

## **A PROPOSAL TO INVESTIGATE TECHNICAL SOLUTIONS TO ELIMINATE THE HUNGER PROBLEM OF STRAY DOGS IN ERDEK UMUT STREET**

### **1. INTRODUCTION**

According to a study conducted in 2018, there are approximately 900 million dogs worldwide, of which 200 million (22%) are stray dogs, 520 million (58%) are free-range dogs, and 180 million (20%) are pets [1]. Free-range dogs can find their food in nature, and pets are fed by their owners. However, it is difficult for stray dogs to find food on their own due to urbanization, which is why they depend on humans for food [2]. Therefore, this study only focuses on the solutions to satisfy the nutritional needs of stray dogs.

The care of stray dogs, which outnumber pets, is undertaken by municipalities, shelters, and volunteers, which are a small part of society [3]. In America, which has the largest dog population in the world, with 70 million stray animals in 2020, 670 thousand dogs had to be euthanized in shelters due to the lack of budget allocated for stray dogs and the lack of coordination between officials and volunteers [3]. On the other hand, the death of the dogs could have been prevented by establishing a system where they could feed regularly on the streets without needing shelter, especially since eating a meal every 24 hours is enough for them to live a healthy life [4].

For this study, Turkey was chosen as the pilot country since the country has only 250 shelters for 10 million stray dogs that require volunteers to take responsibility for feeding dogs [5]. In Turkey, Balıkesir Erdek's Umut Street was chosen as the pilot area since the area has great fluctuations in its population due to its popularity in summer months which required the sharing of responsibility for stray dogs between municipalities, shelters, which will be referred to as officials in the remainder of the report, and volunteers.

This study aims to establish a regular feeding system for stray dogs in Erdek Umut Street. The impact of this study is to prevent stray dogs from starving to death by ensuring they are fed regularly. The significance of this study is becoming an example of sharing the responsibility of feeding stray dogs between officials and volunteers to prevent the death of dogs whose basic needs cannot be met.

## **2. PROBLEM DEFINITION**

In Erdek, where the number of stray dogs does not change according to the seasons, the population is approximately 32 thousand in the winter months, increasing approximately ten times in the summer months [6], [7]. This situation causes stray dogs to starve, especially in winter. In Umut Street, one of the streets of Erdek that consists primarily of summer houses, ten dogs live in two groups every season (see Appendix A). They suffer from hunger, especially in winter, since there is no regular feeding system. This problem can be systematically investigated by considering the following parameters:

- “Who” – Volunteers and officials are involved in the problem that influences Stray Dogs.
- “What” – The stray dogs in Erdek Umut Street cannot be fed regularly.
- “When” – Especially in winter; however, the problem still exists in other seasons.
- “Where” – At Erdek Umut Street.
- “Why” – Lack of coordination among the people.
- “How” – Stray dogs starve because they are not adequately fed.

The root cause, the lack of coordination among the people, occurs for three reasons:

- (1) The lack of containers of food and water for the stray dogs in the street prevents people from knowing whether the animals are hungry or not by the fullness of these containers.
- (2) People are more isolated from each other than usual since Umut Street is a summerhouse street, which makes it difficult to know if the dogs were fed.
- (3) Very few people remain in the street during winter.

## **3. PROPOSED SOLUTIONS**

The proposed technical solutions to eliminate the hunger problem of the stray dogs in Erdek Umut Street are:

- (1) Cloud-based RFID tag system tracks stray dogs' feeding times.
- (2) Bluetooth-integrated LED system to track the feeding times of stray dogs.
- (3) A smart feeding machine.

### **3.1. Cloud-based RFID Tag System**

Radio Frequency Identification Technology (RFID) is a communication technology that uses radio waves to transmit data [8]. RFID systems consist of RFID tags and RFID readers [8]. RFID tags have an integrated chip that stores the information and an antenna for receiving and transmitting signals [8]. The solution will use a passive high-frequency RFID tag. The passive

RFID tag has the disadvantage of low-range communication but the advantage of not requiring a power source [8]. It uses the energy of the radio waves that the reader device sends and transmits the data stored inside using this energy [8]. High-frequency RFID tag, or in other words, Near Field Communication (NFC) Tag, is chosen since most mobile phones can communicate with NFC Tags.

