Pet Cleanup Project
Problem Definition Review

Group C

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Problem Definition Review

1. Introduction and Value Proposition

In 2021, over 70% of U.S. households owned a pet [1]. People keep pets in their household for loyalty, companionship, and affection, among many other reasons.

However, pets can also be messy or disruptive or demand much of their owners' time. They are dependent on humans to provide them with food, water, and health care. Some aspects of pet care can be tedious or frustrating for the pet owner. With this in mind, this review identifies a target problem with pet ownership to address. To do this, research is conducted to identify the most important problems pet owners face.

Pet owners are very focused and dedicated to the health and wellbeing of their pets; however, pet care can be difficult for owners. After conducting two surveys and doing thorough research, the team has found that pet owners are focused on efficient and low-cost products for their pets. 37.9% of survey participants reported that they negatively perceived cleaning up after their pets (Appendix D). Pet owners surveyed indicated that they wanted a product to be reliable and helpful. The group is moving towards creating a product that will assist busy pet owners with the process of cleaning their pets so it is easier and more efficient. Even though the project is targeted towards busy college students that own pets, a solution can be used by all pet owners. The group's solution will take less effort and time out of pet owners' days.

2. Problem Definition

2.1 Task
This project addresses the task of cleaning up for one or more pets.

2.2 User Experience Chart
Refer to Table B1 (Appendix B).

2.3 Pains
- Owning pets is time-consuming: Pet owners must spend their time on their pets. For example, they have to walk their pets outside or clean up after their pets. Not all of this time is enjoyable.

- The pets can hurt others or damage objects: Pets can sometimes act aggressively towards people or objects. They bite or scratch using their claws especially when they feel unsafe. Some pets also mark their territory or scratch or chew furniture.

- Needs someone to take care of the pets when the owners are not around: If owners need to be away from the house, they must find alternate pet care arrangements. Some pets also suffer from separation anxiety when their owners are not present.

- Owners must bring their pets to a veterinarian in case of sickness: It is the responsibility of the pet owners to pay attention to their pets' health and well-being.

- Pets may disturb their owners' sleep if they are hungry or bored.

2.4 Gains
- Getting comfort and companionship with pets: Pets bring companionship to a household and are thought of as part of the family.

- Having a healthy and happy pet: Pet owners want their pets to be healthy and happy.

- Spending less time on pet maintenance: Maintenance and grooming for pets can take a lot of time and money. A lot of people are busy and it takes a lot of effort to care for a pet.

- Service animals: A lot of dogs are used as service animals that assist people with disabilities to help them with day to day tasks.

2.5 Discussion
These pains and gains were chosen as interactions that a typical user (a college student) may have with pet care. Several alternative tasks were considered before pet care was decided (Appendix A, Tables A1 and A2). For example, the main benefit of having pets, their comfort and companionship, is a significant gain. Similarly, bringing the pets to the vet is listed as a pain, as it can be stressful, expensive, and unpleasant for both pets and humans. To decide which issue with pet ownership is the most significant, research needs to be conducted.

3. Research Plan

3.1 Research Questions
In order to determine what the most substantial issues with pet ownership are, research is required. Both qualitative and quantitative data will assist in deciding which issues to focus on. This plan gathers data on the current state of the pet products industry and the struggles that pet owners face. By collecting this, the most prominent problems faced by users can be found and existing solutions can be examined. The research goals and methods are presented in Table C1 (Appendix C).

3.2 Preliminary Survey Methodology
To narrow the scope of the project, it is necessary to know what aspects of pet care pet owners struggle most with. To find this information, a survey is created.

The survey is designed to not collect sensitive information from the respondents. As the survey is focused more on pets than their owners, very little information is collected about the pet owner. Each submission will be assigned a number, so the respondent's identity will not be included in the survey results. Respondents are informed at the beginning of the survey that none of the questions are mandatory and they may opt out of the survey at any time by contacting the survey administrator.

The survey asks users to rate four activities on a 1-5 scale: cleaning up after their pets, feeding their pets, transporting their pets, and training their pets. The data is sorted into two categories: respondents who own one or more dogs and those who own one or more cats. This enables average scores to be generated for both of the most common pet types. Responses that own both cats and dogs are counted in both categories. Survey questions and responses are available in Appendix D.

3.3 User Need Survey Methodology

With the information from the preliminary survey enabling the decision of a target problem, further research must be conducted. To understand what struggles users have cleaning up after their pets, a secondary user needs survey is presented. By analyzing these users' needs, a solution can target and address the most needs that users feel are most important.

Survey questions and average responses are presented in Appendix E.

3.4 Discussion

Research must be conducted to determine what problems pet owners most frequently face. Using a combination of existing data, articles, and conducting a survey, information can be collected that can shape the decision of a problem to address. With the planned research, it will be possible to decide on one problem to target. With a target problem, a solution can be created. The research questions are designed to enable insights into problems faced by pet owners and the state of the pet industry. For example, research question 5 is designed to determine what difficulties pet owners have with transporting their pets. If pet owners respond that they have significant difficulties transporting their pets, that could be identified as a problem and possible solutions could be generated.

4. Research Results

4.1 Preliminary Survey Results

After conducting a preliminary survey (described in Appendix D), 51 "valid" responses were received. Responses are considered valid when they consented to their answers being recorded and indicated that they owned a pet. One response was not in English and was removed from the data. If they did not consent to being recorded, they were removed from the data. If they did not own a pet, they were not considered as they are outside of the target demographic. The survey was distributed mainly to Ohio State University students through group messages for several student organizations. The average scores, broken down by type of pet and overall, are presented in Table 3.

As seen in Appendix D, Figure D1, where combined data from all pet owners surveyed is presented, most of the data follows a somewhat normal distribution. Pet clean-up is rated the lowest on average.

The lowest-ranked activity is cleaning up after dogs, followed by cleaning up or feeding cats. The highest-ranked activity is feeding dogs, followed by transporting dogs. Based on this information, along with open-ended responses from questioned users, the problem is narrowed to cleaning up after pets. Average results are presented in Appendix D, Table D1.

