



WasteLink

Taekyung Hill, Monika Kaneshige, Nantahala Kerns, Andoni Telonidis

Final Report: March 8, 2024

Table of Contents

Table of Contents	1
Background and Introduction	2
Problem	2
Solution	3
Customers and Beneficiaries	4
Evidence For Solution	5
Business Model	6
Impact	7
References	8
Appendix 1 - Theory of Change	9
Appendix 2 - Randomized Control Trial Description	10
Appendix 3 - Empathy Maps	12
Appendix 4 - Prototype	14
Appendix 5 - Prototype Feedback	17
Appendix 6 - Business Model Canvas: WasteLink	18
Appendix 7 - Story in Seven Sentences	19
Appendix 8 - Price Calculator	20
Appendix 9 - Revenue Model	21
Appendix 10 - Sixteen Questions	22

Background and Introduction

Across Bangalore, approximately 18,500 pourakarmikas [1], government sanitation workers, travel door to door collecting solid waste. On top of this, another 35,000 informal waste pickers collect and process waste from the streets and material processing facilities. When operating properly, the waste collection service in Bangalore looks like this: collection vehicles come by, often playing a tune to alert residents of their arrival. Then, residents must stop what they're doing and rush down to hand off waste directly to their collector. Of the 4500 metric tons of solid waste generated each day, approximately 38% goes uncollected [2] and is left on the street.

As of 2023, Bangalore is divided into 225 wards [1]. How waste is processed and quality of waste collection services varies widely across the city. In wards where a Dry Waste Collection Center (DWCC) exists, collectors deliver dry waste (non-compostables) where it is sorted and sold into recycling streams. When available, wet waste (compostables) is delivered to composting facilities. That said, not all wards have a DWCC or composting facility to deliver waste to. Mixed waste is frequently delivered to a landfill since it becomes too costly to segregate it for wet and dry waste streams after being collected. In Bangalore, these landfills are often unengineered, resulting in high quantities of leachate being passed into surrounding soils and water bodies with detrimental environmental consequences.

Problem

As stated earlier, Bangalore's flawed waste management system leads to altercations between residents and waste collectors about segregation of waste, waste collectors often have to wait five to ten minutes for residents to come down and hand off their waste. This results in the waste collector's route taking more time to complete than it needs to. Ineffective communication contributes to untimely collection, poor segregation of waste, and residents opting to dump their waste in the streets rather than handing it off to collectors at their door. These dumping spots either end up burned, exposing surrounding neighborhoods to toxic fumes, or cleaned by waste collectors exposing them to hazardous work conditions like broken glass and harmful chemicals. Many of these blackspots reemerge daily, costing collectors valuable time and energy when they have to visit between 700 and 1,200 residences a day. Collectors continuously express frustration with blackspots and their inability to curtail resident behavior to make their work easier.

Residents we interviewed articulated concerns about others in the area not segregating. People have also voiced concern for inconsistent and unpredictable pick-up times. Many residents expressed negative impacts from the blackspots in their community such as bad odor, and unpleasant appearance. Some residents submit complaints to the BBMP, which is the Bangalore's Administrative body responsible for civic amenities, to try and get them cleaned up. These interviews show that there are many Bangaloreans who want to live in a clean city, and are willing to take action to make it happen. In addition to the lack of communication regarding knowledge of delays or special waste services, blackspots either get burned, or collectors are

required to do extra labor to clean them up. The current methods of clearing blackspots has created a culture of public dumping with little to no repercussions, because the blackspot will soon be cleared. However, burning trash creates air pollutants hazards on roadsides. When the waste is picked up, it is all mixed waste, and goes straight to a landfill instead of circular waste streams.

Poor segregation of waste at the source is detrimental in Bangalore's waste management system. There is a lack of easy access to specific information regarding segregation of unique and difficult-to-sort items. The direct health and environmental impacts of improper waste management are not emphasized enough. Many education and awareness programs about waste management fail to emphasize residents' active participation in the failing system and fail to give them the resources to take responsibility for their waste. The persistence of blackspots are clear evidence of the problem Bangalore faces today.

Solution

Our solution is WasteLink, a mobile app that connects residents to waste collectors and gives them resources on appropriate waste services that will alleviate confusion and frustration. The app has 4 main components which are easily accessible after you sign up and select whether you are a resident or waste collector (see Appendix 4).

1. The Information Section

The information tab has 7 different sections and addresses the confusion we found many people face when segregating their waste and disposing of special types of waste like electronics, textiles, and bulk waste. There is a full detailed list of accepted dry, wet, and reject waste along with a search bar so people can easily look up what category a specific item goes into [3]. By clicking on the different sections, it will take users to different resources for managing whatever waste they want, many of these services are provided by NGOs, the BBMP, and local charities who already have an established system for disposal. They can also request other services, like community clean ups, that The Ugly Indian (TUI) and other NGOs facilitate. Residents can learn more about how to live sustainably, and how to get more involved in improving waste management.

2. Collector Route Tracking

The next component of the app is the collector tracking which is meant to provide residents with early reminders of when pick-ups are, alerts when the collection vehicle cannot come that day, and the location of the collector through their route. Through interviews with residents, we found that a feature to know when the waste collector arrives ahead of time at different intervals like 30, 15, or 10 minutes would help alleviate the pain of rushing down to hand waste to the collector. They will receive reminders on how to segregate waste properly, and entire neighborhoods can be easily notified of major delays. Residents can also notify collectors if they do not have any waste for them to collect or if they have specific types of bulk waste or other

special items that they need to dispose of. This allows the collectors to know ahead of time if they can skip houses who don't have waste that day, or if they need to bring an extra truck to pick up large items.

3. Resident Segregation Rating System

Waste collectors will be able to rate how well residents are segregating their waste which will then be used to create a spatial heat map of Bangalore to visualize which areas need improvement in waste segregation. The collectors will not be rating specific resident accounts but just the location by pressing on the map of where they are and choosing "Bad, Okay, or Perfect" on the selection tab that shows up on the top of the screen. Over time the heat map will improve in accuracy and be used as a data collection tool. Solid waste management organizations can use the segregation data to inform where they need to concentrate resources. The most impact can be made when there is informed allocation of educational and outreach programs on waste and sustainability.