This solution will use an RFID tag (see Appendix B), a mobile phone with built-in RFID reader ability, a mobile app, and a cloud system. The solution prerequisites the registration of the stray dogs since their ear tags (see Appendix C) will be used. In this solution, the RFID tags will be inserted into the dogs' ear tags and will store the information of the last fed time. All dogs in the street, volunteers, and officials will be registered to the mobile app. The information on the last fed time of all dogs will be stored in the cloud system, and if any dog's last feeding time is passed 24 hours, all users will be notified. When a user feeds the dog, the user will use his mobile phone to communicate with the dog's RFID tag, which will change the data on the RFID tag to the current time, and the data on the cloud system will be changed synchronously (See Appendices D-E for detailed process diagram, mobile app interface, and app notifications). The officials will insert an RFID tag, and the mobile app developer will develop a mobile app. NFC API and Core NFC Framework will be used for programming RFID Tag on Android and IOS devices, respectively. Firebase Realtime Database will be used as a cloud system. Similar products exist for storing contact information in case a pet is lost [9].

### **3.2. Bluetooth-integrated LED System**

Bluetooth is another communication system that operates on 2.4 GHz radio frequencies [10]. While NFC tags can be read from a few centimeters, Bluetooth devices can be communicated about ten meters with the disadvantage of requiring an energy source, unlike RFID tags [10].

This solution will use a simple circuit consisting of the NRF52832 low-energy Bluetooth module (see Appendix F), a microchip, a timer, a led component, and a battery. The solution prerequisites the registration of the stray dogs since their ear tags (see Appendix C) will be used. This solution will insert the circuit above the dogs' ear tags. When the feeder connects the Bluetooth module with her phone, the timer in the circuit will be reset. When the timer is below 24 hours, the led will be green; otherwise, the led will be red (see Appendix G for a detailed process diagram). This way, people can see the dogs' last fed time around them. Similar products

exist in terms of when the Bluetooth connection is established, a device does some predetermined action. For example, Apple Airtag, which has the same Bluetooth module inside, plays a sound when the Bluetooth connection is established [11]. A hardware developer will construct this circuit.

### **3.3. The Smart Feeding Machine**

Currently, some places other than the pilot area have feeding systems for stray animals that are required to manually check the stock of food and water by volunteers and officials [12]. This solution proposes the development of the current feeding systems by using Global Positioning System (GPS) technology. The GPS devices work by calculating the distance of itself from at least four different satellites [13]. Then GPS device detects its position on the Earth [13]. This solution will use a simple circuit consisting of the ultrasonic transducer, a microcontroller, a GPS module, a feeding system with food and water containers, and a mobile app to see activated machines. The ultrasonic transducer will be inserted into containers and measure the time it takes to receive back the ultrasonic waves it sends. If the time is above some threshold value, the microcontroller will activate the GPS module, and the machine will be visible on the mobile app (See Appendices H-I for a detailed process diagram, mobile app interface, and app notifications). Two of these machines will be placed on Umut Street, and the volunteers and officials will be registered to this app. GPS technology is used for similar purposes, such as tracking pet positions [14].

## **4. CRITERIA FOR ASSESSING SOLUTIONS**

The solutions will be assessed in terms of cost, practicality, and sustainability.

### **4.1. Cost**

The cost of the solutions will be important since the municipalities often allocate not much money to care for stray dogs [3]. The cost of each solution will be evaluated by the following steps:

- Cloud-based RFID Tag System: The one-time cost of developing the app and installing the RFID tag on the dog and the monthly cost of the cloud system per dog will be calculated.
- Bluetooth-integrated LED System: The one-time cost of constructing the circuit per dog will be calculated.

- The Smart Feeding Machine: The one-time cost of constructing the machines and the circuit per dog will be calculated.

#### **4.2. Practicality**

The solutions will be evaluated in terms of the practicality of their usage:

- Cloud-based RFID Tag System: The practicality of communicating with the NFC tag and mobile app usage will be checked.
- Bluetooth-integrated LED System: The practicality of communicating with Bluetooth and seeing the LED will be checked.
- The Smart Feeding Machine: The practicality of placing food into one place and tracking the stock through the app will be checked.