4.2 User Need Survey Results

After conducting the user needs survey, several insights were apparent in the data:

-Pet owners preferred a solution to be pet-safe, helpful, and reliable, in that order.

-Cost was not as significant of a factor, with "low cost" being the lowest-ranked need in the survey.

When asked to rank existing products, some patterns emerged:

-Pet hair brushes were ranked highly in all aspects, being the highest ranked product listed in four out of the six needs.

-Pet nail trimmers were consistently ranked quite poorly in all aspects, landing near the bottom of the ranking in most aspects.

Additional data on these results is presented in Appendix E. Table E1 presents survey respondents' average rankings of various needs on a 1 to 5 scale, with 5 being the most important. Table E2 presents respondents' rankings of how well various products fulfill those same needs. Squares highlighted in green indicate that this product was ranked highest in that need, with yellow indicating second place. Table E3 presents all of the responses that consented to their answers being published anonymously.

4.3 End Users

To better characterize the end user, an example end user was created. "Molly Thompson" is a fictional 20-year-old female college student. She represents college students who own pets. Like many college students, she is busy with classwork and has limited time to spend caring for or playing with her pet. Because of this, she could benefit from a solution that would alleviate some of the work of pet care. A detailed description of this fictional persona is available in Appendix F, Figure F1.

Ease of use, cost, reliability, helpfulness, speed, and pet safety are all important traits in a product or solution for a pet user. As such, these are selected as end user needs.

To rank the user needs in Appendix F, Table F1, a score is assigned based on how much the hypothetical user may value a certain need. For example, ease of use is given a score of 4 out of 5, as not all users are experienced with complicated technology. If a product requires detailed knowledge of the underlying technology, it is not very helpful to a user who is not familiar with it. As such, ease of use is ranked highly. According to data from the American Pet Products Association, 27% of pet owners in 2021 were Baby Boomers [8]. Older generations may not have experience configuring and troubleshooting smart-home devices, and as such, a solution that is easy to use and understand is more valuable to them. Even for those such as the example user who are more technologically literate, an easy solution saves time and effort.

To refine the needed rankings, a pairwise comparison is made in Appendix F, Table F2. This matches user needs against each other. A more important need is selected from each pair. If the

need at the top is more important, a 1 is put in the cell. If the need on the left is more important, a 0 is put in the cell.

To determine the more important need of each pairing, research can be conducted. For example, in all pairings with pet-safe, pet-safe is given priority. Owners care significantly about the safety of their pets, and any product that is not safe for a pet is not a good solution for a pet owner. M. Giordano and L. Strampe begin their article with a list of dos and don'ts when caring for a cat, emphasizing the importance of taking care of the pet [10]. Likewise, between helpful and fast, helpful is given priority. A solution that is fast, but is not helpful, gets nothing done quickly and is not useful to the user.

4.4 Market Character
4.4 (i) Stakeholders

Apart from the end user, several stakeholders must be acknowledged. Most obvious is the pet or pets. The product must work alongside the pet and cannot be frightening (such as a vacuum cleaner) or obnoxious to the pet. This means that it cannot produce loud sounds, move fast, have a strong smell, or be otherwise threatening to a pet.

Additionally, the pet owner may live with other people. Their needs must also be addressed; for example a solution cannot be loud or intrusive to their privacy. Similarly, neighbors may need to be considered if the owner lives in a dorm or apartment.

The pet industry is very large, and numerous companies exist selling pet related products. These are considered as stakeholders as well. Any physical product will need distribution channels, adding retailers, distributors, and manufacturers to the list of stakeholders. A table of stakeholder needs is presented in Appendix F, Table F4.

4.4 (ii) Market Size

Over 70% of households in the United States have one or more pets [1]. This leads to a pet industry that, in 2020, generated $103.6 billion. The largest segments of this market are pet food and treats ($44.1 bn) and supplies, live animals, and over-the-counter medicine ($23.4 bn) [8].

Specific to pet cleaning, the pet grooming market was valued at $3,872 million in 2017, with consumable goods like shampoo and conditioner accounting for a large portion of sales. Combs and brushes are second in sales. [13]

4.4 (iii) Current Alternatives

With so many pets, pet owners must clean up after their pets. Pets generate waste and shed fur, which can be difficult to remove from upholstered furniture. Respondents to the preliminary survey indicated cleaning up as the worst task, with an average score of 2.9 out of 5, lower than the other tasks listed. Cleaning up after waste is not comfortable for humans either - a significant number of respondents to the preliminary survey mentioned the smell of pet waste as a challenge to cleaning up. Several also mentioned managing shed fur as a challenge. Of course, many products are already available to aid pet clean-up. Appendix F, Table F3 presents several of these

solutions and indicates which user needs they satisfy. In it, spaces are marked with an "X" when the user's need is fulfilled.

4.5 Discussion

The survey conducted allows the group to understand the frustration surrounding cleaning up after pets. The pet owners and the pets themselves are the largest stakeholders for pet care. They use and are affected by products; however, the pet care industry benefits from every pet product purchase. With most households owning pets, the pet care industry is a multibillion-dollar industry that is continuously growing every year. Pet owners are spending more to spoil and take care of their pets. As a result, there are many options for pet care today. Pet owners use litter boxes, hairbrushes, nail trimmers, fecal waste bags, vacuum cleaners, and furniture coverings, among other tools, to clean up after their pets. All of these products are helpful to pet owners, yet most of these take up more time than some people have. Most of the products are easy to use and can be bought at a low price. However, only some of them are reliable which means that it is possible that the other products will be unable to be used over a period of time. The most important thing about these products is that all of them are safe to use on pets. Pet safety has to be deemed important in this case where it is crucial to notice if the pets are hurt when these products are used on them.

5. Design Focus

Based on the responses we received, we found that it is burdensome for pet owners to take good care of their pets, especially in terms of cleaning. A large amount of effort is needed to keep them clean. For college students, much of their time is occupied with classes, assignments, and on-campus jobs. As such, they do not have significant amounts of time to clean up after their pets. Moreover, although there are many pet cleaning products in the market right now, our respondents indicated they were not satisfied with their performance. For example, when asked which pet cleaning product needs improvement, most respondents selected nail clippers and litter boxes. Plus, one of the challenges that the respondents face when cleaning after their pets is that the pets can be messy and smelly. Hence, the group aims to solve these problems and help the pet owners to clean after their pets without having the feeling that it is a burden. The product must focus on aiding the user while being safe for pets, easy to use, reliable, and fast.

