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ELECTRONIC IDENTIFICATION OF STRAY DOMESTIC ANIMALS – BARRIERS AND CHALLENGES

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ABSTRACT

Animal homelessness is a complex issue. Animal shelters, rescue organizations, and even authorities all around the globe fight an unfair fight: the number of animals that become homeless is much greater than the number of animals that are provided for adoption or are found by them. Regardless of whether the condition of the animal is caused by abandonment or loss, these numbers grow in an alarming way

The method to be implemented in a certain location, shelter, or even for individuals may be a sort of study and in many cases will depend on the cost, range, types of animals, region, and environmental issues. Many tools for record-keeping and identification of animals have been used throughout time. From collars to tattoos, from ear tags to record books, shelters, and authorities engaged in the problem have taken efforts to improve and advance in their work. With the invention of the microchip and with its almost exponential evolution, a whole new world of possibilities has opened in this area. As technology advances, new methods are implemented, such as facial recognition.

Key words: electronic identification, microchipping, identification, collars, ear tags

INTRODUCTION

In recent years, the issue of stray domestic animals has gained significant attention due to its impact on animal welfare and public safety. Let's take the UK as an example. At any given time, there are an estimated 100,000 dogs – and countless cats – without homes in the UK. Left to fend for themselves on the streets, cats and dogs often suffer and die after getting hit by cars, being attacked by other animals, succumbing to extreme temperatures, starving, contracting contagious diseases, and facing other dangers. Many stray animals are poisoned, shot, mutilated, tortured, set on fire, or killed in other cruel ways (PetaUK, 2023).

The ability to effectively record and identify these animals is crucial for their well-being, as well as for implementing appropriate measures such as reuniting them with their owners or facilitating their adoption into loving homes. With advancements in technology, electronic identification methods have emerged as valuable tools in the field of animal welfare. These methodologies provide efficient and reliable means of tracking, recording, and identifying stray domestic animals, enabling better management and improved outcomes for these vulnerable creatures. This paper various electronic methodologies employed for the identification and record-keeping of stray domestic animals, shedding light on their descriptions, advantages, disadvantages, procedures, maintenance requirements, and other important implications.

By employing electronic identification and record-keeping methodologies, animal welfare organizations, shelters, and responsible pet owners can enhance their ability to locate, track, and manage stray domestic animals. These methodologies utilize innovative technologies such as microchips, radio transmitters, electronic collars and tags, facial recognition, and other cutting-edge tools. Each methodology brings unique features and benefits, along with specific considerations in terms of reliability, cost, visibility, longevity, risks, and data-gathering methods. Understanding the characteristics and procedures associated with these methodologies is essential for effectively implementing them and ensuring their practicality in real-world scenarios. Through the integration of technology and data-driven approaches, these methodologies empower animal welfare organizations, shelters, and individuals to make informed decisions, reunite lost animals with their owners, promote adoption, and contribute to the overall well-being of stray domestic animals.

PURPOSE

The purpose of the paper is to present the available methodologies for the electronic identification of homeless animals. As well as showing the advantages and disadvantages of the available methods in order to improve them and overcome the problems.

RELATED WORKS

MICROCHIPPING

Is a relatively recent technology, first developed in the 1980s. A British company developed the first commercial microchip called Destron Fearing, which used passive radio frequency identification (RFID) technology to create a small, implantable chip. Initially, microchips were primarily used for livestock identification, but they quickly became popular for identifying pets. The first microchips were relatively large and required a large needle to implant, but over time the technology improved, and smaller, easier-to-implant chips were developed (*Microchip implant (animal), 2023*).

*Usage:*Since their first use in the mid-1980s, passive integrated transponder devices (PIT tags) have allowed innovative investigations into numerous biological traits of animals. The tiny, coded markers injected into individual animals allow assessment of growth rates, movement patterns, and survivorship for many species in a manner more reliable than traditional approaches of externally marking animals for identification (*Gibbons & Andrews, 2004, 447*). The procedure is virtually painless and doesn't even require anesthetic. Typically, the tiny chip is inserted under

pet`s skin between the shoulder blades using a syringe or similar applicator, so the animal won't feel much more than a quick pinch, much like getting a shot (*Wimmer, 2023*).

The most direct importance of microchipping an animal is that if a pet is lost and someone finds it and takes it to an animal shelter or vet clinic, the staff on duty will scan it with a microchip reader. If it is microchipped, the scanner will beep and give the staff member the chip number, which they can then lookup in the microchip system and contact its owner. (*Animal Rescue League of Iowa Inc., 2017*).

