* Many animals entering an animal shelter are euthanized in shelters due to lack of physical facilities.
  + New strategies are needed to reduce euthanasia.
* It is possible to reduce euthanasia numbers by utilizing the space resources of animal shelters efficiently.
  + Efficient utilization of facility space in shelters.
  + High impact on improving animal welfare in shelters if they are properly combining with strategies encouraging adoptions.

**INTRODUCTION**

* In a sustainable society, animal welfare, as well as human well-being, can become sustainability measures because we can judge how mature society is from its attitude toward animals that are weaker than humans.
* Animals in shelters can be euthanized when they are no longer accepted at the shelter because of a lack of budget or a lack of physical facility.
  + Natural deaths often occur during the protection period due to poor shelter conditions and resulting infections.
* The proportion of animals euthanized tends to decrease every year due to increasing public interest in animal welfare.
  + Reduction of the negative perception towards stray animals.
* The number of animal shelters is not increasing enough for the growing number of rescued animals under circumstances where the adoption rate is decreasing.
* The infrastructure for the animal shelter cannot be expanded in a short period of time.
* The study deals with ways to reduce the number of unnecessary euthanasia procedures by efficiently utilizing the existing space resources of the given shelters.
* There are difficulties in resolving problems through information sharing and cooperation among shelters.
* Shelter Management Model
  + Capacity for Care (C4C)
    - Calculates the optimal daily population in the shelter based on meeting the shelter’s goals to anticipated adoptions and improved animal housing.
    - Associated with lower daily populations, increased probability of adoption, and decreased the probability of euthanasia in the shelter.
  + Logistic Regression Model
    - Predicting the conditional probability of adoption from variables such as age, sex, coat color, and reasons for relinquishment.
  + Free Adoption Strategy
    - Promoted during times of overcrowding can help animal shelters.
* There are difficulties in resolving problems through information sharing and cooperation among shelters.
* This study aims to study methods of optimizing the operation of animal shelters, including transfer between the shelters.

PROBLEM DESCRIPTION AND OPTIMIZATION MODELS

* The main reason for the euthanasia at the shelter is the saturation of the facilities in the shelter.
* The budget for the protection of shelter animals is at a minimum cost level in line with the legal protection period, a certain level of euthanasia is inevitable for each shelter to operate the facility within the limited budget.
  + Unavoidable euthanization of animals that do not have health problems should be minimized to promote animal welfare.
* Solutions:
  + The number of stray animals should be reduced through policy measures.
    - Inducing changes in the perception of companion animals
    - Enacting laws to curb excessive reproduction.
  + Essential that the number of shelters and animal shelter budgets be increased.
* Some shelters may have a lack of capacity due to the large number of rescued animals that are admitted during a certain period.
* Other shelters may have sufficient capacity due to the relatively small number of admitted animals.
* IMBALANCE IN CAPACITY DUE TO THE RELATIVELY SMALL NUMBER OF ADMITTED ANIMALS.
  + Leads to unnecessary euthanasia.
* Solution: Shelters can share the information about the number of additional animals they can accommodate the transfer of animals from overcrowded shelters to relatively less-crowded shelters may enable the effective use of available resources for rescued animals.
  + Reduce the number of unnecessary euthanasia.

**RESULTS AND DISCUSSION**

* The euthanasia rate can be significantly reduced with the help of animal transfer between shelters and the increase of shelter capacity.
* The shelter animals are redistributed from overcrowded shelters to less crowded shelters.
  + Note that for the reduction of euthanasia to be meaningful, it should be accompanied by strategies encouraging adoptions such as waiving adoption fees or increasing media promotion.
  + Without the increase of adoptions, the euthanasia of healthy animals is inevitable under the limited capacity of shelters.
* Cooperation such as information sharing among shelters is ESSENTIAL.
* With the introduction of information systems to enable information sharing between shelters.
  + Recent advances in sensor monitoring systems can help animal shelters collect real-time information about shelter animals.
* One of the limitations of this study is that many qualitative factors related to animal welfare were not considered.
  + Negative effects, such as stress that animals will experience due to transfer between shelters.
  + Negative effects due to mental stress from animal euthanasia experiences by veterinarians and shelter staff in charge of euthanasia.

**CONCLUSION**

* The study developed mathematical optimization models to determine the operation of the animal shelter with the objective of minimizing euthanasia.
  + Used animal transfer between shelters combined with an increase of shelter capacity to reduce euthanasia.
* As a result, animal transfers and the increase of shelter capacities can contribute to a significant reduction in the use of euthanasia.
  + If combined with policies encouraging adoptions, it is expected to contribute greatly to improving animal welfare in shelters.