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Appendix A: Brainstorming Tasks

Table A1: Daily Tasks for College Students

No.	Task	No.	Task
1	Managing finances	6	Cleaning up your room
2	Organization	7	Shopping
3	Working out	8	**Pet care/playing with pets**
4	Commuting / going off campus	9	Communicating with friends
5	Preparing and eating meals	10	Doing laundry

Table A2: Pains and Gains for Pet Care and Laundry

Pet Care		Laundry	
Gains	**Pains**	**Gains**	**Pains**
Happy pets	Takes up time	Clean clothes	There is not enough machines
Companions	Messy	Organization	Poor maintenance
Keeps pets engaged	Your pets could hurt others	Hygiene	Takes time
Healthy Pets	Being away from pets		Pay for detergent

Appendix B: Problem Definition

Table B1. User experience chart for college students who own pets

User Experience Rating	Cleaning up after pets	Feeding pets	Playing with pets	Caring for pet health	Purchasing food for pets	Transporting pets	Protecting furniture from pets	Training pets
++			X					X
+								
0		X						
-				X	X		X	
--	X					X		

Appendix C: Research Plan

Table C1. Research plan

No	Research Question	Qualitative Data Collection	Quantitative Data Collection
1	What is the average number of pets per household?		Online article presenting statistics on pet ownership [2]
2	What types of pets are the most common?		Online article presenting statistics on pet ownership [2]
3	What are pet owners' experiences with cleaning up after their pets?	Preliminary survey question 4	Preliminary survey question 3
4	What are pet owners' experiences with feeding their pets?	Preliminary survey question 6	Preliminary survey question 5
5	What are pet owners' experiences with transporting their pets?	Preliminary survey question 8	Preliminary survey question 7
6	What are pet owners' experiences with training their pets?	Preliminary survey question 10 Online article with advice on pet training [3]	Preliminary survey question 9
7	What other difficulties do pet owners face?	Preliminary survey question 11	
8	How much do people spend on pet health care?		Online article presenting statistics about pet owners' spending on their pets [4]

9	How much money is spent on various pet care expenses?		Online article presenting statistics about the pet industry [5]
10	How much money do people spend on pet training?		Online article presenting the costs of dog training [6]
11	How popular have pets become?		Online article about pet ownership and insurance statistics [1]
12	How many animals are in shelters?		Online article about animal shelters [7]
13	How much money do pet owners spend on pet toys?		Online article with pet industry statistics overview [8]
14	What tools do pet owners use to clean up after their pets?	Online article presenting strategies to clean up after dog messes [9]	
15	What are some supplies pet owners need or want?	Online article presenting cat toys and supplies [10].	

Appendix D: Preliminary Survey

The survey is available at
https://docs.google.com/forms/d/1msf4Yzq5C03ka6Kc0sQOZ9cD9F2a4vh8uYzQ1Pt2Hb4

Questions included on the survey: an initial consent: "Please indicate if you consent to your responses being recorded and published anonymously here. Please do not include personally identifying information in your response."

1. Do you have a pet or pets? (Yes/no)
2. If yes, what kind of pet or pets do you own and how many? (short answer)
3. Rate your experience cleaning up after your pet(s) (5 point negative to positive scale)
4. What difficulties have you experienced cleaning up after your pet(s)? (short answer)
5. Rate your experience feeding your pet(s). (5 point negative to positive scale)
6. What difficulties have you experienced cleaning up after your pet(s)? (short answer)
7. Rate your experience transporting your pet(s). (5 point negative to positive scale)
8. What difficulties have you experienced transporting your pet(s)? (short answer)
9. Rate your experience training your pet(s). (5 point negative to positive scale)
10. What difficulties have you experienced training your pet(s)? (short answer)
11. Are there any other difficulties you have experienced with pet care? (short answer)

Table D1. Preliminary survey average user scores

	Cleaning Up	Feeding	Transporting	Training
Cat owners (1 or more cats)	3.08	3.08	3.79	3.17
Dog owners (1 or more dogs)	2.64	4.43	3.89	3.36
Overall (any number of any pets)	2.90	4.42	3.77	3.25

Figure D1. User ratings of pet care activities

Table D2. Activity rating survey responses[1]

ID	Dogs	Cats	Other	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)
3	1	0	0	DOG	4	Dirty dirty boy gets muddy a LOT with thick fur	5	We like food in this household	5	Dog tongue out of the window go flop	4	Good boy knows many tricks, but if too excited will be unresponsive	No
4	0	0	1	1 bird (cockatiel)	2	Birds poop around every 15 minutes so it can be quite a hassle to clean up for everything.	4	Not too much. You just have to provide food daily.	2	The bird is scared of the transportation box.	2	Requires a lot of patience.	Keeping the cage clean/
5	3	1	0	3 dogs And 1 cat	4		5	Separating dogs to make sure they eat their food and the right amount	5	None	4	Some rescues are harder to train	
6	0	0	1	A goldfish	3	Cleaning the bowl and maintaining the cleanliness	4	No difficulties	5	No difficulties	4	No training	No
8	1	1	0	1 Cat, 1 Dog (black lab mix), 2 crested eyelash geckos, one ferret	3	Stinky	5	None, besides remembering	4	Dog and cat are very loud	4	Amount of time it takes	So. much. Hair balls.
9	0	1	0	Cats	5	They scratch me	5	Nothing	5	Nothing	2	They cant be trained	No
10	0	1	0	Cat and only one	4	The smell.	4	It is a routine, I usually forgot to do that.	3	Since I don't know how to drive, I have to ask others to drive for me.	2	It is very hard to train a cat.	When they sick, I will feel sad and I have to commit my time to take care of them since it I have to observe their activities
11	0	6	0	6 cats	4	Its very tiring	5	So far so good	5	My cat is very behave in the car	3	My cat doesn't listen to my instruction	No
12	0	1	0	Cat 1	3	Become aggresive and hurting myself	5	The cat become picky eater	2	Never try it	1	Never try it	The cat injured after getting into fight with other cat

[1] Responses which did not have any pets, did not consent to their responses being recorded, or were not in English were removed.