#### **4.3. Sustainability**

The solutions will be evaluated in terms of usage time. Sustainability in harsh conditions such as rain, stroke from other dogs, and extreme temperatures will be checked.

### **5. PROPOSED RESEARCH METHODOLOGY**

Proposed criteria will be assessed using market research, expert opinion, and survey methodologies.

#### **5.1. Market Research**

Market research will be conducted to determine the cost of each solution.

#### **5.2. Expert Opinion**

Hardware vendors will be consulted to understand the hardware's technical capabilities to assess each solution's sustainability. Mobile app developers will be consulted to take a price for developing the necessary apps that the solutions needed. Bilkent University BCC employees will be consulted on how to code the RFID tags inside the Bilkent University ID cards.

#### **5.3. Survey**

A survey will be conducted with the municipality and volunteers to compare the solutions' practicality.

## 6. REFERENCES

- [1] N. Cosgrove, "How Many Dogs Are There? (US & Worldwide Statistics 2022) | Pet Keen", *Pet Keen*, 2022. [Online]. Available: <https://petkeen.com/how-many-dogs-are-there-statistics/>. [Accessed: 14- Oct- 2022].
- [2] "İçişleri Bakanlığı'ndan araştırma: 'Sokak hayvanları tehlikeli mi?' 'Evet' yüzde 34, 'Hayır' yüzde 45", *Hurriyet.com.tr*, 2022. [Online]. Available: <https://www.hurriyet.com.tr/yazarlar/nedim-sener/icisleri-bakanligindan-arastirma-sokak-hayvanlari-tehlikeli-mi-evet-yuzde-34-hayir-yuzde-45-42029404>. [Accessed: 14- Oct- 2022].
- [3] "How Many Pets Are In The World & The US? 71+ Pet Stats", *Simply Insurance™*, 2022. [Online]. Available: <https://www.simplyinsurance.com/pet-statistics/>. [Accessed: 14- Oct- 2022].
- [4] "Feeding pet dogs just once a day might keep them healthier as they age", *New Scientist*, 2022. [Online]. Available: <https://www.newscientist.com/article/2298623-feeding-pet-dogs-just-once-a-day-might-keep-them-healthier-as-they-age/>. [Accessed: 14- Oct- 2022].
- [5] "4 Nisan Sokak Hayvanları Günü: Türkiye'de sokak hayvanları ne durumda ve neden tartışılıyor? – BBC News Türkçe", *BBC News Türkçe*, 2022. [Online]. Available: <https://www.bbc.com/turkce/haberler-turkiye-60947128>. [Accessed: 14- Oct- 2022].
- [6] "Balıkesir Erdek Nüfusu 2021 - 2022 | Erdek İlçesinin Yüzölçümü kaçtır?", *Bölge Gündem Haber*, 2022. [Online]. Available: <https://www.bolgegundem.com/balikesir-erdek-nufusu-2020-2021-erdek-ilcesinin-yu-zolcu-mu-kactir-1429462h.htm#:~:text=2021%20-%202022%20Balıkesir%20Erdek%20nufusu,Bin%20038%20kiři%20olduđu%20aşıklıandı>. [Accessed: 14- Oct- 2022].
- [7] "Erdek sahilleri Akdeniz'i aratmıyor FOTO GALERİ", *hthayat.haberturk.com*, 2022. [Online]. Available: <https://www.haberturk.com/ekonomi/turizm/haber/534319-erdek-sahilleri-akdenizi-aratmiyor-foto-galeri>. [Accessed: 14- Oct- 2022].
- [8] "What is RFID? | The Beginner's Guide to How RFID Systems Work | atlasRFIDstore", *Atlasrfidstore.com*, 2022. [Online]. Available: <https://www.atlasrfidstore.com/rfid-beginners-guide/>. [Accessed: 17- Oct- 2022].
- [9] "Smart Touch Nfc Ntag213/ntag216 Chip Unit Qr Code Finds Pet Id Tag Funny Collar Anti-lost Pet Epoxy Tag For Cat Dog - Buy Smart Touch Nfc Unit Qr Code Finds Pet Id Tag Funny