As microchips became more widely used for pets, animal shelters, and rescue organizations began using them as a way to identify and track homeless animals as well. In the United States, for example, many animal shelters began requiring that all adopted pets be microchipped, and some shelters also began implanting chips in animals they took in (*Wikipedia - Microchip implant (animal), 2023*).

Today, microchipping is considered to be one of the most effective ways of identifying homeless animals. The process is relatively quick and easy, and once a microchip is implanted, the animal can be identified and traced back to its owner or the organization that implanted the chip. This can be particularly important for lost or stolen pets and stray animals that are taken in by shelters or rescue organizations (*HomeAgain Pet Recovery, 2023*).

In Chicago for example, Chicago Animal Care and Control (CACC) strongly recommends that all pet owners' microchip and obtain a collar and tag for their pets. Animals that get lost are 9 times more likely to be reunited with their home if they arrive at a shelter with a collar and tag or microchip. Dogs are 5 times more likely to be returned home to their owner if they have a collar and tag or microchip. It is also the law for all dogs to have a city dog license. If a pet gets lost and is found by the CACC shelter they will research the tag and microchip information and contact the owner (*Chicago.gov, 2023*).

Advantages

- The chip is permanent, lasting the whole life of the pet. Your information has to be registered with your bar code number so that you can be contacted if your pet ever becomes lost (*Lifetime Animal Care Center, 2023*).
- Microchips cannot be removed or tampered with without surgical intervention (*WSPA, 2008*).
- The implant procedure is a relatively harmless veterinary procedure (*Lifetime Animal Care Center, 2023*). It will not cause any discomfort if implanted correctly, and will not alter the animal's appearance or affect its behavior (*WSPA, 2008*).
- A handheld scanner reads the radio frequency of the chip and displays the information on it. Hence, minimal or no handling or restraint is required (*The Humane Society of the United States, 2023*).
- Microchips are completely safe for pets and have become standard practice. Many pet owners request microchipping when they bring their pets in for a spay or neuter. This procedure is performed in the clinic using a sterile, pre-loaded syringe (*Dr. Phillips Animal Hospital, 2022*).
- This is the only method that can guarantee a unique, unalterable code (*WSPA, 2008*).
- Personal information of owners will not be visible to the public (*WSPA, 2008*).

- Low margin of operator error (the code is pre-programmed and reads electronically) (*WSPA, 2008*).
- Provides traceability which may infer wider benefits in relation to long-term monitoring and data collection, e.g. longitudinal studies of feral cats, alerting breeders to congenital defects (hence encouraging responsible breeding practices), and general companion animal statistics such as adoption and death rates (McGreevy P *2019*).

Disadvantages

- Though microchipping a pet is relatively affordable for the pet's owner (*Wimmer, 2023*), microchip scanners are expensive, and it is often cost-prohibitive to purchase several types of microchip scanners (*Peeva, 2023*).
- Supply may present a problem in some regions. Unless scanners are made freely and widely available to equip all agencies encountering stray dogs and cats, microchipped animals may go unidentified (*WSPA, 2008*).
- A microchipping registry requires significant infrastructure, incorporating a computerized database and a 24-hour staffed call center or website access (*WSPA, 2008*).
- Identification is only possible if a suitable scanner is available (*WSPA, 2008*). As different manufacturers are able to produce and patent different microchip technologies with different frequencies, it is possible that the scanner is not able to read a specific microchip (*Peeva, 2023*).
- No visible identification. It is still required a collar tag or other type of visual identification (*Wimmer, 2023*).
- Cross-compatibility, standards, and technology obsolescent issues. In most countries, pet ID chips adhere to an international standard to promote compatibility between chips and scanners. In the United States, however, three proprietary types of chips compete along with the international standard. Scanners distributed to United States shelters and veterinarians well into 2006 could each read at most three of the four types. Scanners with quad-read capability are now available and are increasingly considered required equipment. Older scanner models will be in use for some time, so United States pet owners must still choose between a chip with good coverage by existing scanners and one compatible with the international standard (McGreevy P *3*).
- There is a risk of subcutaneous migration of the microchip from the original implantation site, especially in loose-skinned animals, although with more recent methods and technology it is unlikely that the chip will migrate more than a few centimeters (*WSPA, 2008*).
- The accuracy of this method is dependent upon the owner, e.g. in informing the database provider of changes in contact details or ownership (*WSPA, 2008*).
- Comprehensive operator training is required (*WSPA, 2008*).
- Risk of microchip failure, or of 'scrambling' if a second chip is implanted (*WSPA, 2008*).
- Though small, there are reports of some adverse reactions to the microchip (McGreevy P 2019).