14				8	2	It is gross, but smells bad if I don't don't	5		4	They can get rowdy but are usually well behaved	4		
15	1	0	0	1 Dog	3	They chew things and ruin them	5	None	5	None	4	They don't always pick up the training	No
16	1	0	0	1 Dog	3	Cleaning up after going to tha bathroom	3	Cleaning up my dogs mess after he eats and drinks	2	Bathroom Breaks, growling to get our attention, smell of the dogs farts in the car	3	Time consuming, sometimes have to pay money for other people to train dogs	Zoomies, trying to relax around my dog
17	1	1	0	1 dog and 1 cat, 2 total	1	Cat urinating on my bed	5	None	5	None	3	N/a	
18	0	2	0	2 cats	2	Smell	4		3		5	They are cats	
19	0	1	0	1 cat	3	Don't like to touché their waste, even with gloves or a scooper	5	They eat too much	4	They are loud in cars	5	They do not like to listen	Nope
20	1	2	0	2 cats and 1 dog	1	I live at the top floor of an apartment building so getting the dog down is a pain. Also carrying cat litter is a pain.	4	Prefer to feed cats over dogs as cats can be fed less often (the don't eat it all in one go).	3	Don't transport them often	1	The Dog is untrainable other than potty training, even after taking him to a training school, the habits easily untrained even with reinforcement.	
21	1			One dog	3	it's messy and often not an easy task if they make a big mess	5	Their food can spill quick easily.	4	My dog does not like to sit still in the car. We have a special seatbelt for him so he can be safe and not disturb us	4	It's hard to communicate exactly what you want them to do without being repetitive or frustrated.	Not really
22	2			I have 2 dogs	2	They sometimes destroy pillows and it can be very tedious to clean up	4	Other than the occasional small appetite, i have rarely had issues with feeding my pets.	5	none	3	They learn commands well and are usually very calm but sometimes they get too excited and it's hard to get them to sit still.	not really no
24		3		3 cats	2	Smelly	5		5		2		Hard to understand what they want
25	1			Dog	2		4		3		4		

#				Pet									
26	1			1 Dog	4	Forgetting to bring poop bags, having to hold poop bag, poop bag tearing :(	5	Kibble spills	4	My dog falls out of seat from braking. She jumped/fell out of my car window from sticking her head out (we were going very slow)	4	She only listens if she feels like it	Bathing/cleaning her is difficult
27	4			4 dogs	1	It's not fun	3	When they're puppies, they can be a little food agressive	3	They get hair in the car	4	Can be a long process	No
28	0	0	1	One chinchilla	3	Chinchillas have extremely fine, wispy fur that floats through the air and gathers on random nearby possessions, including my bookshelves and tabletop minatures collection. If we had an air purifier, it would probably get clogged with fur wisps. Also she's supposed to use the litterbox in the corner of her cage but sometimes she doesn't.	4	None, she is happy to eat the same thing every day: bagged pellets and dry timothy hay. The hay does get stuck in the vacuum, sometimes.	2	She is FAST and HATES being in small confined spaces so I have to use her dust bath as an "elevator" to move her around since it's the only thing she will always get inside willingly.	3	Chinchillas are not really trainable except for litterbox use. At least mine isn't.	Chinchillas are rodents with powerful teeth and they will nibble/consume everything within reach. I have to make sure things are chinchilla-safe before putting them on/in/near the cage, and she's doing slow but steady damage to the cage liners (hard plastic) and the running wheel (painted metal). Also, not every vet is qualified to care for a chinchilla patient; dogs and cats can be seen basically anywhere.
29		1		One Cat	2	Their s*** stinks like hell and we have to spend quite a lot of money on litter sand	4	Their food is expensive and my cat is a pretty picky eater so it's hard to switch to other brands of food	1	Cats are scared of everything so they don't like to move around a lot	1	Cats generally do whatever they want and don't listen to you	Cats hair falls everywhere and sometimes causes allergies
31	3	2		3 dogs and 2 cats	3		5		5		5		
32	1	1		A cat and a dog	1	My dog is still just a puppy and he is having trouble being potty trained. Once	4	My dog hates eating medicine	4	My cat is afraid of cat rides, but we rarely have to take him anywhere	1	The dog just doesn't want to be trained… :/	In my family, it's an issue of time. Not having enough

ID	A	B	Pet	R1	Text1	R2	Text2	R3	Text3	R4	Text4	Text5
					you clean up his pee on the wood floor, he pees again, even after taking him outside!				besides the vet like once every few years, so it's not a big deal.			time to properly train the dog. He ends up about half-way trained and still pees on the floor…
33	4		4 cats	4	Nothing	5	Nothing	5	Nothing	3	Cats are difficult to train	No
34	10		Cats/>10	4	Some of them might not enjoy being cleaned hence acting a little aggresive	5	-	5	-	4	Sometimes it takes longer than expected	None
35	1		1 Cat	3	None	3	None	2	He scream for he uncomfy	3	It's a cat	No
36	1		One cat	2	I don't like cat poop	4	He's cute when he's hungry but kinda annoying when he wakes me up at 5am for food	4	He looks cute in the carrier but he doesn't like cars and sometimes screams about it	5	He doesn't always like to listen	His insurance doesn't cover yearly wellness checkups
37	1		Cat	5	To make sure their fur is completely dry	4	Sometimes when it come the time they need to eat, they are not at home. So, their feeding time is vary	2	No, difficulties.. all is well	3	It takes a lot of time to train them, sometimes I do not have time to train them because of classes	I have difficulties to know if my cat is sick..so I need to be alert more if they show any weird things
40	5		Cats, 5 of them	2	Laziness because we have to be doing it consistently as daily routines ahahaha	5	No difficulties as it is the best part of having a pet	2	They tend to get aggressive while in vehicles	4	They are quite reluctant to be trained but it's still fun nevertheless	
41		2	rabbit , 2	4	none	4	none	3	my pet don't want to enter the carrier	4	none	Only the part where i have to throw out their poops/faeces
42	2	1	1 cat and 2 dogs	4	The feces	4	My pet is fat, it wanted to eat frequently	4	He likes to lay on bed	2	Didn't listen to me	yeah , when i need to bath them
43	7		7 cats	3	They litter everywhere	4	Only choose expensive kibbles	5		2		I'm a muslim so we keep our dogs outside
44	2		cat , 2	5	They are not easy to be cleaned, always act like they are super scared when it comes to grooming	5	Finding the right wet food for my cats	5	None	5	They require a lot of time to be trained, but eventually can be trained	their furs keep falling and stick to clothes