4. Chats

The messaging feature of the app is where residents in a community can talk to each other about anything regarding cleanliness in the neighborhood. They can encourage others to segregate better and organize community clean ups together. Residents can message their collector regarding special waste item pickups, or ask any questions they have. There is also the option of contacting the local BBMP official who often has to organize collector routes and the ward marshall who is in charge of imposing fines and enforcing rules regarding waste management.

Customers and Beneficiaries

Our customer and direct user of the app are household and small apartment (less than 5 unit) residents and waste collectors in Bangalore. These are arguably the most important and largest group of stakeholders when it comes to waste management and therefore our solution must serve them first. Research into how positive behavioral changes are developed in communities showed that having civil service workers, waste collectors, involved was an effective tool in encouraging others to shift their behavior [4]. This shows why bridging the gap between residents and collectors is so important and that bottom up approaches can serve as effective methods of shifting the mindset of the public. Our beneficiaries include residents and waste collectors as well NGOs and the BBMP. NGOs would benefit from the app because we, with their permission, will have links and details of special waste services they do such as community clean ups, e-waste, textile, and bulk waste pick-ups, and educational events. We would act as partners with them as the app would promote their organization to those that may need them and we are able to lead residents to resources that were unknown to them before. The BBMP is another beneficiary that gains from collector efficiency (since the collectors work under the BBMP) and can use segregation data collected from the app to find areas that need improvements in waste management.

Direct users of the app will be residents of Bangalore in houses and small apartments and formal waste collectors. Waste collectors will share their location during their route and provide updates to delays. In turn, they'll benefit from a faster, more convenient collection process as residents can prepare ahead of time and be reminded to segregate their waste through the app. Some collectors call ward marshalls while on their route to report residents who are not segregating, WasteLink would simplify this process as the collector can just press a button and the ward marshall will have information of what areas need to segregate better. The residents would benefit from being able to know more ahead of time when collectors are coming and notify them easily if they cannot physically hand off their waste a certain day. They also have easy access to information and services on how to dispose of special waste which will alleviate frustrations or confusion for those that do not know about the many options available. Through surveys with city residents we found that many were not sure of how to properly dispose of e-waste and large bulky waste like furniture, often resorting to just giving it to regular waste collectors who would have to then give it to another organization. Several people told us directly that having information such as this, along with a regular list of dry, wet, and reject waste, would make them more inclined to use the app.

Evidence For Solution

We know our solution can work in a growing metropolitan like Bangalore as current trends in the city indicate the middle class, making up the majority of the population, desire to shift to more environmentally friendly lifestyles. A 2013 Bangalore study states that household behavioral change is only made possible by, “neighborhood based coordination, involving multiple actors such as environmentally-conscious residents, domestic help, and hired waste workers”. The study discusses the disconnect between emerging sustainable movements in Bangalore middle class with increasing consumer habits. WasteLink target customers are middle class as they are the largest population and creators of waste per capita. They possess the social interest and financial resources to shift to environmentally friendly waste management but are unable to facilitate communication and coordination with the waste management system [4].

Another report published by Hasiru Dala in December 2020, supports that positive behavioral change is possible at a large scale when waste workers are included from the beginning. Community encouragement of behavioral change is effective and takes less time and resources than infrastructural change. The report outlines how to enact behavioral change with residents. First, understand the belief system that causes current behavior and develop alternative belief systems. Second, communication of ‘why’ change is necessary is crucial. Third, the new behavior must be incentivised and rewarded either financially or socially. The report emphasizes that initiatives should not force residents to choose between supporting waste pickers and professionalizing the city’s waste system. This is why we are prioritizing the waste collectors and the residents, and utilizing the collectors as an agent of change to encourage others in the community to care about waste segregation and management [5].

A systematic review published by Frontiers in Artificial Intelligence reviewed 148 sustainable waste management apps and analyzed which app approaches enacted the most significant behavioral changes. The review found that the six most important design implications for creating lasting behavioral changes with the use were; (1) user friendly and simple routines, (2) adaptive and personalized features, (3) automated intelligent notifications, reminders to users about how to meet target behaviors and keep track of their waste management activities, (4) performance tracking, (5) credible and responsive design, and (6) a social support design, creating a social interface where users can interact with other users. Using these design implications we designed WasteLink with features that simplify users waste collection, adaptive features such as notification timing, automated notifications reminding residents to segregate their waste and when delays will occur, waste segregation tracking and rating, a responsive design with help and support features, and a social aspect for residents to discuss concerns with other residents, collectors, and officials [6].

Business Model

WasteLink would operate under a multi-sided business model. The app acts as an intermediary platform that brings together residents and collectors, who would pay nothing to use the app. This decision is made to provide the best possible incentive for our direct users to participate.

Experts in app development gave us a cost estimate of about 27 lakh INR or 33 thousand USD to develop the app in India with a team of 4 people over the course of 2 months. Our primary source of revenue will come from contracts with food delivery apps, such as Swiggy and Zomato. Under these contracts, WasteLink would offer coupons to residents based on their waste segregation performance. In turn for directing traffic for these delivery sites, WasteLink would receive an affiliate marketing commission. During the first two years, we would need only 30% participation of residents in 10 wards, in order to break even for initial app development, operations and maintenance costs (see Appendix 9) [7].

A smaller, secondary form of revenue comes from NGOs who will pay to access data collected in WasteLink's feedback system. NGOs will find value in using this data to identify areas for their programs, such as neighborhood cleanups or educational campaigns on waste segregation. Waste management contractors outside of the BBMP would benefit from the data collected, thus creating an incentive for them to pay a small price as well. Long term, we plan on the BBMP further endorsing WasteLink as a useful tool in waste management data collection and information dispersal to the public. In doing so, we would be able to garner government funds which would ensure financial sustainment. Estimates within the revenue model (see Appendix 9) forecast WasteLink breaking even within 2-3 years, on par with most app based startups and not taking into account city government funding.