- Collar Anti-lost Pet Epoxy Tag For Cat Dog,Nfc Tag,Id Tag Product on Alibaba.com", *Alibaba.com*, 2022. [Online]. Available: [https://www.alibaba.com/product-detail/Nfc-Chip-Tag-Nfc-Rfid-Tags\\_60841583620.html](https://www.alibaba.com/product-detail/Nfc-Chip-Tag-Nfc-Rfid-Tags_60841583620.html). [Accessed: 14- Oct- 2022].
- [10] "What is Bluetooth Range? What You Need to Know", *Adorama*, 2022. [Online]. Available: <https://www.adorama.com/alc/bluetooth-range/>. [Accessed: 17- Oct- 2022].
- [11] "AirTag Teardown: Yeah, This Tracks", *IFIXIT*, 2022. [Online]. Available: <https://www.ifixit.com/News/50145/airtag-teardown-part-one-yeah-this-tracks>. [Accessed: 14- Oct- 2022].
- [12] "Vending Machine for Stray Dogs", *The Bark*, 2022. [Online]. Available: <https://thebark.com/content/vending-machine-stray-dogs>. [Accessed: 14- Oct- 2022].
- [13]"What Is GPS? Fleet Management Experts Answer | Geotab", *Geotab*, 2022. [Online]. Available: <https://www.geotab.com/blog/what-is-gps/>. [Accessed: 17- Oct- 2022]
- [14]"Tractive Waterproof GPS Dog Tracker - Location & Activity, Unlimited Range & Works with Any Collar (Midnight Blue)", *Amazon.com*, 2022. [Online]. Available: <https://www.amazon.com/tractive-TRNJADB-Dog-Tracker-4/dp/B099SF2X9L/>. [Accessed: 17- Oct- 2022]
- [15] "Buy 13.56Mhz NFC Sticker/Tag - ISO14443A, Ntag 213, 25mm with cheap price", <https://www.robotistan.com/>, 2022. [Online]. Available: <https://www.robotistan.com/1356mhz-nfc-etiket-iso14443a-ntag-213-25mm>. [Accessed: 14- Oct- 2022].
- [16] "Marking Street Dogs – Parsemus Foundation", *Parsemus Foundation*, 2022. [Online]. Available: <https://www.parsemus.org/pethealth/markings-street-dogs/>. [Accessed: 14- Oct- 2022].
- [17] "Free Avatars, lol - uistore.design", *uistore.design*, 2022. [Online]. Available: <https://www.uistore.design/items/free-avatars-lol/>. [Accessed: 17- Oct- 2022].
- [18] "Minew MS50SFA NRF52832 Low Energy 5.0 Bluetooth Modülü", *hepsiburada*, 2022. [Online]. Available: <https://www.hepsiburada.com/minew-ms50sfa-nrf52832-low-energy-5-0-bluetooth-modulu-pm-HBC0000132PZD>. [Accessed: 14- Oct- 2022].

## APPENDICES

### APPENDIX A

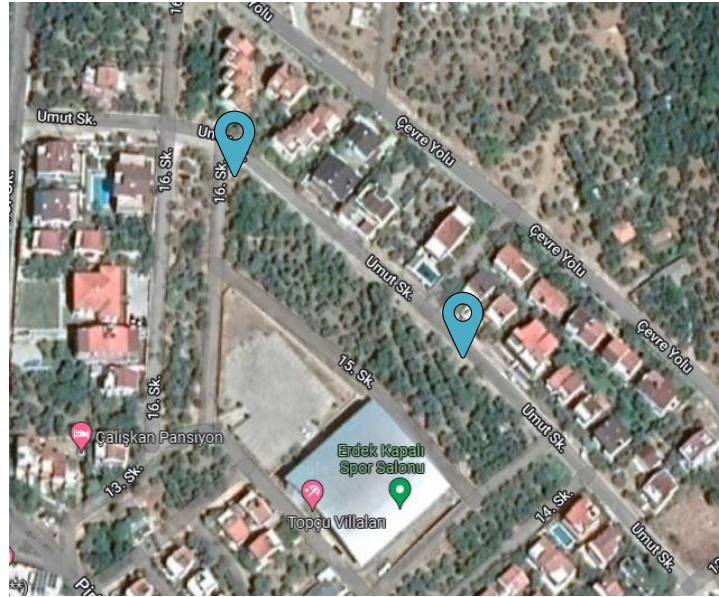


Figure 1: Living Positions of the Two Groups of the Stray Dogs

### APPENDIX B



Figure 2: RFID Tag Small Enough to Fit in the Dog's Ear Tag [15]