ID				Pets										
45	1	2		1 dog and 2 cats	2	Cleaning the litter box when having 2 cats gets hard bc if you don't do it everyday it stinks	4	Not very many except my one cat always spills his food and my dog eats it	2	All of my pets hate the car rides and it's always a pain	4	getting them to focus	Not that i can think of
46	2			2 dogs	2	Shedding	4	Overfeeding	5	None	3	Getting then to respond	No
47	1			1 dog	4	It smells.	5	None	5	It smells.	5	He is 13 years old.	He will runaway sometimes.
48	2			2 dogs	2	Dealing with messes, smells, or staining on carpet/surfaces.	5	Normally there is no difficulty, but if I'm not home it's difficult to make sure they are fed enough or making sure someone else is able to feed them.	5	None, mine are usually good in the car/going places.	3	Just going through the training process & figuring out what works for the dogs. House/potty training is usually the most difficult.	
49	1			A dog, 1	2	Scrubbing floors	3	Not difficult just not fun	3	My dog like to squirm when being carried	3	Dog is a slow learner so it takes a sec to teach	No
50	3			I own 3 dogs. A husky and two shih tzu.	4	The dificilt part is the smell obviously it stinks but it's normal.	5	None, my dog enjoy their dru dog food with chicken or meat.	5	None the two shih tzu are angel and behave well. The husky is a bit difficult.	4	It was hard since they obey my mom abs my mom doesn't like to train.	Walking all of them.
51	1			1 dog	3	Carpet stains, lingering odors, etc	4	Adjusting pets to new diet requirements	3	Facing my pets anxiety	2	Accidents in the house/cleaning up after them	
52				3	3	Cleaning a litter box is not ideal	5	none	5	none	3	It takes a lot of reinforcement	no
53	1			Dog 1	2	Picking up the poop	4	The mess my dog makes after eating	3	He runs everywhere and makes me fall a lot	3	He doesn't want to listen and will do whatever he wants	My dog likes to bite
54	2		1	2 dogs, lizard	3	It is a tedious job and sometimes can be more difficult than other times	5	None	4	They take up a lot of room in my car	3	They are stubborn	Shedding on my clothes
55	1			one male pitbull	4	not having a bag	5	he won't eat	4	sometimes he barks in the car	3	he's very stubborn and does not learn easily	he's too cute for his own goof
56	1			One dog	3	grossed out if they throw up inside	5		4	carsick the first time in car	4	Took a long time	

#	A	B	C	Pets	R1	Q1	R2	Q2	R3	Q3	R4	Q4	Notes
57	1			I own a Maltipoo dog. Just one dog.	2	Finding the correct cleaning product to pick it up. Also the directions for most cleaning products take over a day which is not convenient.	5	Not too many difficulties but I would like there to be more variety since my dog starts to dislike eating the same thing over and over again.	3	My dog gets nervous driving in cars and I even try to put my dog into a seatbelt, which doesn't work out too well and isn't comfortable. I'm always afraid for my dog if I were to get into an accident; would she be able to survive it?	1	Maltipoo breeds are known to be very anxious and our dog seems to have many behavioral problems so training her has been a nightmare. We have considered hiring someone to train her but we found it too expensive. She is on anxiety medication and she is unbearable without it.	With this particular breed, I only wish training was more accessible.
58	1			1 Dog	3	Loose Stool	4	Accommodating my dog's sensitive GI tract	3	Anxiety about riding in cars	3	Noncompliance without food	Leaving pet by themself when I need to do chores outside the home and dealing with the consequences
59		2	2	2 cats, 2 rats	3	cleaning a litter box is hard on my back, I had a spinal fusion.	4		4		3		
60	2			2 dogs	3	My dogs are still puppies so they're still learning to be house trained	4	One of my dogs jumps on me before dinner time but it's kinda cute.	3	One of my dogs gets car sick	5	Each of them responds better or worse to certain commands	They're getting their adult teeth in ig and they're chewing on EVERYTHING, even the walls.

Appendix E: User Need Survey

The survey is available at
https://docs.google.com/forms/d/1-CalurayVzMiRCFD3QIGrRAg-0t-pXnzsyWRw2C3LfE/edit

Questions included on the survey: an initial consent: "Please indicate if you consent to your responses being recorded and published anonymously here." Users are asked not to include personally identifying or sensitive information in their responses.

1) Number of cats owned (1-10+)
2) Number of dogs owned (1-10+)
3) Any other pets owned (short answer)
4) Do you currently live with your pets? (Yes/no)
5) Easy to use (1-5)
6) Low-cost (1-5)
7) Reliable (1-5)
8) Helpful (1-5)
9) Fast (1-5)
10) Pet safe (1-5)
11) Users rate six existing products, indicating which of the above needs they fill. Products include: Litter boxes, pet hair brushes, nail trimmers, poop bags, vacuum cleaners, and furniture coverings.
12) Users are asked what product they use the most when cleaning up after their pets. Options include the six above or an "other" option.
13) "What pet cleaning product do you feel needs improvement and why?" (Free response)
14) "What challenges do you have cleaning up after your pets?" (Free response)

Any responses that did not consent to being recorded were removed.

Two responses were removed as they were not serious responses - one claimed to own 13 monkeys and another included a rant about how vacuum cleaners were unable to pick up rhinoceros feces.

Responses that indicated they did not own pets were excluded from any comparisons or statistics.