Next Steps

Our next step is developing the actual app, and a three month pilot in Shakambari Narar, Ward 179, where the DWCCs are currently supported by Hasiru Dala and the workers have long-standing relationships with them. There are approximately 33,000 residents and our goal is to observe a positive change to the amount of segregated waste being collected at the end of the three months compared to before and get user engagement [8]. The following steps to test our solution are:

1. Have every waste collector driver download the app and teach them how to use it. We know that the majority of collectors have smartphones and are comfortable with using them. Since about 3-4 people accompany each truck, we just need at least one smartphone amongst them.
2. Waste collectors would talk to the residents on their collection route about the WasteLink and its benefits along with handing them infographic flyers for the app as well.
3. Achieve 50% resident download within the first 3 weeks, however if this is not met, further outreach with people from the development team to residents or surveying to find better incentives will be done to get to 50% in 6 weeks.
4. Measure the average weight of segregated waste collected by each truck per week at the DWCC for 4 weeks before pilot. Then measure the average weight for 4 weeks after the 3 month pilot. Survey residents biweekly on what they think of the app and record adjustments that should be made.
5. If there is an increase in the amount of segregated waste collected at the end, then we will continue with our Randomized Control Trial 1 (see Appendix 2) and expand to other wards. If not, we will implement ways to further encourage and incentivize segregation through the app.
6. Expand to working with food delivery apps such as Zomato or Swiggy as an affiliate by giving coupons to the users within the best segregated neighborhoods. Also partner with NGOs by selling the segregation data to them as well as data on worker and resident concerns received from the app. Long term, work with BBMP and other waste management companies using our data to find areas that need improvement and officialize it as a tool within the solid waste sector.

Impact

By mending the missing link between residents and collectors, WasteLink improves the effectiveness and efficiency of existing solid waste management. In doing so, it can foster healthy and productive relationships between waste collectors and the neighborhoods they serve. By providing residents with the right tools, WasteLink enables them to make easy choices with their waste that are convenient and sustainable. With increased awareness of collection vehicle schedules, residents will be better prepared and save time. Overtime, WasteLink can help to remove blackspots across Bangalore, leaving behind healthier and happier neighborhoods.

