**University of Texas Permian Basin**

**EENG 4460 Senior Design**

**Report #2: Requirement Analysis**

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Submitted to ---

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**EENG 4460 Senior Design**

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**Background:**

According to the Veterinary Center of America (VCA) Animal Hospitals, approximately 25-30% of the general canine population is obese in the United States, with 40-45% of dogs aged 5-11 years old weighing in above that of healthy weight range **[1]**. Additionally, stated in the Raw Bistro Blog, food aggression is quite common in dogs. One study reported that nearly 20% of all dogs show signs of food aggression **[2]**. According to the results of a 2021 survey conducted by the American Pet Products Association, dog ownership in the United States has increased by 13% since 1988 **[3]**. Most dog feeding products on the market fail to safely feed multiple animals with different types of foods in a single device.

**Needs:**

Many dog owners struggle to keep their animals healthy and safe during feeding time. Overfeeding canines is a problem that countless pet owners struggle with. As a result of a continually growing market, there is a strong need for a product that easily enables dog owners to feed their dogs remotely and in a healthy manner while maintaining a safe environment for both animals and humans. It would also be necessary for this product to service multi-dog homes in a safe manner.

Many prescription and specialty diet dog foods are high cost and use volatile compounds to stimulate dog appetite that evaporate when open to atmosphere. Automatic dog feeding products currently on the market either continually gravity flow all stored food from an unsealed container or blindly dispense a preset amount. Many pets eat less when their owners are not home for extended periods of time. There is a need in the market for a multi-animal automatic pet feeder that can measure how much food was eaten, what remains, and acts on that information while sealing the remaining supply to preserve freshness and conserve food.

**Objectives:**

In order to meet this need, a fully automated, self-training, dog food dispenser is to be designed that does not overfeed or underfeed animals. It will also be styled in such a way that multi-dog owners can feed each individual dog the correct serving amount and food brand to meet each individual dog’s needs. Also, this product will have a training component to alert which dog needs to eat and prevent any other animal from stealing another dog’s meal. There will be multiple feeding compartments that sense if the correct dog is there before it opens. If the wrong canine comes to the incorrect compartment, it will not open. If it is already open, it will close when the wrong dog gets too close. Weight sensors will be utilized to detect if the food has been eaten or if some remains to ensure proper feeding amounts. This will all be programmable using a local keypad and displayed on the LCD screen(s). Pet owners will not have to be present at feeding times.

**Marketing Requirements:**

1. Low cost.
2. Easily portable when food storage is empty.
3. User-friendly.
4. Should maintain a healthy diet for canines.
5. Should be safe and usable for multi-dog applications.
6. Be able to feed any size of dog for a minimum of 1 week.
7. Excellent sound quality for food-time alerting.
8. Keeps food sealed and fresh.

**Engineering Requirements:**

1. Marginal production cost should not exceed $60.
2. The dimensions should not exceed 3’x3’x2’.
3. Be able to power using a cord plug-in to a 120v, 15amp receptacle.
4. System will operate for a minimum of 28 feeding cycles in absence of power.
5. System will operate 24/7, 365 days a year given power source.
6. System should be able to operate in the temperature range of 60 degrees F to 80 degrees F.
7. Should be programmable for food proportions for dogs weighing 3-12lb, 13-20lb, 21-35lb, 36-50lb, 51-75lb, 76-100lb, and 100lb+.
8. Provide 1.8 gallons of food storage for each dog.
9. Owner should be able to select a unique sound per dog to be used for the alerting process.
10. System should alert dog(s) based on users inputted schedule.
11. Average feeding-time should not exceed a specified time, chosen by the user.
12. Compartments will open or close when dog is at 1m from apparatus.
13. Feeding amount accuracy will be within 90% with a resolution of ¼ cup.

**Engineering Requirements:** Properties

1. Marginal production cost should not exceed $60.

This requirement is verifiable because it correlates the prices with current dog feeding systems, while providing a superior product. Additionally, listing a singular cost is unambiguous because it provides a clear understanding of the product value. This price is also traceable and realistic as it serves the customer needs at a competitive market dollar figure.

1. The dimensions should not exceed 3’x3’x2’.

The required dimensioning is abstract because it states the size conditions of the apparatus. Furthermore, the proportions are verifiable as they align with the volume needed to house the required amount of dog food. Additionally, this requirement is unambiguous because it simply states the size limit. It is also traceable and realistic because it satisfies the customer needs in affordability, portability, being user-friendly, multi-dog safe, and providing adequate storage capacity.

1. Be able to power using a cord plug-in to a 120v, 15amp receptacle.

The required power source is abstract and unambiguous because it simply states how the product will be energized. Furthermore, it is verifiable and realistic because 120v, 15 amp receptacles are the most common power source in residential homes. It is also traceable because it satisfies the customer needs in affordability, portability, being user-friendly, multi-dog safety, and storage capacity.

1. System will operate for a minimum of 28 feeding cycles in absence of power.

This requirement is abstract and unambiguous because it provides a minimum number of feeding cycles and, it is a short and clear statement. Additionally, it is verifiable and realistic because this measurement meets the feeding needs of 2 dogs for 1 week. It is also traceable because it satisfies the customer needs of being user friendly.

