

1. Introduction

The world is polluted by tons of unrecycled waste. Humanity produces 300 million tons of plastic per year. Around 9 million of it ends up dumped in our oceans. This highly affects the life of third world countries such as Indonesia, the Philippines, Vietnam, etc. The waste from the developed countries enters the oceans through the rivers and is accumulated in specific areas. The waste in the oceans also affects flora and fauna. Many ocean inhabitants get stuck within the plastic and die. Some waste stays within the land. A variety of animals and birds eat plastic thinking it is food and die from that. Lots of small ponds and rivers in the cities are polluted to the level that we can barely see the water.

You might think that waste pollution does not affect you. However, microplastic is already inside of us. You are consuming it with all the food you are eating. Plants are growing on the polluted soil and animals do not always die from direct plastic consumption. We have to care about ourselves and the ones we love. We have to care about our environment. We have to understand that the waste that we do not sort, affects the lives of people in other countries, as well as flora and fauna all over the world. Your small efforts save tons of animals' lives, bring impact to the environment and make the life of all countries better. However, even people who are willing to make an impact and recycle waste might not have the opportunity or motivation. The LeKote team is here to provide you this opportunity and motivate others to be part of the eco-movement.

2. Whom our project for?

This is Katya. She lives in Moscow in a regular two-bedroom apartment with a husband and a daughter. Katya has read a lot of information about waste pollution and how south-east Asia countries are suffering from plastic waste in the oceans. She also read that recycling is a great way to prevent pollution. In the ecoactivist public, she found out that if people start doing the waste sorting this helps the recycling companies to collect more recycle materials and prevent the increase of waste pollution in the nearest area.

Katya is eager to sort waste, and she started to separate wastes in her apartment, but she faced a problem that there are no recycling bins in her neighborhood. The one that is semi-close to her house looks abandoned, and she does not trust that if she puts recycling waste in the special bin it will not go to the regular dump with all the trash (**trust issue**). There are reliable recycling bins further away, however, going there requires extra time that has to be spent specifically to ride a car to these bins (**time issue**). Katya is working a lot and she does not have time and energy to go too often to these places, as well as there is not enough space in their two-bedroom apartment to collect and store recycling waste for a long time (**space issue**). Therefore, even though Katya wants to help the environment she does not have a good enough opportunity for that.

In addition, it is hard for Katya to deal with the issue on her own. Her husband and daughter are very skeptical about the waste sorting because since they see no impact from the time they spend on the waste recycling they think the time they spend is not worth it (**motivation issue**). Both husband and daughter understand the waste pollution issue but they cannot find enough motivation to get involved in the waste sorting. Katya wants to have an opportunity for an easy way for waste sorting as well as find a strong motivation for her family and friends to be part of the eco-activist movement.

3. Market Research

Municipal solid waste (MSW) management system is one of the key components of a country's overall environmental and resource efficiency framework. The municipal solid waste management market size will grow by USD 34.04 billion during 2019-2023, and it will post a CAGR of close to 3% during the period 2019-2023 ([Technavio report](#) of Global MSW management market 2019-2023).

In the United States, up to 40 percent of all municipal waste is recovered; the EU Member States typically recover around 60 percent of municipal waste—ranging from 25–30 percent in the Czech Republic, Slovakia, and Poland to 95–99 percent in Austria, Belgium, and Switzerland. (World Bank's [summary report](#) of MSW Management in Russia.)

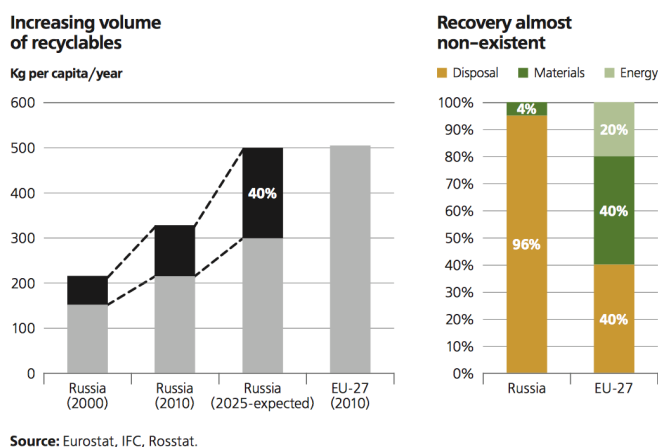


Figure 1. Comparative MSW recycling rates

The amount of garbage produced per capita is growing everywhere, and although Russia now produces less waste (per capita) than European countries, the recycling rate is only 4%. Russia is ramping up its imports of plastic waste year after year as its lack of a national waste sorting system leaves recycling plants lacking raw materials ([RBC news](#)).