Table E1. Average user rankings of various needs

Easy	Low Cost	Reliable	Helpful	Fast	Pet Safe
4.68	3.98	4.79	4.82	4.20	4.96

Table E2. Average user rankings of various existing products

	Litter boxes	Pet hair brush	Nail trimmer	Poop bags	Vacuum cleaners	Furniture coverings
Easy	24	30	14	25	28	6
Helpful	20	34	24	27	31	16
Low cost	18	29	12	28	13	7
Reliable	27	28	20	25	32	11
Fast	7	17	5	16	26	3
Pet safe	17	26	18	18	18	14

Table E3. Pet cleaning product survey results

ID	Cats	Dogs	Other Pets	Lives with Pets	Easy (E)	Low-cost (L)	Reliable (R)	Helpful (H)	Fast (F)	Pet-Safe (S)	Litter Boxes	Pet Hair Brush	Nail Trimmers	Poop Bags	Vacuum Cleaner	Furniture Covering	Most Used	What pet cleaning product do you feel needs improvement and why?	What challenges do you have cleaning up after your pets?
4	9		9,cats	Yes	5	4	5	5	5	5	E	H	DNU	DNU	DNU	DNU	Litter box		
5	0	0	Fish	No	5	5	5	5	5	5	E, L, R	DNU	DNU	DNU	L, H, F	L, R	Litter box	Litter box, make it easier to clean and not smelly	They don't use the things we provide them
7	1			Yes	5	5	5	5	5	5	R, H, F	DNU	DNU	H, F	DNU	DNU	Litter box	Litter box because it cost a lot	Bad smell
8	2	0		Yes	5	2	5	3	5	5	R	L	R	H	L	L	Poop bags	pet disinfectant	do nit sit at one place
9	0	0	Mantoy	No	5	4	5	5	3	5	L, R	E	DNU	R	S	S	Litter box	I'd say litter box since it's definitely a hassle for the pet owner to clean up their pet's poop as it requires a lot of patience and indeed they are hoping for more reliable and efficient type pf products for them to rely on.	Bad odour and thorough cleaning of the litter box
13	0	1		No	5	5	5	5	5	5	DNU	E, L, R, H, F, S	L, R, H	L, H, F	E, R, H, F, S	DNU	Poop bags	Nail trimmers. My dog hates her feet being touched	Poop pags are annoying to get out and pick up the poop. Bags tear sometimes
14	0	1		No	5	3	5	5	4	5	DNU	E, R, H, S	E, H, S	E, L, R	R, F	R, S	Poop bags	Poop bags. They'd can be flimsy and rip easily.	It's messy poop is gross
15	0	1	1 Fish	No	3	4	5	5	3	5	DNU	R, H	R, H	E, L	R	H	Poop bags	Brushes bc I have a schnoodle and he get mats and most brushes aren't made to detangle	My nails break through the poop bag :(
16	1	0		Yes	5	3	5	5	2	5	R, H, S	E, L, R, H, S	R, H, S	H, S	R, F, S	DNU	Litter box	Litter boxes because they stink up the whole house and the good ones are expensive	Consistency in remembering to do it every week
17	0	1		Yes	5	5	4	5	4	5	DNU	E, L,	DNU	E, L,	R, H,	DNU	Poop bags	Fur brushes because they	None

#	n1	n2	pets	Y/N	r1	r2	r3	r4	r5	r6	c1	c2	c3	c4	c5	c6	Product	Comment 1	Comment 2
												R, H		R, H, F, S	S			are too rough	
18	1	0		Yes	3	4	3	5	5	5	E, L	E, L, R, H, F, S	R, H	E, L	E, R, H, F	R, H, S	Furniture coverings		
19	0	0	1 hamster	Yes	4	3	4	5	3	5	DNU	E, L, R, H, S	E, R, H, F, S	DNU	DNU	DNU	new bedding		
20	0	1		No	5	2	5	4	5	5	DNU	E, L, H	L, R, H	E, L, R, H, F, S	E, R, H, F	DNU	Poop bags	Nail trimmers. Just a bad experience all around. No one is having a good time but it needs done.	Finding things that are safe but also quick to use.
21	3	1	2 Fish, 1 snail	Yes	5	5	5	5	5	5	E, R, F, S	E, L, R, H, F, S	DNU	DNU	E, R, H	DNU	Litter box	Honestly I think the letterbox should be bigger, with 3 cats sometimes the poop overflows and then the dog tries to eat it. I dont like when the dog eats it.	My dog loves the taste of cat poop so it sometimes cleans the litter box for me
22	2	0		Yes	5	5	5	5	5	5	H	F	S	DNU	L	R	Litter box	vacuum cleaner	clean vacuum cleaner
23	1	0		No	4	3	3	4	5	5	E, L, R, H	H	H	L, H	R, H	H	Litter box	Nail trimmers and litter box	Scooping the litter is time consuming and a hassle when I am crunched for time
24	2	0		Yes	5	4	5	5	3	5	E, R, S	L, R, H, S	E, R, S	E, L, R	E, L	DNU	Litter box	Nail trimmers can sometimes be difficult to use, especially with cats!	Little boxes often stink and sometimes it's impossible to keep up with the accumulation of cat hair.
25	2	2		Yes	5	5	5	5	5	5	E, L, R	DNU	L, R, S	L	E, L, R, H, F	E, L, R, H, S	Vacuum cleaner	Vacuums. They don't pick up the hair enough they need to be able to suction them fast and accurately.	All of the fur
26	2	1		Yes	4	4	5	4	5	5	L, R, S	L, R, F, S	E, L, R, S	E, L, R, H, F	L, R, F	DNU	Vacuum cleaner	Nail trimmers	None
27	2	2		Yes	4	4	5	5	4	5	E, L, R, H	E, H	H	E, L, R, H	E, R, H	H	Vacuum cleaner	scent neutralizers don't really work so that should be improved	scent problems