### APPENDIX C



Figure 3: The Dog's Ear Tag [16]



## APPENDIX D

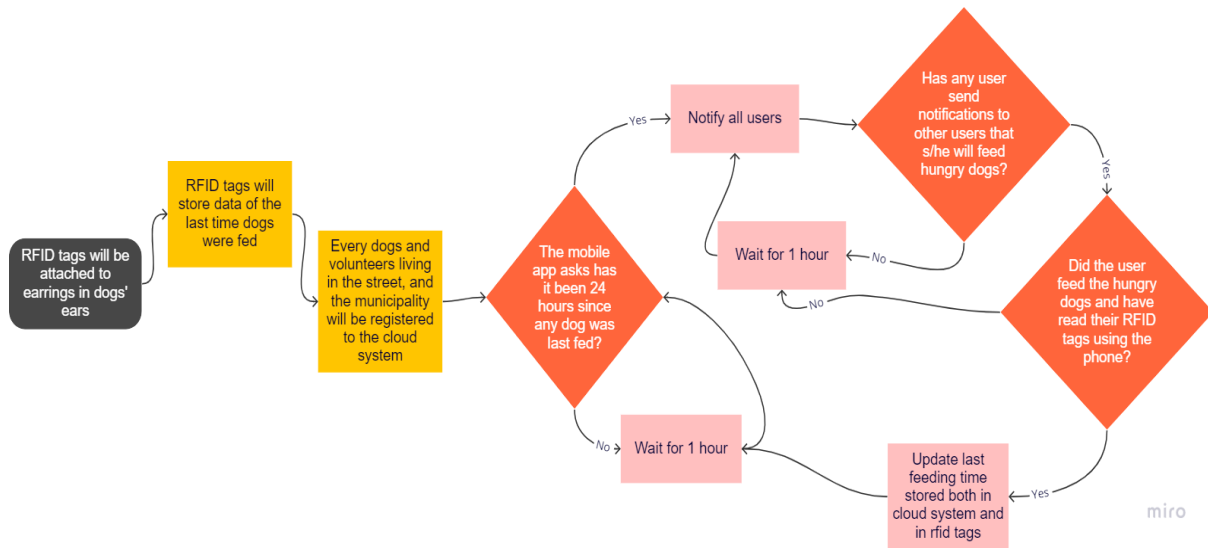


Figure 4: The Process Diagram of RFID Tag System

## APPENDIX E

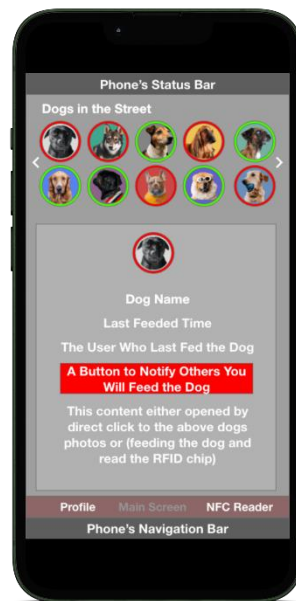


Figure 5: The Mobile App Interface of RFID Tag System [17]

**{Dog name} was last fed 24 hours ago. Now is a good time to feed!**

Figure 6: App Notification 1

{Username} will feed {Dog name} soon.

Figure 7: App Notification 2

{Dog name} was fed by {username}.