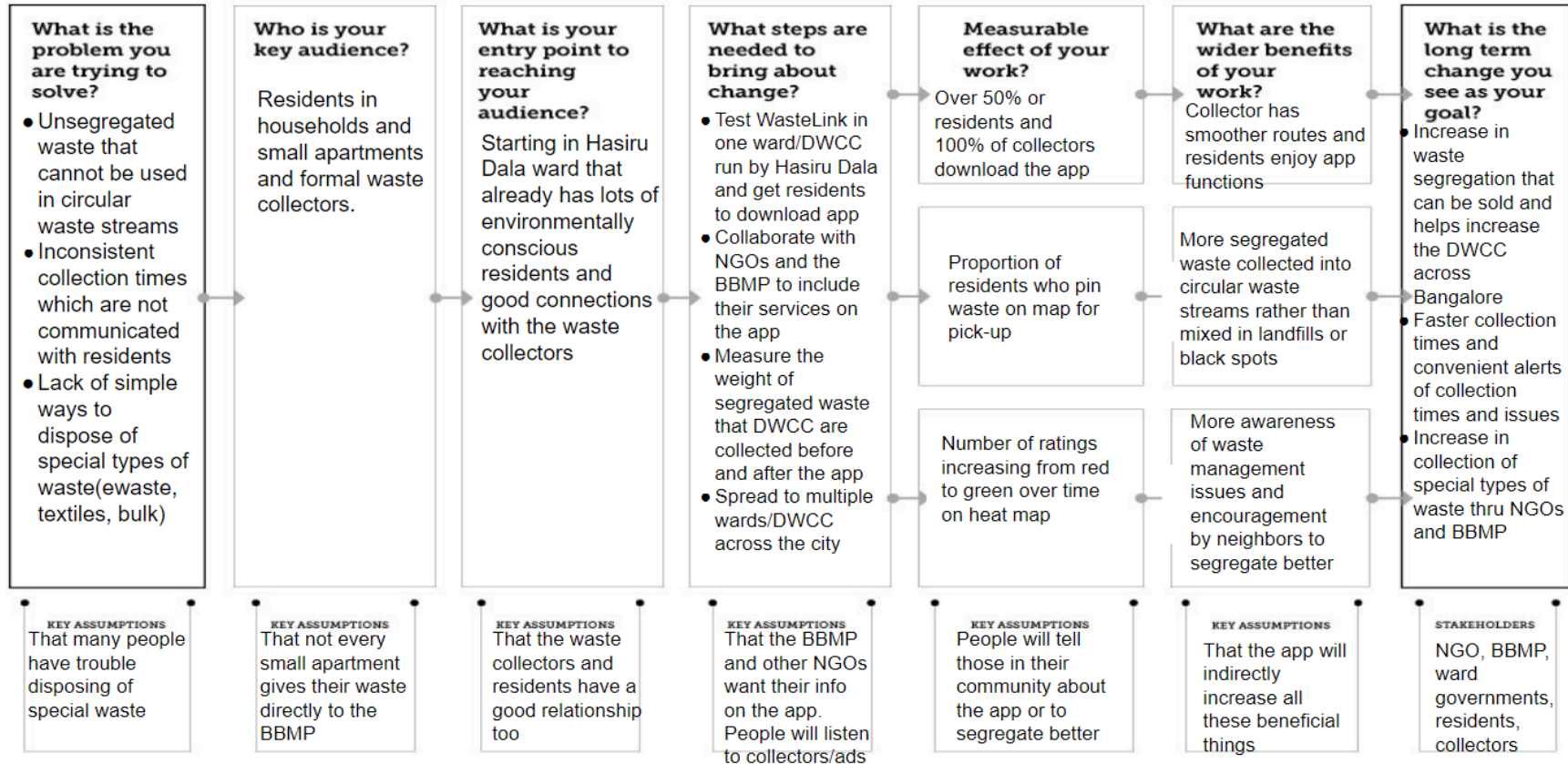
References

- [1] “City Statistics .” *SWM*, BBMP, site.bbmp.gov.in/departmentswebsites/swm/#:~:text=BBMP%20has%20a%20fleet%20of,100%25%20door%20%20to%20%20door%20collection. Accessed 8 Mar. 2024.
- [2] Chandran, Pinky, et al. *Valuing Urban Waste the Need for Comprehensive Material Recovery and Recycling Policy*. Hasiru Dala, 2018
- [3] Ravikiran, Hamsa. “Indian Household Wastes - Categories and their management” *Bruhat Bengaluru Mahanagara Palike*, 2012, <https://site.bbmp.gov.in/documents/waste-notice.pdf>,
- [4] Anantharaman, Manisha. “Networked Ecological Citizenship, the new middle classes and the provisioning of Sustainable Waste Management in Bangalore, India.” *Journal of Cleaner Production*, vol. 63, 8 Sept. 2013, pp. 173–183, <https://doi.org/10.1016/j.jclepro.2013.08.041>.
- [5] Danielson, Joi. *Leave No Trace Vital Lessons from Pioneering Organizations on the Frontline of Waste and Ocean Plastic*. Hasiru Dala, 2020, *Hasiru Dala*, <https://hasirudala.in/resources/documents/>, Accessed 2024.
- [6] Nkwo, Makuochi, et al. “Persuasive apps for Sustainable Waste Management: A comparative systematic evaluation of behavior change strategies and state-of-the-art.” *Frontiers in Artificial Intelligence*, vol. 4, 9 Dec. 2021, <https://doi.org/10.3389/frai.2021.748454>.
- [7] “Zomato Affiliate Program Offer [CPA] Highest Payout @ ₹70/Action.” *INRDeals*, inrdeals.com/campaigns/zomato-affiliate-program. Accessed 7 Mar. 2024.
- [8] “Delimitation of Wards in Bruhat Bengaluru Mahanagara Palike (BBMP)”, *Deputy Commissioner, Bangalore Urban District*, 2019, <https://data.opencity.in/dataset/23239fff-4694-44bf-bc16-0c6d0d580d76/resource/a354f3f2-7d9d-43d6-9895-e9db826ed53a/download/bbmp-delimitation-note-2019.pdf>

Appendix 1 - Theory of Change

I want to clarify my priorities
by defining my goals and the path to reach them

THEORY OF CHANGE



Appendix 2 - Randomized Control Trial Description

We have two randomized control trials that will be implemented to test out theory of change: (1) an initial randomized control trial to test the effectiveness of WasteLink at increasing proper segregation and the amount of household waste collected, and (2) a randomized control trial to test the most effective strategy to encourage residents to download and utilize WasteLink.

RCT (1):

Assumption: Households use of WasteLink will reduce frustrations of both the households and the waste collectors. Consistent and informed waste collection will increase the amount of properly segregated waste collected from households.

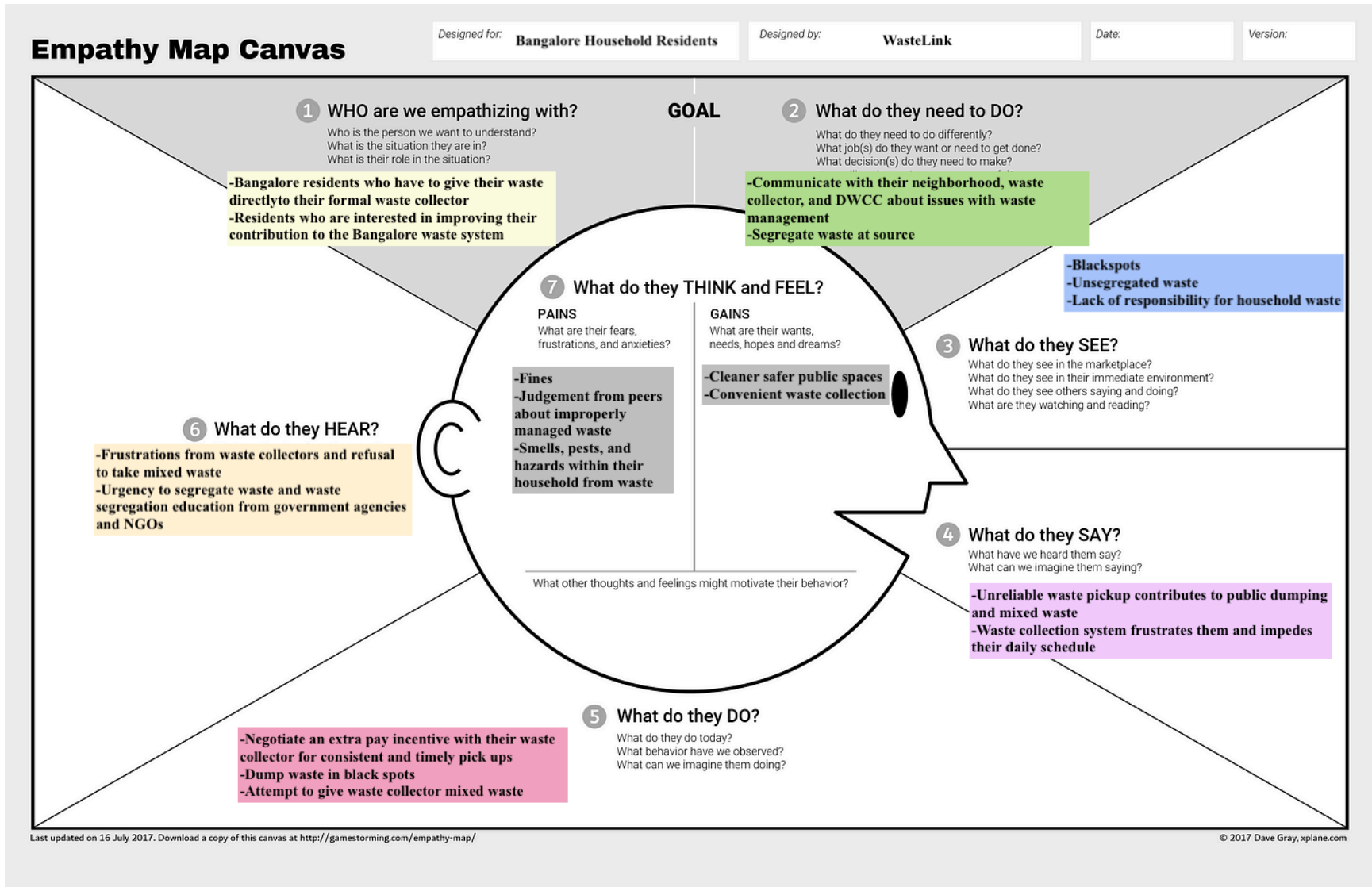
The randomized control trial will begin by selecting thirty Bangalore wards with similar socioeconomic demographics and amount of public dumping. Fifteen wards will be our test wards (group A), they will be introduced and encouraged to download WasteLink. The other fifteen wards (group B) will be the control group and continue to have their waste collected as usual. The effectiveness of WasteLink will be measured by an increase in collected segregated waste from the test wards. Dry waste collection centers weigh daily intake of waste already so we will use this data to measure if there is an increase. This will also measure an increase in properly segregated waste because the weigh in is of only segregated dry waste. Even if waste collectors still receive mixed waste and the DWCC attempts to sort that waste the majority of the waste is unsellable and goes to landfill. An increase in daily DWCC yield would represent an increase in properly segregated waste collected from households. These results would be measured over a period of ten weeks, the first two weeks would be utilized to introduce the app to residents, the next eight weeks would measure change in the DWCC daily yield. We would compare the last eight weeks of DWCC yield to the DWCC's yield data for the ward's previous eight weeks before the RCT. Any change in DWCC yield would then be compared to our control group B, data from during and before the RCT.