28	0	0		No	3	4	4	4	4	5	DNU	DNU	DNU	DNU	DNU	DNU		A pet vacuum cleaner to pick up pet hair all over the house/furniture	Pet hair on furniture and all over the house
29	1	0		Yes	5	4	5	5	4	5	E, L, R, H, F, S	E, L, R, H, F, S	DNU	DNU	E, L, R, H, F, S	E, L, R, H, F, S	Litter box		
30	1	1		Yes	4	3	5	5	4	5	E, L, H, S	L, H, F, S	S	E, L, R, H, F	E, R, H, F	DNU	Litter box	Poop bags, usually not environmentally friendly	Dealing with the smell
31	1	1	none	Yes	5	5	5	5	3	5	E, R, H, S	E, L, R, H, F, S	L, R, H, S	R, H	E, R, H, S	DNU	Vacuum cleaner	nail trimmers, my dog is always scared of them and hates getting her nails clipped so i wish there was a way to clip her nails without her being stressed	her hair is hard to clean up all of the time, the vacuum doesn't always get all of her hair and her hair is EVERYWHERE
32	0	1		No	5	4	5	5	5	5	DNU	E, S	DNU	E, L, R, H, F, S	E, L, R, H, F, S		Poop bags	Poop bag, need a way to pick it up without reaching down and grabbing it with only the bag.	If she owes in the carpet it is a little hard to clean
33	1	3		No	5	5	4	3	4	5	L, R, F, S			E, L, H, F, S	R, H, F	E, R, H, F	Poop bags	Dog bowls because the food falls out right away	My dog biting me or jumping on me
35	0	1	1 snake	Yes	5	5	5	5	3	5	DNU	E, L, F	H	E, L, H, S	E, R, H	DNU	Poop bags	Nail trimmers - I feel like they all hurt my dog	None
36	3	3		No	4	3	5	5	3	5	L, R, S	H, S	S	L, R	H, F	DNU	Poop bags	Litter boxes, there has to be a way to reduce the smell	
37	10	0		Yes	5	5	5	5	5	5	E	H	DNU	DNU	DNU	DNU	Litter box	I think everything is fine , but for me i think the automatic litter box is really helpful but quite expensive , so yeah. Maybe , anyone could design a cheaper one :) because i really loves cats but it is hard for me to always clean up the litter box while online learning. Thank youuuuu, just that for now.	I found that it was really challenging for me to dry my pet's fur after bathing them

ID			Pets	Owns pet													Product	What they wish existed	Biggest frustration
38	0	3		No	5	3	4	5	3	5	DNU	E, L, R, H, F, S	E, L, R, H, F, S	E, R, S	E, R, H, F, S	DNU	carpet cleaner for accidents	dog hair trimmers because they're always too big for some areas on my dog	none
39	0	2		No	5	5	5	5	5	5	DNU	E, L, R, H, F, S	DNU	E, L, R, H, F, S	E, H, F	DNU	Poop bags	Vacuum	Hair everywhere
40	10	0	None	Yes	5	3	5	5	5	5	E, L, R, S	E, L, H, S	DNU	DNU	DNU	DNU	Litter box		
41	0	2		Yes	5	3	4	5	5	3	DNU	E, L, R, H, F, S	R, H	E, L, R, H, F, S	E, F, S	H, S	Vacuum cleaner	Vacuums bc they don't always pick everything up	Stains don't come out
42																			
43	0	0	5 goldfish	Yes	5	5	5	5	5	5	E, L, R, H	E, L, R, H	E, L, R, H	E, L, R, H	E, L, R, H	H	Furniture coverings	Fish	They're too damn loud
45	0	2	2 fish	Yes	4	4	5	5	3	5	DNU	E, L, H, S	L	E, R, F, S	E, R, H, F	S	Vacuum cleaner	nail trimmers because they can hurt your dog	the mess is there again in another 10 min
46	0	1		Yes	5	3	5	5	3	5	DNU	E, L, R, H, F, S	DNU	E, L, R, F, S	R, H, F, S	DNU	Vacuum cleaner	Vacuum cleaner. They almost never capture all the hair!	Making sure to capture all of the pieces of torn up toys!
47	2	3		No	5	4	4	4	5	5	F	H	F	H, DNU	F	S	Litter box		
48	0	1		Yes	4	3	4	5	3	5	DNU	E, L, R, H, S	L, H, S	L, R, H, F, S	E, R, H, S	E, R, S	Vacuum cleaner	Pet brushes, takes a long time to use	Feel like there's a mess shortly after cleaning
49	0	1	2 fish	No	5	3	5	5	4	5	DNU	R, H, S	E, R, H, S	R, S	E, R, H, S	H, S	Vacuum cleaner	Sprays for floor stains	Some stains are impossible to get out
50	2	1		Yes	4	3	5	5	4	5	E, R	L, H	E, H, S	L, H	E, R, H	DNU	Litter box	Litter that doesn't smell	The smell of the litter
51	1	0		Yes	5	5	5	5	5	5	E, L, R, H				E, L, R, H		Vacuum cleaner		
52	1	0	1 cat	No	4	3	5	5	3	5	E, R, H, S	E, L, R, H, F, S	E, L, R, H, S	E, L, R, H, F, S	E, R, H, F, S	DNU	Litter box	Nail trimmers can be difficult to use when pets squirm	Time
53	1	2		Yes	5	3	5	5	4	5	H	R	R	E	R	H	Litter box		