Figure 8: App Notification 3

## APPENDIX F

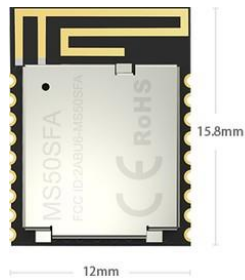


Figure 9: The NRF52832 Bluetooth Module [18]

## APPENDIX G

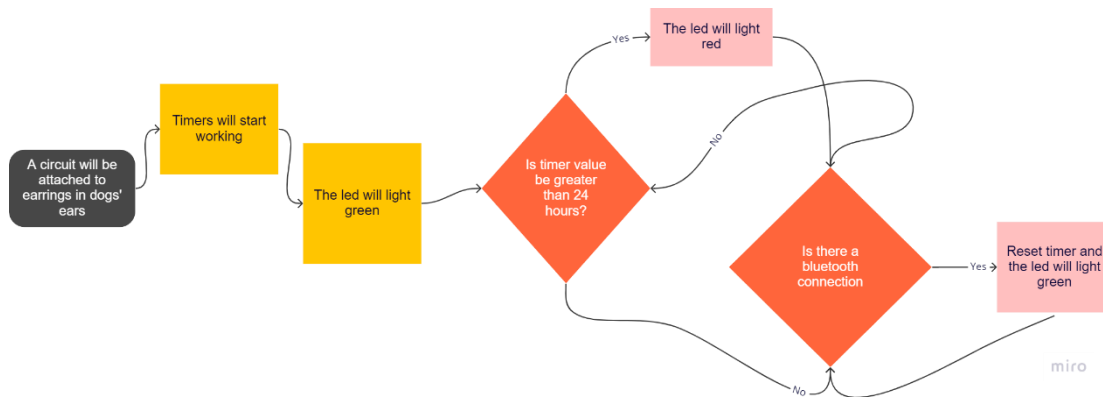


Figure 10: The Process Diagram of Bluetooth-integrated LED System

## APPENDIX H

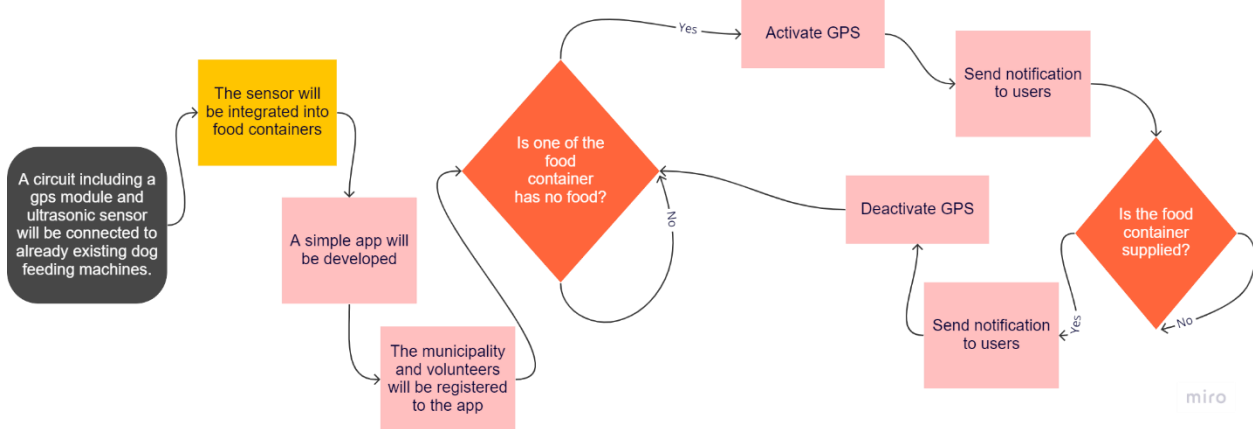


Figure 11: The Process Diagram of the Smart Feeding System

## APPENDIX I

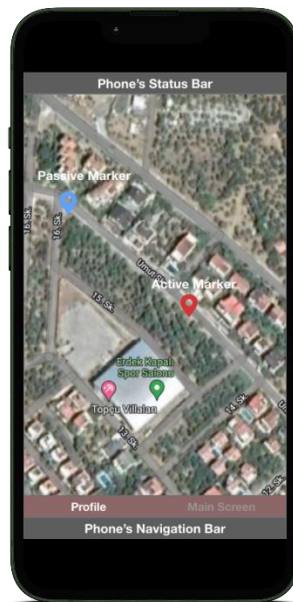


Figure 12: The Mobile App Interface of the Smart Feeding System

**{Machine name} is empty. Now is a good time to resupply it!**

Figure 13: App Notification 1

**{Machine name} is resupplied.**

Figure 14: App Notification 2