RCT (2):

Assumption: Residents will value the opinion of their waste collector and feel encouraged to download WasteLink after their waste collector communicates the mutual benefits. Household residents want to improve their current waste collection system and value an improvement of communication between them and their waste collector.

The randomized control trial will begin by selecting two Bangalore wards with similar socioeconomic demographics and amount of public dumping. Ward A will have waste collectors encourage residents to download and begin to utilize WasteLink. Waste collectors will be provided a pamphlet with basic information on how the app interface works, how to download, the benefits for waste collectors, and the benefits for residents. Waste collectors will be encouraged to give the pamphlets to all of the households they collect from. Waste collectors will also be encouraged to converse with residents about why they think it's important for the residents to download and utilize the app. Ward B will have pamphlets distributed by WasteLink to households; the pamphlets will include benefits only to household residents. Ward B will also have fliers posted around the neighborhood advertising the app and how it will reduce resident frustration with the waste collection system. The results of the RCT will be measured by the number of downloads in each ward over an eight week period.

Appendix 3 - Empathy Maps



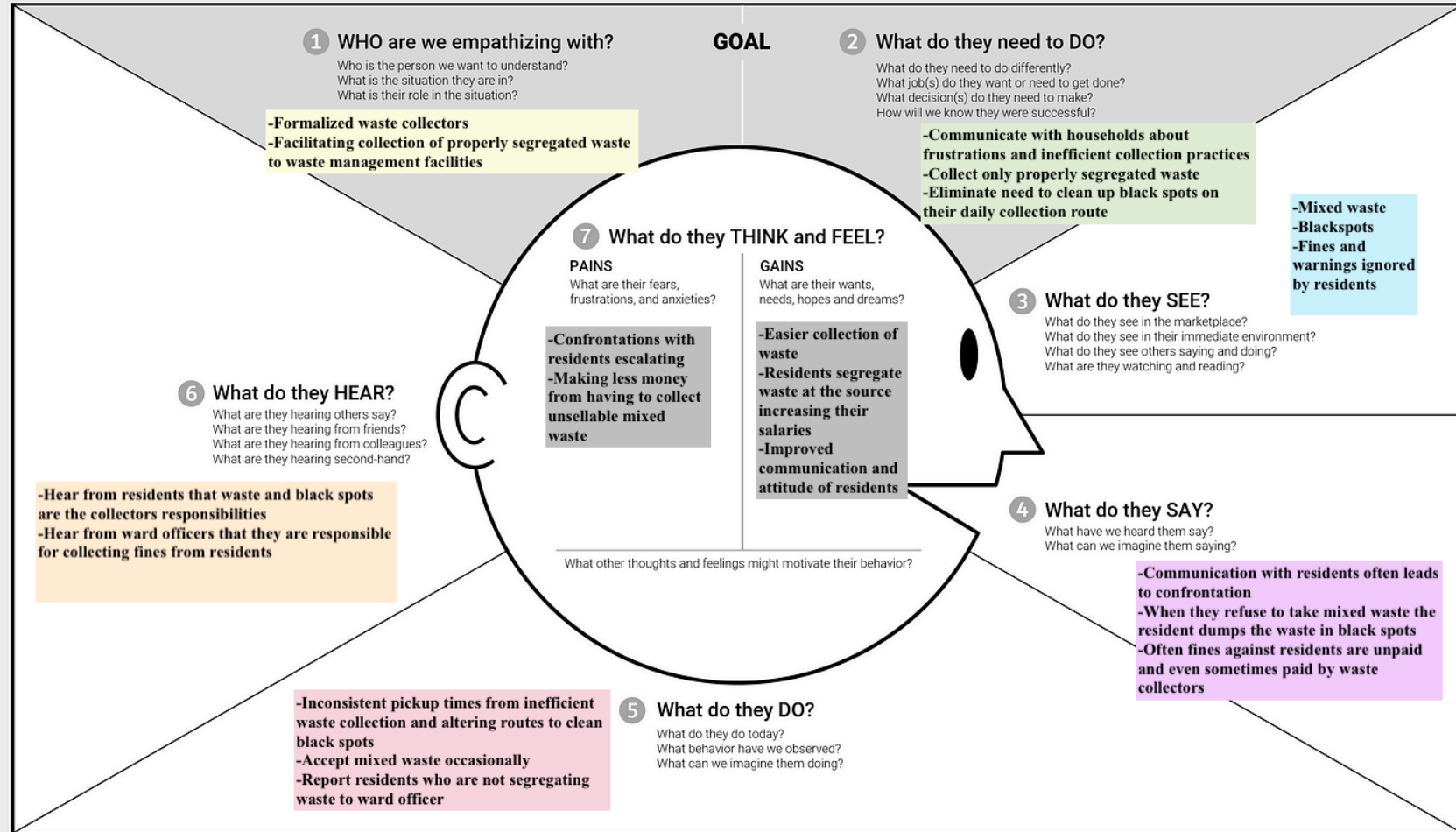
Empathy Map Canvas

Designed for: **Waste Collectors**

Designed by: **WasteLink**

Date:

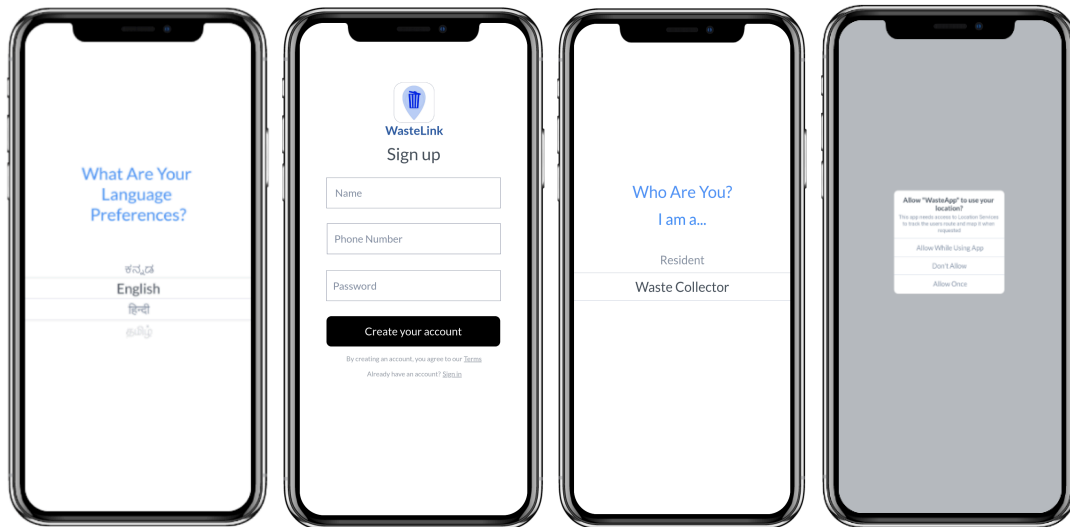
Version:



Last updated on 16 July 2017. Download a copy of this canvas at <http://gamestorming.com/empathy-map/>

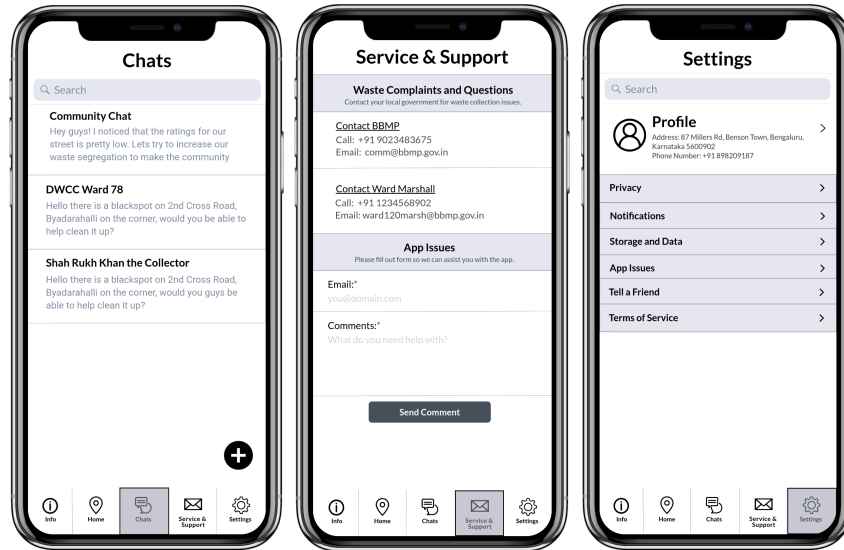
© 2017 Dave Gray, xplane.com

Appendix 4 - Prototype



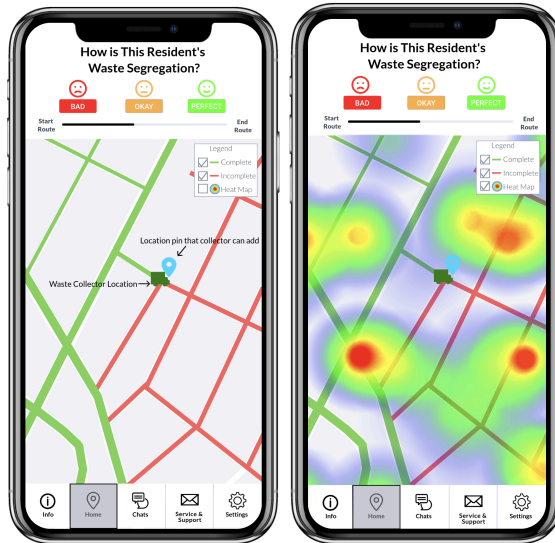
Above are the first pages you see when you open the app, regardless of resident or waste collector. Going from left to right, we first have the language preference page that has Kannada, English, Hindi, and Tamil, however more languages can be added if we observe a need for it by users. It then takes you to the sign up page where you need to put your name, phone number, and password. Unless you delete the app, you should stay logged in and there is a “Forget Your Password?” option if you do not remember. You can then choose which category you fall into: resident or waste collector. The last screen above is where you share your location, it should be known that you have to share it for the app to work.





The seven screenshots above show the resident user interface which is similar to how the waste collector version will look like. The functions residents have are:

1. Pin their address location permanently(or change it in the settings if they move) which tracks automatically to a specific ward, route, and waste collector.
2. See the real-time location of the waste collector who is assigned to the route with approximate ETAs.
3. Find information regarding:
 - a. full lists of accepted dry, wet, and reject waste
 - b. where to dispose of every special waste item outside of BBMP and through NGOs
 - c. how to organize a community clean-up with an NGO
 - d. how to practice more sustainable habits through zero-waste principles
 - e. how to get more involved in improving waste management, blackspots, and spreading awareness.
4. Raise a request for a custom pick-up of bulk, special, or regular waste and reply to follow up messages sent by the waste collector.
5. Send and receive messages through a community chat that includes every user in a street with AI moderation for any inappropriate content.
6. See contact details of the BBMP office, ward marshall or the waste collector and message them if needed.
7. Report app issues and update profile via a form on the support & services tab and through the Settings tab, respectively.
8. View and update my profile, and change notification intervals on the settings tab.



There is overlap of the resident user interface with the collector user interface in the information, settings, chat, and service & support tab with only slight differences. For example, the waste collector wouldn't have neighborhood community chat access. The main difference is that the collector home tab would have the resident waste segregation ratings. Residents will also have access to view the waste segregation heatmap for their locality. Here are specific functions the collector can do that the residents cannot:

1. Start location sharing at the start of the route and stop it once it is done.
2. Rate residents waste segregation on a specific street by tapping the location and selecting a rating without having to fill in the resident's specific information (see the last two screenshots).
3. See the waste pick-up requests by residents and send messages to them if needed to coordinate the pick-up.
4. See all messages sent by the residents and reply back to them.
5. Send alerts/notifications to the entire route automatically if there is a delay or change of collection date.

Appendix 5 - Prototype Feedback

Waste collectors' feedback was very positive. They said that communicating with households about improper waste segregation is a frustrating and contentious conversation usually leading to an argument. They were interested in a better way to get the residents on their route to segregate waste better. This affirmed our idea that the app's rating system would simplify the process for waste collectors.