But there is a positive side – Russian people are more and more interested in recycling. Despite the lack of the national waste sorting system, more and more citizens collect and sort waste by themselves. The interesting fact was also noticed: during this isolation period the number of requests in Yandex for “recycling” is rapidly increased (See Appendix A).

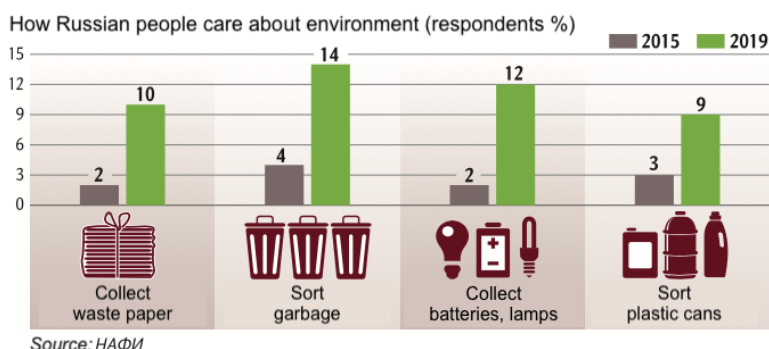


Figure 2. Russian people interest in changing in waste sorting ([NAFI](#))

The difference between European countries and Russia is our opportunity to enter this market because there is a lot of produced garbage that is not sorted. We see that people are ready to sort their wastes but don't have enough opportunity for this. GarbageGo is here to provide this opportunity.

4. Our solution

As a solution to the proposed problem, we offer smart recycling bins in the stores that count the statistics of the sorted waste. The bin works in conjunction with a mobile app where the user can observe personal as well as regional waste sorting statistics.

The bin solves three problems of wastes sorting: space, time, and trust. By placing the bins in the local stores in the neighborhoods, we give people an opportunity to conveniently sort the waste with a minimum effort, and they do not need to collect so many wastes in their apartment.

The app with the statistics reshapes the waste sorting in a fun game, where users can compete with friends and earn achievements that they can share in their social networks. In addition based on the statistics the user gets discounts for products. Therefore, statistics tracking, and the app serves a motivational purpose.

The LeKote smart system consists of four bins: plastic, paper, glass, and metal as shown in figure 3 below. Our bins have an appealing and eye-catching design that will fit in the store design ecosystem. In addition, as one can observe, we are collecting bottles separately from the rest of the plastic.



Figure 1. GarbageGo bin system design

Each bin is equipped with a scaling and counting system. Since different types of wastes should be counted in a different way, our system takes that into account: the paper would be weighted; glass, metal cans, and plastic bottles should be counted. Furthermore, plastic takes up a lot of space, so it's going to be embedded by the press system to make it not so volumetric

(see figure 5 to observe the inside view of GargageGo). When the user disposes the waste into the bin, it weighs (or counts) the waste, sends the data from the sensors to the server. The data is used for the statistics in the app.



Figure 5. Inside view of GarbageGo. (press system on the right)

All our bins have a protection system from the unauthorized waste disposal (Ex: throwing an apple into one of our bins). Our bins stay closed until the user activates the specific bin via QR code or a button in the app (see figure 6). The bins “windows” opening is driven by step motors. This way the bin knows who is disposing of waste and can track personal statistics for each user. In addition, a person without a profile in the app cannot dispose of the waste. It might seem inconvenient; however, we are focusing on the people who go to our bins with a goal. and These users are interested in downloading the app. Besides, other people who see our bins might get interested and download the app from where they find the motivation to start the waste sorting. Since all the bins are connected to a single server, the user can utilize the LeKote bins system at any location.