Equipment: A microchip is an integrated circuit contained within a very small transponder, ranging in size from 12 to 28mm long and 2 to 3.5mm in diameter. The device is encased in biocompatible glass, so it can be inserted into living tissue without causing injury or adverse reaction, and can fit inside a compatible hypodermic syringe. The memory circuit of each microchip is programmed with a unique 15-digit alphanumeric code. The microchip itself is inactive with no internal power source – it is energized by the radio signal transmitted by the scanner (WSPA, 2008).

The Scanner: Scanners generate a low-frequency radio band that is intercepted by the microchip, which uses the energy from this band to power itself and transmit a return signal to the scanner. The scanner decodes the signal and displays the microchip's identification code on a liquid-crystal display window. With some scanners, the code can be relayed via a computer interface to a database to instantly yield information about the microchipped animal (WSPA, 2008).Scanners should have passed the ISO-approved performance test and be able to read FDX-B (ISO 11784:1996, 2021) microchips. They should also be compatible with the communication protocols in the geographic locale in which it is to be used, i.e. able to read microchips commonly used in the country. It is recommended that the scanner can read FDX-A microchips until 2026. Cheaper scanners will read fewer types of microchips. However, each additional technology to be read reduces the efficiency of the device's operation (e.g. speed, range etc), so the more expensive scanners should read the most available microchips but may be slower to operate (WSPA, 2008).

Battery-powered scanners should have a low battery indicator and stop operating when the operating function is compromised by low power input. Batteries should be always fully charged and that the manufacturer's directions for battery care are followed closely. As scanners emit and received electromagnetic energy they may be affected by other electronic equipment or metallic objects and should be kept at least one meter away from these.

Microchip implanting gun*:* There are many implanting guns for animal microchips, from a good variety of manufacturers. An Injector Pistol from Avid, one very know microchip manufacturer. There are few restrictions to the usage of a pistol. It should be compatible with the microchip being used, sterilized, and well-calibrated. (*Avid Identification Systems, 2023*)

Microchip registration/certification*:* While microchipping a pet, the owner must be provided with a registration certificate, which must be provided by the microchip's manufacturer to the entity that performs the implanting procedure. It has all the information of the microchip, as well as the information given to be recorded in the database and within the microchip. As an example, in Ireland dog owners are legally required to be in possession of a Microchipping Certificate, which is a printed legal document confirming the information that is registered on a government-approved database (*Dublin Dogs Trust, 2023*).

Procedure: In most countries, microchip implantation is not considered a medical act and hence does not require a veterinary surgeon. Before setting up a microchipping system, however, it is important to check local and national regulations. According to the UK's Royal College of Veterinary Surgeons, the procedure does not need to be performed by a veterinary surgeon unless (RCVS, 2023):

- the method used is not the subcutaneous route, an ear tag, or bolus;
- the entry site needs to be repaired or closed;
- the animal needs to be chemically restrained; or
- there is any undue risk to the health or welfare of the animal.

The American Veterinary Medical Association, however, categorizes microchip implantation as a veterinary procedure, which must be performed by a veterinarian or under the direct supervision of a veterinarian (AVMA, 2023).

Whether or not they are a veterinarian, the implanter should be suitably trained by a competent organization or professional. All companies following the ICAR Code of Practice provide training courses in the use of their products (ICAR, 2023). Training should be comprehensive and include:

- the implantation procedure,
- potential adverse reactions,
- standard implantation sites,
- microchip technology,
- animal handling,
- health and safety issues, and
- registration.

A certificate should be issued to non-veterinarian agents along with an Implantation Manual, which confirms the individual attended and understood the course.

The ISO standard implantation site for companion animals is subcutaneously on the dorsal midline just cranial to the scapulae (shoulder blades). This is also recognized by the WSAVA. The standard implantation site in continental Europe is in the midway region of the left neck, and this is the only other site recognized by the WSAVA (WSAVA, 2023).

Registration :It is very important to keep up to date with the animal's information. This is what will provide reliability to the system. Without effective, reliable database administration, the system will fail (WSPA, 2008).