54	10	0		Yes	5	3	5	5	4	5	E, H	E, H	DNU	E, R, H	E, F	DNU	Poop bags	Vacuum cleaner. Maybe should create special vacuum for fur that can clean all the fur and automatic sanitize system. It is because to make it easy to clean up the fur that fall and sanitize the house at the area the cats play	To take them for the shower
55	1	1		Yes	5	5	5	5	5	5	R	R	DNU	DNU	F	H, DNU	Vacuum cleaner	N/A	It smells:/
56	10	10	Dogs	Yes	5	5	5	5	5	5	E, L, R, H, F, S, DNU	E, L, R, H, F, S, DNU	E, L, R, H, F, S, DNU	E, L, R, H, F, S, DNU	E, L, R, H, F, S, DNU	E, L, R, H, F, S, DNU	Poop bags		
58	2	0	-	Yes	5	5	5	5	5	5	E	S	H	E	L	S	Poop bags	-	-
59	0	1		Yes	4	4	5	4	2	5	DNU	E, L, R, F, S	E, H, S	L, R, H, S	E, R, H, F	DNU	Carpet cleaner or windex	Resolve carpet cleaner, too reliant on other Resolve products and barley works without them main g it too much of a hassle	It's gross and it's too often and very complicated to use
60	10	6		No	5	5	5	5	4	5	H	DNU	H, DNU	H	H	H	Litter box		
61	10	0	-	Yes	4	4	5	5	3	5	E, R, H, S	E, R	DNU	DNU	DNU	R, H, S	Litter box	The design of the litter box for low-cost design.	Their poop always went out from the litter box
62	10		Fish 9	Yes	5	5	5	5	5	5	R	R	E	L	L	L	Litter box	Litter box. To make sure cats poop in the area only	Time
63	0	2	NA	Yes	5	3	5	5	5	5	DNU	E, L, R, H, F, S	E, R, H, F, S	E, L, R	E, R, H, F, S	DNU	Vacuum cleaner	Vacuum cleaners should all have removable/easy to clean rubber in the revolving pick up brush! It would pick up more hair and be easy to clean.	Vacuums can never pick up all the hair or will push it around on hard surfaces.
64	2	0	1 Rabbit	Yes	5		5			5	E, L, R, H, F, S	DNU	DNU	E, L, R, H, F, S	DNU	DNU	Litter box	Litter box for more efficient cleaning	Poop

65	9	0	None	Yes	5	4	5	5	5	5	E, L, R, H, S		E, L, R, H	H, S	S	R, H	Litter box	Furniture Covering	too many cats sharing the litter box and litter box need to be check regularly
66	6	0	Fish	Yes	5	4	5	5	4	5	E, R, H, S	E, L, R, H	DNU	DNU	E, S	E, L, S	Vacuum cleaner	Furniture covering because the one i bought is small and have to buy many to cover the furniture. And it's hard to cover the furniture with the cover.	Products easily broken and does not longlast.
67	1	0		Yes	5	5	5	5	5	5	L, H, S	E, L	DNU	DNU	E, R, H, F, S	DNU	Litter box		

Appendix F: End User Needs and Market Character

Fig. F1. Fictional user profile. Using a photo from [11].

Table F1. End user needs

User Need	Description	Score (1-5)
Easy	Easy to use and understand. Does not require significant technical expertise.	4
Low-cost	Does not cost too much for the user.	2
Reliable	Has a low failure rate and will not require significant maintenance.	3
Helpful	Assists in their pet care needs.	4
Fast	Frees up user's time instead of demanding more of it.	5
Pet-safe	Does not harm or distress the user's pet.	5

Table F2. Pairwise comparison of user needs

	Easy	Low-Cost	Reliable	Helpful	Fast	Pet-Safe	Total	Normalized	Original
Easy		1	1	0	1	0	3	3.0	4
Low-Cost	0		0	0	1	0	1	1.0	2
Reliable	0	1		0	1	0	2	2.0	3
Helpful	1	1	1		1	0	4	4.0	4
Fast	0	0	0	0		0	0	-	5
Pet-Safe	1	1	1	1	1		5	5.0	5

Table F3. Available pet cleaning alternatives

User need	Litter box	Pet hair brush	Nail trimmers	Fecal waste bags	Vacuum cleaner	Furniture coverings
Easy		X		X	X	
Low-cost		X	X	X		
Reliable	X			X		X
Helpful	X	X	X	X	X	X
Fast					X	
Pet-safe	X	X	X	X	X	X

Table F4. Stakeholder needs

Need	Owner	Pet	Neighbors	Retailers
Privacy	X		X	
Noise	X	X	X	
Convenience	X			
Packaging	X			X
Pet-safety	X	X		

Appendix G: Group Responsibilities

PD01: Problem Definition & Task Analysis			
Project Manager for Assignment		Angelina Barone	
Deputy Manager for Assignment		Mira Faizul	
Drafted Assignment	All group members	**Revised Assignment**	All group members
Reviewed Assignment	All group members	**Proofread Assignment**	All group members
Created Figures	Dan Haikal	**Created Tables**	Ranga Rutiser Sundar
Other Contributions			
N/A			
Problems Overcome			
The group was able to decide on a final task to examine for the design project. Several possibilities were discussed before pet care was decided on.			

PD02: Research Plan			
Project Manager for Assignment		Ranga Rutiser Sundar	
Deputy Manager for Assignment		Dan Haikal	
Drafted Assignment	All group members	**Revised Assignment**	All group members
Reviewed Assignment	All group members	**Proofread Assignment**	All group members
Created Figures	Mira Faizul	**Created Tables**	Angelina Barone
Other Contributions			
N/A			
Problems Overcome			
The group was able to gain more knowledge and better defined the task through research.			

PD03: End User Needs			
Project Manager for Assignment		Ranga Rutiser Sundar	
Deputy Manager for Assignment		Mira Faizul	
Drafted Assignment	All group members	**Revised Assignment**	All group members
Reviewed Assignment	All group members	**Proofread Assignment**	All group members
Created Figures	Angelina Barone	**Created Tables**	Mira Faizul
Other Contributions			
N/A			
Problems Overcome			
The group better defined the needs of the user audience and created a persona for an example user.			

PD04: Market Character			
Project Manager for Assignment		Dan Haikal	
Deputy Manager for Assignment		Angelina Barone	
Drafted Assignment	All group members	**Revised Assignment**	All group members
Reviewed Assignment	All group members	**Proofread Assignment**	All group members
Created Figures	Ranga Rutiser Sundar	**Created Tables**	Mira Faizul
Other Contributions			
N/A			
Problems Overcome			
The group was able to learn about the individual users to understand the potential impact related to the pet project.			

PD05: Research Results and Value Proposition			
Project Manager for Assignment	Ranga Rutiser Sundar		
Deputy Manager for Assignment	Angelina Barone		
Drafted Assignment	All group members	**Revised Assignment**	All group members
Reviewed Assignment	All group members	**Proofread Assignment**	All group members
Created Figures	Mira Faizul	**Created Tables**	Dan Haikal
Other Contributions			
N/A			
Problems Overcome			
The group managed to summarize the research results as well as come up with a value proposition.			