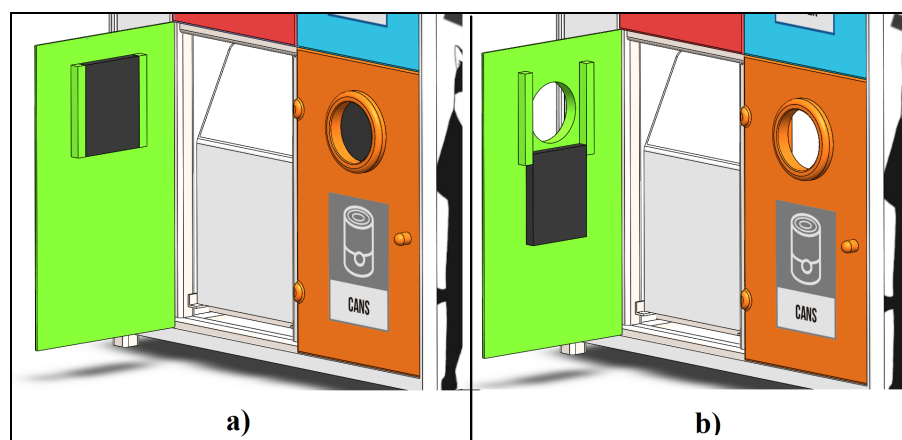


Figure 6. Bin “window” opening: a) closed state, b) opened state

The device is equipped with sensors, actuators, and a display. Sensors data sent with a 3G module to the server. User applications are also connected to the server with HTTP protocol.

For the effective operation of garbage collectors and recycling stations, an API and a website for the local operator will be implemented. The last one and the most important connection - users' relationships. The data transfer logistics is displayed in figure 7.

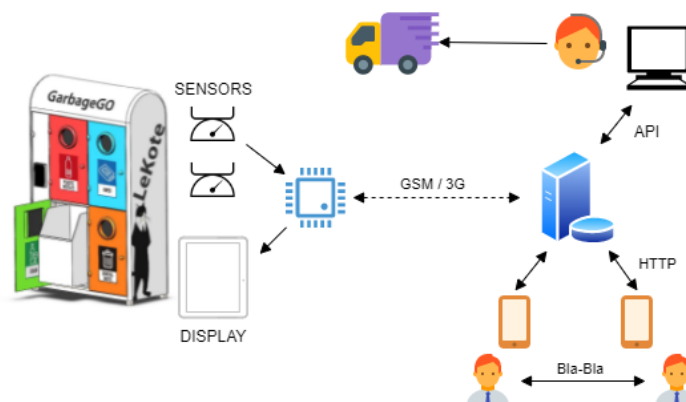


Figure 7. Data transfer schematics

The app synchronizes with data from the server and displays the statistics of how much recyclable waste of each type was sorted in some amount of time (left picture on figure 8). For convenience, in the app the user can observe the locations of all the GargageGo systems directly on the map (right picture on figure 8). Our map is always up to date! Also, the user can observe where and when he or she used the LeKote bin system.

The personal statistics can be compared with the other users (see Appendix B for the app screen example). There are top ratings for each separate LeKote system, neighborhoods, and cities. The app can be synchronized with the user's social media (Facebook, Instagram and etc.) from where the user can find out who from their friends is also using the LeKote app. The user can add friends in the app to compare the statistics and compete with each other.

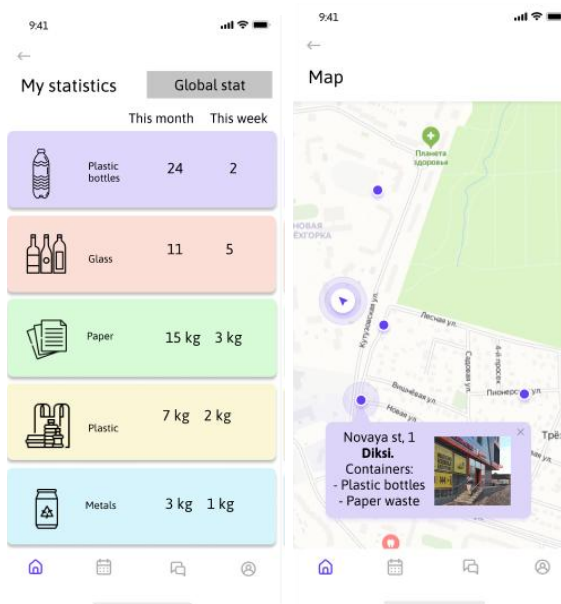


Figure 8. Examples of GarbageGo app screens (left - personal statistics; right - live map with GargabeGo locations).