1. System will operate 24/7, 365 days a year given power source.

The required operation specifications are abstract because it states the products capabilities and the condition of having a proper power source to fulfill them. Furthermore, the operation longevity is verifiable as it provides food for dogs year-round. Additionally, this requirement is unambiguous because it simply states the operation timeline. It is also traceable and realistic because it satisfies the customer needs in being user friendly and provides a realistic target.

1. System should be able to operate in the temperature range of 60 degrees F to 80 degrees F.

This requirement is abstract and unambiguous because it provides the numerical temperature rating capabilities, and it is a short and clear statement. Additionally, it is verifiable and realistic because it is a benchmark that meets product needs. It is also traceable because it satisfies the customer needs of being user friendly as this temperature range falls well within average home temperatures.

1. Should be programmable for food proportions for dogs weighing 3-12lb, 13-20lb, 21-35lb, 36-50lb, 51-75lb, 76-100lb, and 100lb+.

This requirement is abstract and unambiguous because it provides the numerical description of the dog sizes it services and, it is a short and clear statement. Additionally, it is verifiable and realistic because it is a benchmark that measures product needs. It is also traceable because it satisfies the customer needs of being user friendly, pet safe and healthy, and diverse in servicing any size of dog.

1. Provide 1.8 gallons of food storage for each dog.

The required food storage specifications are abstract because the state the product’s numerical food holding capabilities. Furthermore, this quantity is verifiable as it provides dogs with food for at least 1 week. Additionally, this requirement is unambiguous because it simply states the storage volume. It is also traceable and realistic because it satisfies the customer needs in being easily portable, user-friendly, healthy, and multi-dog servicing while keeping food fresh.

1. Owner should be able to select a unique sound per dog to be used for the alerting process.

This requirement is unambiguous because it is a clear description of user input. Additionally, it is verifiable and realistic because it is a benchmark that measures product needs. It is also traceable because it satisfies the customer needs of being user friendly, multi-dog capable, and providing adequate sound quality.

1. System should alert dog(s) based on users inputted schedule.

This requirement is unambiguous because it is a clear description of user input. Additionally, it is verifiable and realistic because it is a benchmark that measures product needs. It is also traceable because it satisfies the customer needs of being user friendly, healthy, multi-dog capable, and providing adequate sound quality.

1. Average feeding-time should not exceed a specified time, chosen by the user.

This requirement is unambiguous because it is a clear description of user input. Additionally, it is verifiable and realistic because it is a benchmark that measures product needs. It is also traceable because it satisfies the customer needs of being user friendly and healthy for canines.

1. Compartments will open or close when dog is at 1m from apparatus.

The required operating distance is abstract because it states the product’s numerical functioning distance capabilities. Additionally, this requirement is unambiguous because it simply states the operating distance. It is also traceable and realistic because it satisfies the customer needs in being safe and usable for multi-dog homes.

1. Feeding amount accuracy will be within 90% with a resolution of ¼ cup.

The required volume accuracy is abstract because it states the product’s numerical dispensing capabilities. Furthermore, this quantity is verifiable as it provides a measurement that fulfills the appropriate feeding amounts. Additionally, this requirement is unambiguous because it simply states the accuracy and resolution. It is also traceable and realistic because it satisfies the customer needs in being affordable and multi-dog healthy.

**Requirement Overview:**

|  |  |  |
| --- | --- | --- |
| **Marketing Requirements** | **Engineering Requirements** | **Justification** |
| **1** | 1. Marginal production cost should not exceed $60. | This is based upon competitive market analysis and component research. |
| **1, 2, 3, 5, 6** | 2. The dimensions should not exceed 3’x3’x2’. | Fits in a vehicle trunk or truck bed for portability. |
| **1, 2, 3** | 3. Be able to power using a cord plug-in to a 120v, 15amp receptacle. | This aligns with the most common power source in a North American residential home. |
| **3** | 4. System will operate for a minimum of 28 feeding cycles in absence of power. | This provides a week worth of food for a 2-dog home. |
| **3** | 5. System will operate 24/7, 365 days a year given power source. | Given that the system can be easily powered by a residential outlet and very small power draw, there should be minimal equipment malfunctions. |
| **3** | 6. System should be able to operate in the temperature range of 60 degrees F to 80 degrees F. | This temperature range should not affect any of the system components and is well within the average home climate. |
| **3, 4, 5, 6** | 7. Should be programmable for food proportions for dogs weighing 3-12lb, 13-20lb, 21-35lb, 36-50lb, 51-75lb, 76-100lb, and 100lb+. | Providing a wide range of dog weights, services a diversified population of clients. |
| **2, 3, 4, 5, 6, 8** | 8. Provide 1.8 gallons of food storage for each dog. | At this volume, the product will be able to feed a 100 lb dog 4 cups a day for a week. |
| **3, 5, 7** | 9. Owner should be able to select a unique sound per dog to be used for the alerting process. | This is a vital aspect of the self-training component imbedded in this system to alert a specific dog to eat. |
| **3, 4, 5, 7** | 10. System should alert dog(s) based on users inputted schedule. | Allowing the dog-owner to customize alerting and feeding schedule fits a wider range of customer needs. |
| **3, 4** | 11. Average feeding-time should not exceed a specified time, chosen by the user. | Allowing the dog-owner to customize allowable feeding range fits a wider population of customer needs. |
| **5** | 12. Compartments will open or close when dog is at 1m from apparatus. | This will eliminate any stealing of or fighting over food between dogs. |
| **1, 5, 6** | 13. Feeding amount accuracy will be within 90% with a resolution of ¼ cup. | Based on dispensing volumes of ¼ cup increments, the feeding accuracy will fall within this range. |
| **Marketing Requirements:**   1. **Low cost.** 2. **Easily portable when food storage is empty.** 3. **User-friendly.** 4. **Should maintain a healthy diet for canines.** 5. **Should be safe and usable for multi-dog applications.** 6. **Be able to feed any size of dog for a minimum of 1 week.** 7. **Excellent sound quality for food-time alerting.** 8. **Keeps food sealed and fresh.** | | |

