bank account details and choose the account to which they want the money to be transferred. In addition, users

can also select to redeem gift cards or coupons, which will be provided by partnerships with different organizations or stores.

Considering the truck drivers interface, on the other hand, firstly each truck driver will be assigned an ID number which is done automatically by the system for easy tracking. Drivers also have to provide details such as their Name, Email, Phone Number and Address. Their interface includes navigation for the location, and options such as pickup requests, pickup schedule, history, profile, and ratings are accessible from the home page.

First, drivers receive requests for the pickups and they can either accept or reject the request. If they choose to accept the pickup, the system will send all pickup details such as location and user details, and that particular pickup will be added to their schedule. If they choose to reject the pickup, on the other hand, the driver has to provide a reason for rejection, which is a required field and they will then be automatically redirected to the home page. The scheduled pickups section will display all the pickups for a particular day, ordered with respect to time and location. When they select a specific pickup, they can also choose the navigation feature to be directed to the pickup location.

If the driver could not find any plastic to pick up at a location, they can leave a message for the user requesting to reschedule. If they do find the plastic, they collect it, weigh it and input the data into the fields under a particular user ID and enter the submit button which is the request for the system to calculate the rewards per user based on the instructions and formulae provided. After all the materials at the location are loaded into the truck and the details are recorded, the driver inputs that the pickup is complete which returns them to the page to select another pickup. Truck drivers, however, do not have the flexibility to edit their personal information in their account profile. If they have to do so, they need to contact Generic Solutions directly.

8. Updated Project Plan

identify remaining tasks and their dependencies, estimate a schedule, and include a staffing summary. It must be a more detailed and accurate plan than provided in the software requirements document. Where does the project stand after the design has been concluded? what needs to be updated after having completed the design (implementation - programming paradigm ,software architecture & testing)
600–800 words

Our initial time estimate for this work after having completed the requirements analysis and taking into account all the processes and stakeholders involved was about a year. However, the timeline of the project has been delayed due to difficulty to schedule many stakeholder interviews because of their busy schedules, and because the complexities of the project were not studied in depth. After more detailed research and extensive conversations, our developers concluded that some

of the functionalities may take more time than anticipated to build and that testing will also take a substantial amount of time.\newline

The main goal of the first iteration of the Generic Solutions recycling system is to deliver the products' core functionalities, which are to make use of RFID technologies to increase efficiency and accuracy in the collection of used plastics for recycling, the ability to send and receive notifications, and the ability to track materials through a shared database, among others. In order to accomplish those functionalities, the core component of the system needs to be made available, which is the central database secured for both Generic Solutions and USRI. Existing USRI customers must then be connected to the database, and any new customers should be able to sign up and connect to the database as well. After further discussions with our expert developers, the estimate to complete these elements was set to four months instead of two months. We also still need to establish a notification system, which will take another month.\newline

In addition, we still need to purchase and integrate RFID software and hardware to both the database and appointed trucks and pickup locations, which will take around four months, as finding RFID consultants has proven to be more difficult and time-consuming than initially anticipated. Another element that is also proving to be more challenging is forming partnerships to provide customers with rewards for the points they have accumulated for their provided plastic materials. This is due to the fact that we are a small company that is new to the market, and don't have enough of a reputation for large companies to think we're worthwhile going into business with. This is why our plan has shifted to target smaller companies like our own to start with. This has pushed back our estimate by a month.\newline

The staffing summary table skeleton below was referenced from a document obtained from the Doit Maryland website[4]. Considering that we have people with specific skill sets working under different teams, we have categorized them according to the work done by the teams. The Development team will consist of 5 to 6 skilled developers who have domain knowledge of the software used in the market and will ensure the delivery of the core functionalities of the project. There will be a testing team consisting of 5 people, each with experience in running scripts, performing manual testing and that with expertise in testing tools. There will also be a UX team, initially consisting of 2 people who will work on how the interface will look and feel like for the users as well as the stakeholders, and focus on making the interaction with our product very pleasant and easy to use. In addition, there will be an API team, who will work closely with the development team for enhanced results. \newline

Furthermore, this scope of work requires a business analyst who can play a liaison role and provide details to the team working at Generic Solutions. Lastly, there will be a product manager that oversees all the work being done, makes sure the schedule is being followed and coordinates interactions between USRI officials and Generic Solutions employees. \newline

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[4] "Department of Information Technology." *Maryland.gov Enterprise Agency Template*, doit.maryland.gov/Pages/default.aspx.

The implementation of the system alone has been re-estimated to take 15 to 18 months, as it involves the integration of a variety of complex processes. In addition, we will conduct recurring walkthroughs and static analysis to review code, as well as update system and user documentation regularly after new feature development and modifications, which will increase our timeline. We will also set up and conduct unit testing, acceptance testing, alpha testing and beta testing to uncover any software faults, errors or failures to ensure our product is efficient and reaches as many people as possible.

Roles	Team	Responsibilities	Level of skill	Estimated Start Date	Duration	Weekly commitment	Dependency
Development	Robert Mayer	Front-end	Medium	1/10/2020	180 days	45 hours	UX design
Development	Marie Johnson	DevOps	High	1/10/2020	180 days	45 hours	API and Testing
Development	Faith Bain	Java developer	High	1/10/2020	180 days	45 hours	API and Testing
Development	Robert Anderson	Java Developer	Medium	1/10/2020	180 days	45 hours	API and Testing

Development	Sean Rooney	Java Developer	Medium	1/10/2020	180 days	45 hours	API and Testing
Testing	Dwyane Bradford	QA Lead	High	4/1/2020	60 days	45 hours	Development
Testing	Lisa McMohan	Manual Tester	High	4/1/2020	60 days	45 hours	Development
Testing	Lucus Frost	Test engineer	Medium	4/1/2020	60 days	45 hours	Development
API Integration	Taylor John	Security	High	2/1/2020	90 days	40hours	Development
API Integration	Scott Mckenzie	API creation and deployment	Medium	2/1/2020	90 days	40hours	Development
UX Designer	Allison Becker	Low-Fidelity wireframes	High	11/1/2019	60 days	40 hours	No
UX Designer	Mariah Thomas	Mock ups and High Fidelity Analysis	Medium	11/1/2019	60 days	40 hours	No
Business Analyst	Jason Beckford	Requirement analysis and liaison work	High	10/1/2019	10-12 Months	45 hours	Yes, the whole team

Project Manager	Heather	Management and interaction with USRI	High	10/1/2019	Full project timeline	45 hours	Yes, USRI and Generic Solutions Team

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