In addition, the app has an achievement system. For specific milestones, such as sorting a first 1kg of plastic, the user gets a badge and increases a personal rating. The user can share the achievements in social media with just one click (see Appendix B for the app screen example). Another great motivation that our app provides is that by earning some amount of points the user can get a discount for specific products in the stores. The discount comes from the store or directly from sponsors such as Coca-cola or P&G.

Finally, our app has additional information for education on the topic of waste sorting and recycling. The user can read the latest news and articles on ecological topics, where the news is filtered by the topics that the user is interested in. In addition, we collect all the latest statistics about waste pollution, sorting, and recycling in the whole world. Also, the app clearly shows the impact or the amount of sorted and recycled plastic by each user. Such reassurance helps to motivate users to stay on top of their sporting habits and feel that the time they spend on waste sorting is worth it!

5. Existing solutions

There are two different types of existing solutions: mobile apps that help people to sort waste and/or show the locations of recycling bins; and reverse vending machines for collecting recyclable waste. In our solution, we unified both the great app and an amazing bin system.

App projects

As competitors in terms of mobile applications, we consider three popular applications: Ecomap, Clean Path, and iRecycle. The idea of all three applications is similar: it has a map on which recycling points are marked and the user can find the point of interest. A detailed comparison of three competitors and our solution is given in table 1 in Appendix C).

The main problem of existing solutions is an outdated recycling map. In our case, the map shows the points with our own sorting bins, so it's up-to-date. Moreover, only our product has the opportunity to automatically keep statistics of sorted waste.








Projects with reverse vending machines

The idea of all the following projects is the same: A big company sponsors the production of reverse vending machines to collect specific waste in the local stores.

These projects have two major limitations: versatility and quantity. They are made only for one specific type of recycled waste and this does not solve the problem of the unrecycled waste in general. Unilever's project is too specific and only household chemicals plastic waste are accepted. This is a very small portion of the recyclable waste around us. We propose a solution that covers all the basic types of recyclable waste. In addition, there are so few vending machines installed that almost no one knows about them. As well as going to the other side of the city is not convenient. A detailed comparison of three competitors and our solution is given in table 2 in Appendix C).

In table 1 below, we have made a comparative analysis among existing solutions and one can clearly see that GarbageGo is better than the competitors in a variety of parameters. We are accepting multiple types of recyclable waste. We have an app that automatically tracks your statistics and gives you an opportunity to compete with friends and yourself. We have a discount encouragement system. GargabeGo will be easy to find in each neighborhood and our map is always up to date, as well.

Table 1. General comparison of our solutions and competitors

	 Пятёрочка	 Перекресток Супермаркет	 ВкусВила	 Ecomap	 CLEAN PATH	 iRecycle®	 GarbageGO
Mobile app	–	–	–	+	+	+	+
PET bottles	+	+	+	Have no hardware			+
Aluminum bottles	+	–	+				+
Paper	–	–	–				+
Glass	–	–	–				+
Plastic	–	Only household chemicals	–				+
Number of machines	10	7	12	–	–	–	Each local store
Statistics	–	–	–	+(manual)	–	–	+(automatic)
Up-to-date map	–	–	–	–	–	–	+
Works in Russia	+	+	+	+	+	–	+

6. Business model

There's not a lot of money on recycling. Rather, because of this, we do not see a large number of startups and projects in this area. However, the mentality of people in megacities has already formed and requires the possibility of recycling. Also, we see the improvement trend in eco products and the implementation of recycling in corporations. For example, Unilever, according to their report, plans to make packaging for its products 99% consisting of recycled materials by 2030. Based on these facts, we have identified the following business model.