When microchipping an animal the following information should be ascertained:

Essential details of the animal: Microchipcode, Date of registration/implantation, Species, Breed, Sex, Colour/description, Health-related information, Spay/Neuter details

If the owner is present: Full name and address, Contact telephone numbers, Name of the animal, Year of birth, Special e.g. dietary needs, Details of veterinarian, Medical problems e.g. allergies, diabetes, and any medication

RADIO TRANSMITTERS

Radio transmitters, also known as radio tracking devices or telemetry systems, can be considered an electronic method for tracking and monitoring animals. They are commonly used in wildlife research and conservation to study the movement patterns, behavior, and habitat use of animals in their natural environments. They consist of a small device attached to an animal that emits radio signals. These signals are picked up by receivers or antennas, allowing researchers to locate and track the animals' movements. The information gathered through radio telemetry can provide valuable insights into animal behavior, migration patterns, home range, and population dynamics.

While radio transmitters are primarily used in research settings for wildlife, they may also have applications in monitoring and tracking stray domestic animals. For example, in cases where specific individuals or groups of animals need close monitoring or where animals are released into the wild as part of conservation or reintroduction efforts, radio transmitters can be employed to track their movements and assess their well-being.

One of the companies that develop radio transmitters is Lotek Wireless. Though they specialize in the design and manufacture of wildlife telemetry solutions, they offer a variety of radio transmitters suitable for tracking and studying different animal species.

Lotek Wireless, with its range of radio telemetry solutions, provides options that can be customized to suit different animal species and research requirements. Their transmitters offer reliable performance and can be programmed to transmit unique identification codes for individual animal identification.

For example, the "Core Implant Series" is a product that can be suitable for tracking species that may not be well-suited to collar or glue-on transmitters. While it may not be explicitly marketed for domestic animals or stray animals, it can potentially be adapted to domestic animals, including stray animals. (*Lotek, 2023*).

The Core Implant Series typically consists of implantable transmitters that are surgically implanted into the animals. These transmitters provide long-term tracking and monitoring capabilities, allowing for the collection of data on animal movement and behavior. The transmitters are small and lightweight, making them suitable for a range of animal species, including domestic animals (*Lotek, 2023*).

Another thing that must be considered is that the implementation of implantable transmitters requires specialized knowledge and veterinary expertise to ensure the well-being and safety of the animals. It's recommended to work closely with professionals and follow appropriate ethical guidelines and regulations when considering the use of implantable transmitters for stray and homeless animals.

It's worth noting that radio transmitters require specialized equipment, including receivers and antennas, and may involve manual tracking or data collection. They are generally not used as a widespread method of identification for stray domestic animals

COLLARS and TAGS

While collars and tags have been used for a long time in history, with the advancements in technology, electronic versions of these devices now are now used as powerful tools in addressing the challenges associated with record-keeping and identification of stray and homeless animals. These electronic solutions provide enhanced traceability, real-time monitoring, and streamlined data management, revolutionizing the way we approach the identification and management of these vulnerable animals.

RFID ear tags: RFID (Radio Frequency Identification) ear tags are more commonly associated with livestock management, where they are used to track and identify individual animals, or sometimes for wildlife tracking, where they can be used for population studies, behavioral studies, etc. However, their application is not limited to livestock alone, and they can also be used for identification purposes in stray or homeless animals.
In the context of stray animals, RFID ear tags can serve as a means of identification when the animals are brought to shelters or rescue organizations. The tags are typically attached to the animals' ears and contain an embedded microchip that stores unique identification information (e-Tag RFID Singapore, 2022).

At present, many countries and regions have implemented RFID electronic logo management for pets such as the United States, Canada, Australia, China, etc. This kind of radio frequency identification technology (RFID) can accurately and effectively help us to track and grasp the situation of pets in time (Xinyetong Sh, 2023).

Each pet implanted with a chip has a globally unique identification number (UID), which will be used as the pet's electronic ID card for the rest of the pet's life because the chip has a life span of more than 20 years. Also, the pet chip can write basic information about pets, including pet name, type, gender, date of birth, physiological characteristics and owner's name, address, contact information, and so on (Xinyetong Sh, 2023).

Pet regulators or pet hospitals can get pet information easily and quickly by scanning the RFID animal tag. RFID animal identification system can also query the pet's UID number, and you can get more and more detailed information about the pet from the pet database through the Internet (Xinyetong Sh, 2023).

When a stray animal is found and brought to a shelter or veterinary clinic, staff members can scan the RFID ear tag using a specialized RFID reader. The reader wirelessly communicates with the tag and retrieves the unique ID associated with the microchip. This ID can be used to access a database containing detailed information about the animal, such as its background, medical history, and any previous ownership records if available.