**Advanced Analysis:**

Legend:

|  |  |
| --- | --- |
| **Symbols:** | **Indications:** |
| ↑↑ | High-positive correlation. |
| ↑ | Positive Correlation. |
| ↑ | Minute-positive correlation. |
| ↓↓ | High-negative correlation. |
| ↓ | Negative correlation. |
| ↓ | Minute-negative correlation. |
| + | Desirable. |
| - | Non-desirable. |

Engineering-Marketing Matrix:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Engineering-Marketing Matrix | | Production cost <= $60 | Dimensions < 3'x3'x2' | 120v 15A receptacle | Power Draw | Battery Capacity | Reliability | Programmability | Food Capacity | Unique Sounds | Speed | Dog Detection | Accuracy |
| - | - | / | - | + | + | + | + | + | + | + | + |
| 1) Low Cost | - | ↑↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 2) Easily portable when empty. | - |  | ↑↑ |  |  | ↓ |  |  | ↓↓ |  |  |  |  |
| 3) User-friendly | + |  | ↑ | ↑ |  |  | ↑ | ↑↑ | ↑ | ↑ |  |  | ↑ |
| 4) Maintain Healthy diet for K9 | + |  |  |  |  |  |  | ↑ | ↑ |  |  | ↑↑ | ↑↑ |
| 5) Safe and usable for multi-dog | + | ↓ | ↓ |  |  |  |  | ↑↑ | ↑ | ↑↑ | ↑ | ↑↑ | ↑↑ |
| 6) Feeds any size dog for 1 week | + | ↓ | ↓↓ |  |  | ↑ | ↑ | ↑ | ↑↑ |  |  |  | ↑↑ |
| 7) Sound alerting | + | ↓ |  |  | ↓ |  |  | ↑↑ |  | ↑↑ |  |  |  |
| 8) Keeps Food Fresh | + | ↓ | ↓ |  |  |  |  |  | ↑ |  | ↑ |  | ↑↑ |

Tradeoff Matrix:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tradeoff Matrix | | Production cost <= $60 | Dimensions < 3'x3'x2' | 120v 15A receptacle | Power Draw | Battery Capacity | Reliability | Programmability | Food Capacity | Unique Sounds | Speed | Dog Detection | Accuracy |
| - | - | / | - | + | + | + | + | + | + | + | + |
| Marginal Production cost <= $60 | - |  | ↑ | ↑ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Dimensions < 3'x3'x2' | - |  |  |  |  | ↓ |  |  | ↓ |  |  |  |  |
| 120v 15A receptacle | / |  |  |  |  |  |  |  |  |  |  |  |  |
| Power Draw | - |  |  |  |  | ↑ |  |  |  | ↓ | ↓ |  |  |
| Battery Capacity | + |  |  |  |  |  | ↑ |  |  |  |  |  |  |
| Reliability | + |  |  |  |  |  |  | ↓ |  |  | ↓ |  |  |
| Programmability | + |  |  |  |  |  |  |  |  | ↑ |  |  |  |
| Food Capacity | + |  |  |  |  |  |  |  |  |  |  |  | ↓ |
| Unique Sounds | + |  |  |  |  |  |  |  |  |  |  |  |  |
| Speed | + |  |  |  |  |  |  |  |  |  |  |  | ↓ |
| Dog Detection | + |  |  |  |  |  |  |  |  |  |  |  |  |
| Accuracy | + |  |  |  |  |  |  |  |  |  |  |  |  |

House of Quality: Complete Analysis

Diagram, engineering drawing

Description automatically generated

**References:**

1. “Obesity in dogs: VCA Animal Hospital,” *Vca*. [Online]. Available: <https://vcahospitals.com/know-your-pet/obesity-in-dogs>. [Accessed: 25-Jan-2023].
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3. “Pet ownership statistics [2022]: U.S pet population,” *Spots.com*, 07-Dec-2022. [Online]. Available: <https://spots.com/pet-ownership-statistics/>. [Accessed: 25-Jan-2023].