The base concept rests on volunteers and partnerships with eco-friendly manufacturer brands like P&G and partnership with local stores like Pyaterochka. This project can be implemented only due to the absence of costs for renting space, labor, and financial assistance from partners. Partners will be interested because open sponsorship of eco-technologies and advertising on devices will increase consumer loyalty to brands.

In table 4, one can observe the weekly unit economics. There we show how LeKote is planning to get revenue from this business model. In the beginning, all the revenue would be invested in creating more and more bin systems. We plan to have GarbageGo in all

neighborhoods in big cities such as Moscow, Saint-Petersburg, etc. As our reputation grows, we plan to enter international markets in China and eastern Europe.

Table 4. Weekly Unit economics

Costs	Revenue
Amortisation: unit cost(1) /operation period(2) = 260 rub	Materials sale(3): 150 rub
Materials transportation: 300 rub	Advertising in-app(4): 60 rub
Area rent-free(3)	
Total: 560	Total: 210
MIN Advertising and partnership income at less 250 rub/week	

Below we show the detailed finance flow calculation. The total cost of each system can be reduced by using the recyclable materials that we collect for the body of GargabeGo. Selling sorted waste is not super cost-effective on the small scale. We can save money on buying the materials and transporting the collected waste if we use part of it for GarbageGo manufacturing. This approach will help us get started. Once we have many GarbageGo systems all over the city, transportation and selling the sorted waste becomes more cost-effective.

- 1) Container cost:
 - a) Mechanics - 4000 rub
 - b) Electronics - 3000 rub
 - c) Body - from 1500 to 300 (*when recyclable materials are used*)
 - d) Assembling - free (*Skoltech volunteers*)
 - e) Delivery & Installing - 2000 rub
 - f) Totaly: from 10500 to 9300 rub
- 2) Unit operation period - 3 years
- 3) We believe to receive weekly from 1 container:
 - a) 30kg of plastics (*reused for new container bodies*)
 - b) 40kg of paper
 - c) 40kg of steel
 - d) 20kg of glass
- 4) From the calculation of 1000 people, using 1 container.
 - a) Price per 1 impression = 0.02 rub
 - b) 3 user visits to the app per week
 - c) $0.02 * 1000 * 3 = 60$ rub

7. Achievements

Our team's achievements at this stage are as follows:

1. Created a 3D model of the sorting bin. A detailed system of the device has been developed, including a data transfer scheme from the sorting device to the phone
2. The mobile app prototype is created, the main functions and user motivation system are described.

3. Our team has an agreement with the VitalClim team, which is to optimize the schedule for taking the trash out with respect to different types of waste and sorting points map, to advertise our product for customers.
4. We have an agreement with the Avengers team. This team has chemistry and biology experts. So they would consult us regarding how to make their sorting device biologically safe and provide real customer feedback.
5. The software developers from the EasyPeasy team agreed to make an app for our project, based on our concept.
6. The Sanitizing Squad team commits to help the LeKote team in terms of sorting waste according to its chemical composition.

8. Future plans

There is a lot that has to be developed and researched in order to have our first MVP. Our development consists of separate tasks that are connected with each other with a general idea. We have three main directions we are working on: bin development, app development, and business.

Bin development is a step by step process where we go from a CAD model to a fully functional bin system. We start with a CAD model that includes basic functionality. Then we make a first simple prototype (without any electronics). This should be done within the first 2 months. Then we should implement the system for automatic “window” opening. Once the app connects to the bin is done, the “window” opens via app command. The next step is to implement the weighting system and transfer the weight data to the app. Finally, we have to implement the press system for the bottles.

App development starts with creating a general idea and concept design. This would be done within the first month. Then we have to have a detailed achievements hierarchy system that each user would follow. Our developers will have to design a secure data transfer between the app and the bin. In addition, we have to connect our app with the most popular social networks such as Facebook, Instagram, etc. Our app will be constantly updated as we develop our company. New features would include point system based discounts for specific products, updated map with the location of GarbageGo bins, a constant improvement on the app design.