About half of the 25 residents we interviewed expressed interest in using our app, saying that it would be useful to have more of a heads up to know when their waste collector will arrive. On the other hand, other residents were convinced that people who dump waste are lazy and are either not willing, or not capable of learning how to use the app.

We asked Annirudha, a waste management expert who works with TUI, about which features of the app would be most useful, and best practices for introducing an app to the public. He brought up how getting collectors on board might be difficult at first, which is an important consideration moving forward with the app. He suggested that when we prototype, we start with the most basic version of the app. This would mean we first only provide the map with live tracking, notifications for estimated time of arrival, and option to leave household waste outside your door. If this crucial feature is a helpful tool for residents and collectors, then we can later launch updates with the other features like the information tab, chat features, and special waste management. He also suggested that the app might be especially helpful in bringing migrant workers into the loop on how waste disposal works in the city. Overall, he ended on a positive note, saying that the app could be an essential tool that can be used in the future.

Appendix 6 - Business Model Canvas: WasteLink

<p><i>Key Partners</i></p> <ul style="list-style-type: none"> ● Waste collectors <ul style="list-style-type: none"> ○ BBMP ○ Independent DWCCs ● DWCC Managers/ Operators & other recycling plant operators ● Food delivery apps <ul style="list-style-type: none"> ○ Zomato ○ Blinkit ○ Swiggy ● NGOs that are interested in reducing blackspots & waste education 	<p><i>Key Activities</i></p> <ul style="list-style-type: none"> ● App maintenance <ul style="list-style-type: none"> ○ Bug fixes ○ Updating waste segregation resources ● Collector route coordination? ● Marketing ● Contract deals with food delivery apps ● Expansion - to more wards 	<p><i>Value Proposition</i></p> <ul style="list-style-type: none"> ● Provide direct communication between collectors and residents ● Provide data gathering platform for waste segregation practices ● Provide incentives for residents to segregate waste, resulting in higher value, segregated waste <ul style="list-style-type: none"> ○ Higher rate of recycling & higher profit for DWCCs ● Easy communication so NGOs can reach entire neighborhoods ● Daily waste collection data <ul style="list-style-type: none"> ○ Heatmaps available to public 	<p><i>Customer Relationships</i></p> <ul style="list-style-type: none"> ● Monitor service and support, answer questions, and make adjustments to app design based on feedback ● Give residents direct resources to useful waste disposal and clean-up services ● Promote NGOs and other businesses we partner with ● Negotiate affiliate marketing commissions with food delivery apps 	<p><i>Customer Segments</i></p> <ul style="list-style-type: none"> ● Bangalorians trying to discard waste from their individual households/small apartments ● Waste collectors ● Neighborhoods with high levels of blackspots ● Neighborhoods with inconsistent waste collection ● Organizations and companies that utilize segregated waste ● NGO working in solid waste management sector
<p><i>Cost Structure</i></p> <ul style="list-style-type: none"> ● App development, operations and maintenance ● Networking and Outreach ● Marketing ● Salary 			<p><i>Revenue Streams</i></p> <ul style="list-style-type: none"> ● Advertisement for food delivery apps ● Organizations/businesses that want to support our mission ● Waste collection data 	

Appendix 7 - Story in Seven Sentences

- 1- Once upon a time, there was a man named Ashba, who had a house in Bangalore.
- 2- And every day Ashba would have to wait in his house for his waste to be collected, sometimes the waste collector would be late and Ashba would have to decide between being late to work, letting his waste accumulate in his house, or dumping his waste in blackspots.
- 3- Until one day, Ashba's waste collector told him to download WasteLink, the app let Ashba know when the waste collector was close by, delayed, or unable to come and had a chat feature which connected Ashba with his waste collector, the local DWCC, and his neighbors.
- 4- And because of this, Ashba was able to get his household waste picked up consistently without having to either be late to work, or have accumulated waste in his house, or dump his waste in blackspots.
- 5- And because of this, Ashba let his neighbors know about WasteLink and the neighborhood began to keep each other accountable for their household waste.
- 6- Until finally, Ashba's neighborhood was able to manage their household waste more conveniently and reduce the emergence of blackspots in the community.
- 7- And ever since that day, Ashba, his neighbors, waste collector, and local DWCC are able to smoothly and happily navigate daily waste collection.

Appendix 8 - Price Calculator

Proposed development timeline and price:

Table 1: Description of development timeline

Activity	Deliverables	Time (working days)
Discuss, refine and finalize requirements with the Team	Frontend Development	3
Product Owner, UX and Solution Architect	Product Specs documented. System Architecture for developers.	5
Design	Finalize High fidelity prototypes Define style guide and components	10
Backend Development and Combined Team Operations(DevOps)	Application Programming Interface (API) Implementation	15
Frontend Development	Mobile app	20
Quality control and automated testing	Done during Frontend Development	10

Total end to end timeline: 40 working days * 8 hours = 320 hours of work

Software development and design team: 4 people

Cost of worker / hour in India: 25.70 USD/hr

Price: 32,986 USD ≈ 33,000 USD ≈ ₹2,700,000

Appendix 9 - Revenue Model

WasteLink will initially generate revenue through two sources for the first 2 years:

1. Affiliate marketing with food delivery companies such as Zomato, Swiggy, and Blinkit. With affiliate marketing we plan on giving out coupons to resident users who segregate the most consistently in the city once a month. With an average of 42,650 residents per ward in Bangalore we expect to have at least an average of 30% app usage across the wards within 2 years. Starting with Zomato who is already doing a carbon neutral sustainability program, meaning their current brand goals align with WasteLink, we plan on giving 20%-30% off coupons to the residents in streets that segregate the best and most are consistently in the 95th percentile. If we start marketing a year after the app's release to ensure it has enough recognition we can earn double the amount it costs to develop that following year. See Table 2 below.
2. NGOs financially compensate WasteLink for advertisements and promotional materials. We have a small portion added in for payments from NGOs in exchange for receiving waste segregation data for wards. However, with smaller or newer organizations, we will include connections to their resources, but they will not receive waste segregation data that we collect. We know that at least 2 NGOs (Hasiru Dala and TUI) will be interested in using our app's data and we believe that after we are more established, larger waste NGOs like Saahas will want to buy our data as well.