By using RFID ear tags, shelters, and animal welfare organizations can efficiently identify and track stray animals, ensuring their proper care and assisting in reuniting them with their owners if applicable. It also helps in documenting the movement and status of animals within the shelter system.

While RFID ear tags may not be as commonly discussed in the context of stray animals as they are in livestock management, they are becoming a popular choice among pet owners. In some cases, it is even required when the owner takes their pet abroad since microchips are necessary to approve pet passports. Owners may also find it in their best interest to microchip

their pets if they use popular services like pet daycares, where their pets mingle with other animals (e-Tag RFID Singapore, 2022).

GPS Tracking Collars: Some organizations and researchers have used GPS tracking collars on stray animals to monitor their movements and gather data on their behavior and habitat preferences. This information can be valuable for understanding their roaming patterns and implementing targeted interventions.

QR Code Tags: can be attached to collars, providing a quick and convenient way to access essential information about a stray animal. The QR code can contain details such as the animal's ID, medical history, the contact information of the rescuer or shelter, and adoption availability. This helps streamline the identification process and facilitates potential adoptions.
It's worth noting that QR code tags can also be generated and printed independently using online services or local pet stores that offer customization options. This allows pet owners to create their own tags with unique QR codes linked to their preferred information sources.

Smart Collars: Advances in technology have led to the development of smart collars that integrate various sensors and connectivity features. These collars can track an animal's location, monitor its activity levels, and even provide health data such as heart rate and body temperature. This information can assist in identifying and managing stray animals more effectively.

Though some manufacturers specialize in smart collars, most of them that produce QR Tags or common GPS tracking collars also have smart collars in their product list. What differentiates "simple" collars with QR Tags, GPS tracking systems, or even RFID from smart ones are their functionalities.

These may include:

- GPS tracking with real-time location updates;
- Activity monitoring;
- Geofencing (or virtual fences);
- Connectivity to a smartphone app;
- Insights into pet's behavior and health;
- Temperature alerts;
- Pet Health Monitoring (such as vital signs tracking, activity levels, and behaviors).
-

ARTIFICIAL INTELLIGENCE

There are nowadays some AI-powered platforms and applications that leverage the data collected from smart collars and other pet monitoring devices to provide insights and make informed decisions related to pet health and behavior. While these AI systems do not replace a professional, they analyze the data gathered from various sensors and generate actionable information for pet owners and veterinarians.

For example, AI algorithms can analyze activity patterns and sleep data to provide insights into a pet's overall well-being and detect any abnormalities or changes in behavior that

might indicate health issues. They can also track vital signs like heart rate, respiratory rate, and body temperature to monitor the pet's health status.

Additionally, AI systems can use machine learning algorithms to identify patterns and trends in the collected data. By comparing a pet's data to large databases of similar pets, these algorithms can provide personalized recommendations for nutrition, exercise routines, and preventive care based on the specific needs of the individual pet.

Furthermore, AI-powered pet health platforms may offer features like symptom checkers, behavior analysis, and remote consultations with veterinarians, allowing pet owners to access professional guidance and make informed decisions about their pets' health.

One example of an AI-powered platform that utilizes data from smart collars and pet monitoring devices for decision-making is the "Voyce Health & Wellness Management System" provided by i4C Innovations Inc. (formerly known as AGL Technology).

The Voyce system incorporates AI algorithms to analyze data collected from wearable devices such as smart collars. It tracks various parameters like activity levels, rest patterns, heart rate, respiratory rate, calories burned, and more. The AI algorithms process this data to provide insights into a pet's health and behavior (*Intersections Inc., 2016*).

The platform offers features such as personalized health reports, trend analysis, and actionable recommendations. It can detect changes in activity levels, sleep quality, and other parameters, allowing pet owners and veterinarians to monitor a pet's well-being and identify potential health issues at an early stage (*Intersections Inc., 2016*).

The Voyce Health & Wellness Management System was developed to empower pet owners and veterinarians with actionable information to make informed decisions about pet health.

FACIAL RECOGNITION

This technology is a rapidly advancing field that has shown promise in various applications, including the identification of animals. While the primary use of facial recognition for animals has been focused on pets rather than specifically homeless animals, the technology has the potential to aid in identifying homeless or stray animals as well.

Just like humans, animals have distinct facial features that can be captured and analyzed by facial recognition algorithms. These algorithms can identify unique patterns, shapes, and markings on the animal's face, enabling individual recognition.