Our business model working plan is also incremental. We start with the development of the general business model idea. Then we have to find the recycling companies with whom we will make a contract. We will deliver all of our sorted waste to these companies and get money for it. Then we have to find store chains that are ready to work with us. We will have to make an agreement with the store chains to accompany both store and our needs (win-win). Finally, we have to get connected with global companies such as Coca-cola, P&G, etc. We are interested in companies whose products have recyclable packages. We would support these companies with the advertisement campaign (showing that they support recycling), while these companies will provide us with discount coupons on their products. In addition, we should constantly work on the advertisement side to get extra revenue for our company. See Appendix D for the milestones representation.

9. Our team

- **Anastasija** (Team lead, engineer)
- **Lidiia** (eco-consulting, app development)

- **Denis** (construction designer and engineer, robotic systems)
- **Nicole** (market research, working with clients)
- **Yaroslav** (data transfer, business model).

Together, we have competencies in 3D modeling, robotics, IoT, and back-end development, so we have enough skills to make a GarbageGo system. Our creativity, knowledge in eco-movement, and networking skills will help us to develop appealing designs and interesting achievement systems in the app. We are highly motivated to make the world better.

10. Call for action/ask money

What do you prefer to see around you? Clear lakes, ponds, or polluted rivers? Happy kids, who are running around the city and do not see all the trash on the streets? In the hidden places, we all find bottles that are sitting there for years. I bet you want to eat clean food that is not full of microplastic, that was disposed of by our parents and grandparents. Do you want to make your life better? Do you want to make the world better for your kids and grandchildren?

Start now! **Open your greenway!** We are here to give the opportunity and motivation to everyone who cares about the world where we live. Take part in our journey:

- Be the first one to set the containers in your stores! We will be happy to work with any store chains or small local stores.
- Be the first to test our app! Help us out to make the best app that will meet all the needs and interests of our users.
- Help us out with investments. To bring this idea to life we need ~ 2 million rubles. We are happy for every dollar that you would be ready to donate to support the great things.

“Great things are not done by impulse, but by a series of small things brought together” -

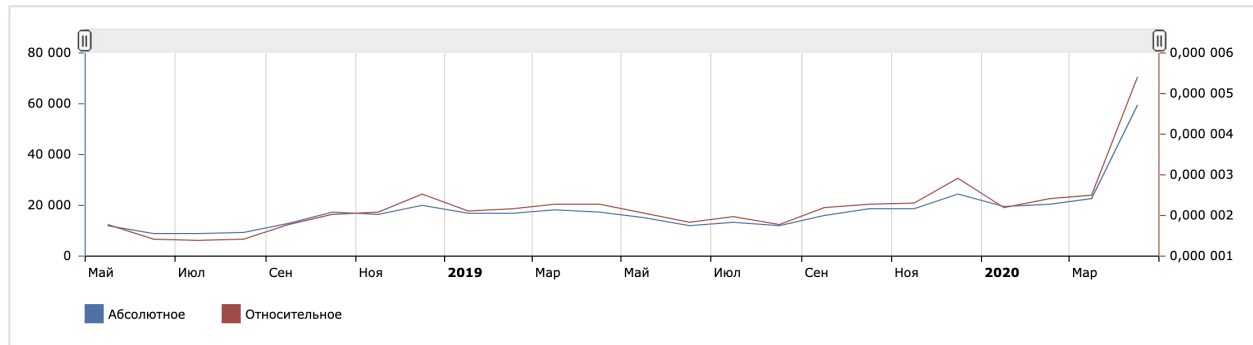
Think of what you can do!

If you are willing to be part of our team, you are welcome! We will be happy to work together with like-minded motivated persons like you!

Together we can make this world better

Appendix A

Yandex Wordstat results “recycling”