Table 2: Calculation of Revenue Streams

Affiliate Marketing: Zomato	
Affiliate commission per purchase (₹)	50
Average amount of users per ward	12,795
Number of wards using app in 2 years	10
Frequency of coupon giveaways per year	12
Amount of coupons given per ward (5% of users)	639.75
Total revenue from coupons per year(₹)	38,38,500
NGO payment for data and advertising	
Amount NGOs pay per month (₹)	500
Number of NGOs	3
Number of months	12
Revenue from NGOs	18000
Cost covered in two years	38,56,500
Total cost of app	27,00,000
Profit	11,56,500

Even if we do not reach these numbers, it is likely we will be close to breaking even within our third year. These numbers do not take into account the expected financial support we would receive from the BBMP for buying our segregation data of the city as a way to find areas of needed improvement in the waste system. These calculations cover our 2 year financial sustainability plan, or until we are able to get funding from the BBMP, which will be a more reliable and substantial form of income in the long term.

Appendix 10 - Sixteen Questions

Problem:

1. What problem are you working on?

Bangalore's waste management system suffers from a communication missing link between residents and collectors along with resources to effective waste disposal services like e-waste, textile waste, and bulk waste. This missing communication contributes to untimely collection, poor segregation of waste, and residents opting to dump their waste in the streets rather than handing it off to collectors at their door.

2. What evidence do you have that this is a problem?

Residents and collectors displayed concerns about others in the area not segregating and we also heard from expert's in the waste management field. Some of the main concerns were:

- 1) Lack of waste segregation in the area
- 2) Arguments between collectors and residents over unsegregated waste
- 3) Inconsistent pick-up times and not knowing if the collector cannot come certain days
- 4) Complaints regarding black spots due to their appearance, odor, and health impacts

3. Who faces this problem?

Waste collectors and household residents who struggle with collection services.

4. Why does this problem exist?

Currently, there is no communication hub for residents and waste collectors. There's no easy access to knowledge of delays or special waste services. Since waste gets cleaned/burned from blackspots, residents have developed an ingrained culture of public dumping - people know they can leave their waste in these spots and it will be out of their hands. Additionally, there is a lack of awareness and education for proper disposal and the consequences of improper disposal.

Customer:

5. Who is your customer/beneficiary?

Residents in houses and small apartments (less than 5 units), waste collectors, NGOs in waste management, and BBMP

6. Why do they face the problem?

Residents face this problem because the waste collector comes at inconvenient and sometimes inconsistent times or misses pick-up days. As waste piles up, many dump it on the streets instead of trying to coordinate with waste collectors.

7. What evidence do you have that they consider this issue to be a problem?

Interviews with the public, and research on public forums of residents in Bangalore complaining about the waste collection system. Waste collectors have to constantly reclean dumping spots and it takes a lot of effort and time.

8. Why haven't they solved this problem themselves?

Currently, it is difficult for residents to get in contact with their waste collectors unless they know them personally. Organizations and the government alike struggle to encourage residents to segregate waste properly and stop throwing waste on blackspots. In many areas, fines are poorly enforced and in person confrontation can quickly lead to unproductive arguments. Given the nature of their work arrangement, waste collectors are

sort of powerless. They must collect waste and they must clean up blackspots, despite the hazards and unprofitable waste.

Solution:

9. What is your solution?

To create the app, WasteLink, that connects residents in a neighborhood with their local waste collectors to allow for direct communication between the two. Show the waste collection vehicle's live location when they start their route, sending a notification to all residents that it is on the way, and can give an approximate time of arrival once route data is collected. Provide a waste segregation rating system that is open to the neighborhood/public to view. The waste collector can choose which days they want to rate sections of their route on an easy rating system. Neighborhood chat and service and support tools that encourage others and give people a direct line of communication with those who can provide service. Information regarding how to properly segregate any item and where to dispose of special types of waste.

10. How will the solution help the problem? (social value proposition/theory of change)

The app provides frustrated residents and the waste collectors a direct avenue of communication. Our feedback system and community messaging function will encourage neighbors to better segregate their waste. This segregated waste is easier for collectors to process, leading to safer working conditions and faster collection times, as well as more profitable to sell than mixed waste.

11. What evidence do you have that the solution will help the problem?

We surveyed 25 residents and 12 of them said having a platform to know how to dispose of any type of waste and a way to accurately track their collector with earlier reminders would be helpful to them. A few others said they wouldn't use an app like this because they are not well educated or comfortable with technology. We also got reviews from employees at Hasiru Dala and TUI who have years of experience working with waste collectors and waste management in Bangalore. They told us that an app like this could help connect residents and collectors which build relationships that support the goals of collectors which is proper segregation at the source.

12. How do you sustain yourself financially? (financial value proposition)

By working with food delivery apps in Bangalore such as Zomato, Swiggy, and Blinkit we will be offering affiliate coupons to the top users of the app that segregate their waste the best. We will receive a small commission with each purchase made with the coupons in addition to a small source of income coming from NGOs who will buy our data and be promoted through the app. The waste segregation data and vehicle tracking system can also be sold to other contractors who have non-BBMP waste collectors. In the long term we want to sustain ourselves through endorsement from the BBMP as they can use our data to find areas of improvement and track timing and collector efficiency as well.

Make it Real:

13. Do you have primary data?

We have done interviews in person and online and have received information that supports our theory of change.

14. Have you received outside feedback on your ideas? (prototype/ minimum viable product [MVP])

We have pitched our prototype to residents, collectors, mentors, and experts in the waste management sector. We made adjustments accordingly and have taken into account the importance of building relationships with the collector and the residents.

15. Do you have a clearly articulated plan for the next steps?

Pilot app in Ward 179 (Shakambari Narar), which has a Hasiru Dala supported DWCC for 3 months to test for how much the usage of the app is increasing the collected segregated waste amounts and aim to get at least 50% of residents using it. Spread the app by starting with the workers and then having them recommend the app to the residents on their route. We would then survey users to see what modifications could be made and what they like or dislike about the app. If we find that there is an increase in segregated waste and we get enough users within the 3 months we will expand to other wards over the course of several years and build recognition as a tool for waste management. We will build relationships with NGOs by promoting their services and with food delivery apps for affiliate marketing. In the long term we will sell the data we collect to NGOs or the BBMP and other waste contractors to help them find areas that need improvement in waste management

16. Do you have the right partners+team; have you identified who you would like to work with/bring into your team?

BBMP, the DWCCs and the waste collectors, other NGOs like Hasiru Dala or Saahas.