Facial recognition systems can compare the captured facial features of an animal to a database of known animals. This database can include records of lost or found pets, shelter animals, or other animals with registered facial profiles. By matching the facial features against the database, the system can identify the animal and provide information about its ownership or background.

Some organizations maintain online databases - called "lost and found databases" - where owners can report their lost pets, including photographs. One example is the American Kennel Club (AKC) Reunite pet recovery service, which links all of the owner's important contact information to the dog's AKC registration number that is printed on a custom AKC collar tag including a toll-free pet recovery service phone number. When a dog is found, AKC Reunite will immediately call, email and text the contact related in the registry to reunite the owner and dog as quickly as possible. It is also possible to include the microchip ID number in the registry (American Kennel Club, 2023).

Facial recognition technology can also be used to engage the public in the identification process. Animal welfare organizations or shelters can develop mobile applications or online platforms where individuals can submit photographs of stray or homeless animals. The facial recognition system can then compare the submitted images against its database to help identify the animals and provide relevant information.

In Chernivtsi, Ukraine, the app called Animal ID Info is used to count stray animals and works by dividing a city into quadrants and sending out volunteers for a couple of hours to snap photos of dogs on their smartphones. The pictures are loaded onto a database together with GPS coordinates. The app estimates the total number of homeless canines residing in the city (Masis, 2016).

Developers realized they had to account for errors that might result if two volunteers photograph the same dog after it runs around the corner. They're now building (dog) face-recognition software into the app, similar to the kind that helps you to tag your friends in Facebook photos (Masis, 2016).

Thanks to the app, animal rights activists counted 7,392 stray dogs in Mykolaiv, 1,865 in Vinnitsa, and 1,882 in Odessa. In the capital Kiev, they discovered about 2,700 stray dogs (Masis, 2016).

There's also the possibility of using pre-existent resources to incorporate to them the function of capturing the data and applying to it facial recognition software. A possible efficient solution could be that the software recognition system uses surveillance cameras to automatically capture the dog face images in the smart city. The deployed surveillance cameras have continuously performed the recording of videos and captured the movements of pet animals (dogs) (Kumar & Singh, 2018, 554).

It's worth noting that facial recognition technology for animal identification is still a developing field, and its application for identifying homeless animals may not be as widespread as other methods like microchipping or physical descriptions. However, advancements in the field continue to expand its potential uses, including identifying homeless animals.

CONCLUSION

While this work described many methods for electronic identification and records of stray domestic animals, it doesn't cover all of them. Many other methods are used on minor or

significant scales, such as tattooing QR Codes, various smartphone applications, different types of collars and tags, and screening methods that aid in veterinarians' diagnosis and shelter receptions.

There is also cutting-edge research in areas like voice recognition and DNA testing that may provide interesting perspectives on the way we treat the problem of stray and homeless domestic animals.

Regardless of the method used, it is always important to consider the applications needed against the characteristics of the solution to be adopted.

The chip is permanent, cannot be removed or tampered with without surgical intervention The implant procedure is a relatively harmless veterinary procedure It will not cause any discomfort if implanted correctly, and will not alter the animal's appearance or affect its behavior (*WSPA, 2008*). Microchips are completely safe for pets and have become standard practice. This is the only method that can guarantee a unique, unalterable code Personal information of owners will not be visible to the public (*WSPA, 2008*).Provides traceability which may infer wider benefits in relation to long-term monitoring and data collection,

Beside this advantages, though microchipping a pet is relatively affordable for the pet's owner microchip scanners are expensive, and it is often cost-prohibitive to purchase several types of microchip scanners (*Peeva, 2023*). Supply may present a problem in some regions. Unless scanners are made freely and widely available to equip all agencies encountering stray dogs and cats, microchipped animals may go unidentified (*WSPA, 2008*). A microchipping registry requires significant infrastructure, incorporating a computerized database and a 24-hour staffed call center or website access (*WSPA, 2008*). Identification is only possible if a suitable scanner is available (*WSPA, 2008*).Scanners with quad-read capability are now available and are increasingly considered required equipment. Older scanner models will be in use for some time, so United States pet owners must still choose between a chip with good coverage by existing scanners and one compatible with the international standard (McGreevy P *3*). There is a risk of subcutaneous migration of the microchip from the original implantation site, especially in loose-skinned animals, although with more recent methods and technology it is unlikely that the chip will migrate more than a few centimeters (*WSPA, 2008*).

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