Appendix B

App design



Appendix C

Table 1. Comparison of the characteristics of the mobile app







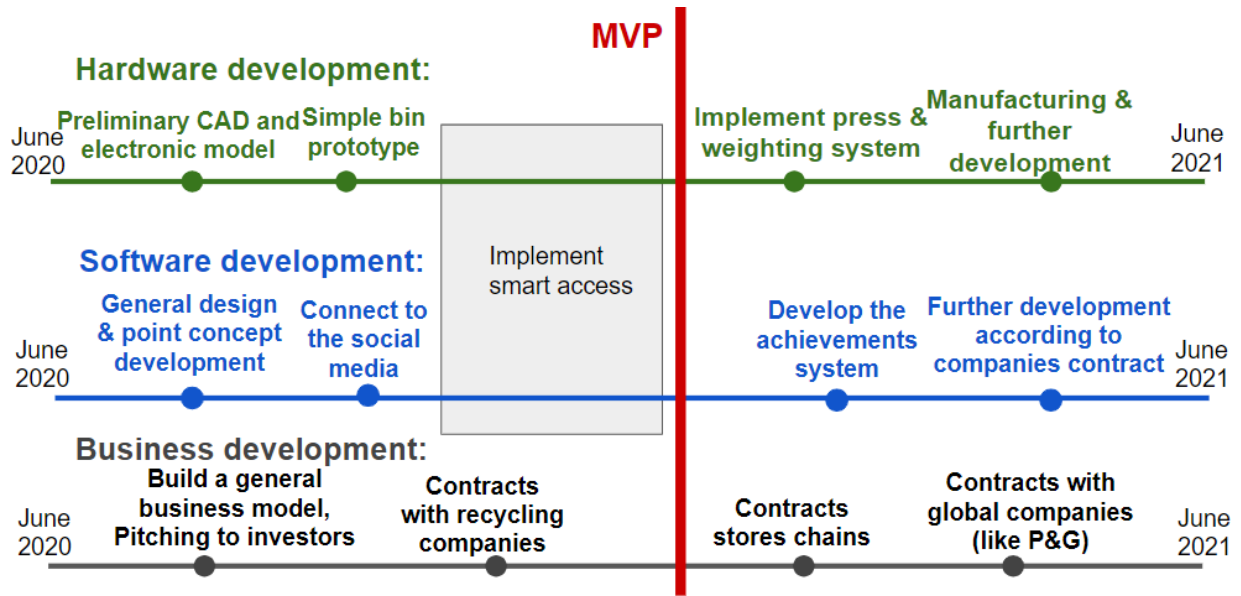
				LeKote
Recycle map	+	+	+	+
Sorting rules	+	+	+	+
Green new	-	-	+	-
Works in Russia	+	+	-	+
Statistics	+(manual)	-	-	+(automatic)
Google Play	-	+	+	+
IOS	+	+	+	+
Electronics and households sorting	-	-	+	-
Up-to-date map	-	-	-	+

Table 2. Comparison of the hardware characteristics

				GarbageGO
PET bottles	+	+	+	+
Aluminum bottles	+	-	+	+
Paper	-	-	-	+
Glass	-	-	-	+
Plastic	-	Only household chemicals	-	+
Mobile app	-	-	-	+
Number of machines	10	7	12	Each local store

Appendix D

Future plans



Appendix E

Sorting solutions ideas

1	Ideas	Score			
2	Criteria	New	Useful	Feasible	Total
3	Home equipment for plastic recycle for everyone	6.2	8.2	5.2	26.44
4	Create cheap decomposers and implement them in the cities.	6.2	8.6	4.4	23.46
5	Marketplace for plastic garbage	8	5	5.8	23.20
6	Implementation of vacuum pipe garbage transport system	6.8	8.2	4.2	23.42
7	Tik Tok/Youtube show with high ratings where participants compete in the challenges related to solving plastic waste problems	6.8	4.8	6.4	20.89
8	Plastic collection in local stores	5.8	6.4	5.2	19.30
9	Mobile app with instructions how to sort waste	4.8	5	8	19.20
10	Educational cartoons for children about waste sorting	4	5.8	7.4	17.17
11	Tik Tok/Youtube show with high ratings where participants are discussing plastic issues in the fun way	6.8	4.2	5.8	16.56
12	Something like water pipes, but from reused plastic for every home	7.4	5	3.8	14.06
13	Make sport competitions, where participants compete who sorts more plastic	8.4	2.8	5.6	13.17
14	Fund most popular influencers and bloggers to actively discuss plastic pollution problems	5	4.8	5.4	12.96
15	Make garbage sorting fashionable	7.2	4.2	4	12.10
16	Introduce waste sorting system in every countries	4	7.2	4.2	12.10
17	Create the plastic recycling system that generates electricity (recycled plastic to electricity).	7.8	8.6	1.8	12.07
18	National organizations' sorting initiative	5	7.8	3	11.70
19	Automation of waste management facilities with robots equipped with computer vision	4.2	5.6	4.8	11.29
20	Marathons. Collected money goes for waste sorting needs.	5.8	3.2	5	11.14
21	Create the accelerator for waste sorting companies	5	7	3	10.50
22	Education program for people about waste sorting	3	5.8	5.8	10.09
23	Talk to delivery services about plastic they use for packing	4	5	5	10.00
24	Automation of waste management facilities with robots equipped with sensors that detect plastics	4.2	5.4	4.2	9.53
25	In colleges, fund eco clubs, to motivate students thinking about the plastic pollution	4.2	3.4	6.6	9.42
26	Massively breed plastic-eating bacteria	6.4	6	2.4	9.22
27	Make building materials from recycled plastic	5.6	3.6	4.4	8.87
28	Governments' waste sorting initiative: allocate money for investments into waste sorting startups	5	6.2	2.8	8.68
29	Throw the garbage to the houses of rich people to push them invest money	7.6	3	3.8	8.66
30	Motivate citizens of first world countries to sort waste by showing more real life stories of the people who live in the Asia pacific regions	3	5	5.6	8.40
31	Plastic shreders at local stores	6	4.8	5.4	15.55
32	Single-use plastic ban	4	8	2.4	7.68
33	Garbage sorting advertising company	2.8	6.4	4.2	7.53
34	Motivate communities to sort waste through competitions	5.8	4	3	6.96
35	Hackathons that are oriented towards waste sorting problem: Machine learning solutions for waste sorting robots	6.2	2.8	4	6.94
36	Invent safe chemicals to treat plastic	6	6.4	1.8	6.91
37	Use plastic as fuel for cars	6.8	6.8	1.4	6.47
38	Governments' waste sorting initiative: allocate money for the program that motivates citizens to sort waste	4.2	6.4	2.4	6.45
39	Establish lots of recyclable manufactures	4.2	7.2	2	6.05
40	Replace plastic with ecology safe and cheap material	3	6.8	2.8	5.71
41	Massive increase of taxes for use of plastic	3.2	6.8	2.6	5.66

41	Massive increase of taxes for use of plastic	3.2	6.8	2.6	5.66
42	Encourage specialists in eco-sphere	3.2	4.6	3.8	5.59
43	Program that motivates scientists to work on garbage sorting and recycling solutions	5.8	3	3	5.22
44	Fell in love with plastic alternatives	6.8	4.8	1.4	4.57
45	Create bacteria for waste decomposition at homes	7	6.4	1	4.48
46	Hackathons that are oriented towards waste sorting problem: App ideas for community motivation to sort waste	5.4	1.8	4.6	4.47
47	On the streets and buildings allow graffiti and pictures on the plastic pollution topic	8.2	2	2.4	3.94
48	Remove garbage from Earth with super-cheap space flights	8.4	5.4	0.8	3.63
49	Manufacture sport equipment from recycled plastic	5	3.2	2	3.20
50	TV show, where grand prize is a mount of plastic	8.8	1.8	2	3.17
51	Bring out the breed of animals that will eat plastic	8.8	6	0.6	3.17
52	Hypnotize government leaders to fight against plastic pollution	7.8	5.6	0.6	2.62
53	Increase world literacy	2.8	4.6	2	2.58
54	Find alien creatures who eat plastic and start to breed them. (or melt plastic with acid - Ellen Ripley approves)	9	6.6	0.4	2.38
55	Change humanity DNA and eat plastic by ourselves	9	6.6	0.4	2.38
56	Transport garbage to the Sun orbit	8	4.6	0.6	2.21
57	Sell plastic waste to another planet civilizations	8.2	5.8	0.4	1.90
59	Transfer humanity mind into machines (Flesh is weak, who needs plastic food containers now?)	8	3.8	0.6	1.82
60	Shrek frightens everyone to not pollute his swamp	9.4	4.6	0.4	1.73
61	Increase Planet pollution on level when plastic pollution will become the smallest problem among others.	8.4	0.6	3	1.51
62	Decrease poverty	2.2	5.4	1.2	1.43