

Design Innovation of a Humane Cat Trapping Device using TRIZ Principles

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Abstract: The advent of globalisation and urbanisation has caused city populations to grow larger and faster by the day. As these populations grow so do the populations of domestic cats. Problems related to free-roaming stray cats are becoming increasingly important due to factors such as animal-welfare public health issues and various societal impacts. Though, it may be true that there are many means to resolve this problem it is crucial that this problem be resolved in the most sustainable, cost-effective and humane way possible. This study posits that the current methods to control the stray cat population are ineffective and hence proposes a more innovative and humane design in order to trap stray cats. The TRIZ methodology was used in this study. The common cat trap design was studied using function analysis and cause-and-effect chain analysis. A few engineering contradictions were formulated. An innovative way to capture cats was proposed by resolving these contradictions using a few selected inventive principles namely segmentation, asymmetry, beforehand cushioning, equipotentiality and dynamisation. This innovative cat trap was also proven to be feasible and affordable with an estimated cost of MYR 80. The cat trap is expected to catch a maximum of 4 cats. Overall, the proposed trap is sustainable, cost-effective and humane and indeed addresses the issue as an effective method in controlling the stray cat population.

Key words: TRIZ, innovative design, cat trap, engineering contradiction, cost-effectiveness, MYR

INTRODUCTION

Now a days, urban cities face problems pertaining to the overpopulation of stray cats. The unowned free-roaming stray cat population is becoming a global issue with concerns of environmental and health impacts to society (Levy *et al.*, 2003). Stray cats can be seen everywhere and this leads to the issue of cat nuisance which affects the quality of life for humans. For instance, stray cats make a lot of noise when they fight. Moreover, they cause a messy environment as they tend to rummage for food at the rubbish bins. These issues could lead to infectious feline diseases, rabies and various other diseases detrimental to not only the cats themselves but also to humans (Levy *et al.*, 2003; Bloomer and Bester, 1991).

Literature review: There have been many debates on the most suitable techniques to control the population of these free-roaming stray cats (Scott *et al.*, 2002). Some methods have included harmful traps, poisons, shooting and introducing infectious diseases to the stray cats (Scott *et al.*, 2002; Jones and Coman, 1982; Mahlow and Slater, 1996; Patronek, 1998; Slater, 2001). Commonly

suggested methods such as euthanasia and TNR (Trap-Neuter-Return) contend that each method is a more operational resolution and more suitable compared to the opposition's solution (Schmidt *et al.*, 2009). Nevertheless, there have been studies that compare the efficacy of both these methods at reducing the free-roaming stray cat population and the findings prove these methods to be debateable and not based on the standard wildlife research techniques (Patronek, 1998; Schmidt *et al.*, 2009; Clarke and Pacin, 2002; Gibson *et al.*, 2002; Hughes *et al.*, 2002; Stoskopf and Nutter, 2004). Of course while there are many ways to solve this issue it is vital that this issue be solved in a most sustainable cost-effective and humane way possible.

Currently, there are many available methods that can be used to capture cats. Regular wired cat traps and angled cat traps are some examples. However, these traps are not really designed to be accommodating to the cat. Cats that are trapped can get injured in the process, especially stray cats which probably have already sustained certain injuries.

Other than that although manpower can be invested upon to manually catch stray cats, the amount of manpower needed to catch a large quantity of cats would

be costly and impractical. In short, there has yet to be an innovative cat trap design which is capable of trapping cats in a cost-saving, sustainable and humane manner. Hence, the problem statement can be formulated as: the current methods to control the stray cat population are ineffective.

MATERIALS AND METHODS

The Theory of inventive problem solving or better known as TRIZ (a Russian acronym) was chosen for this study due to its notable innovative uniqueness in solving complex engineering problems from several studies (Ng and Jee, 2016; Ng *et al.*, 2016a, b). TRIZ is known as a problem-solving technique which is substantiated with logic data and research rather than instinct (Yeoh, 2014). It utilises the previous knowledge and inventiveness of numerous engineers to quicken the capability to resolve issues ingeniously (Yeoh *et al.*, 2015). Upon the identification of the main problem there are 2 major TRIZ tools used in this project namely the cause and effect chain analysis and engineering contradiction. Upon identifying the engineering contradiction(s) the system parameters will be identified and cross-referenced in the contradiction matrix in order to know the recommendations of the TRIZ inventive principles.

Cause and Effect Chain (CEC) analysis: A CEC analysis was performed in order to understand the potential root-causes for the ineffective method in controlling the cat population. The cause of the cat trap's imperfect design could be due to the fact that the cage is unable to catch the cats automatically. This could be due to the poor mechanisms involved.

A CEC analysis on the poor mechanism of the cat trap can be found in Fig. 1. Poor mechanism was due to 3 major causes namely the cat's tail getting stuck when the door closes, cats getting injured in the process and cats escaping from the trap. The potential root-cause which led to the cat's tail getting stuck at the door was the trap gate shutting too rapidly. Another potential root-cause which led to the cats getting injured in the process involves the cat falling in the trap. Finally, a potential root-cause leading to the cat's escape involves the gate of the cage having a two-way opening.

Engineering contradictions and system parameters: From the potential root-causes identified there were about 5 engineering contradictions developed. The system parameters were identified based on the characteristics of the improving and worsening parameters in these contradictions. The 5 contradictions include:

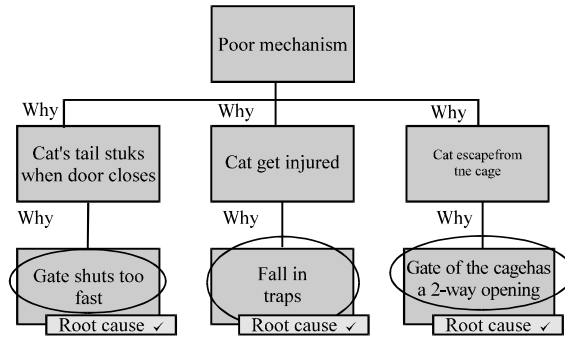


Fig. 1: CEC analysis (Stage 2)

- Forceful trap, damaged cage: if the gate of the trap shuts fast, then the cat can be forcefully and effectively trapped (#10: Force) but the cage may get damaged in the process (#34: Ease of repair)
- Forceful trap, injured cat (due to speed): if the gate of the trap shuts fast, then the cat can be forcefully and effectively trapped (#10: Force) but the cat's tail may get caught in the process (#9: Speed)
- Easily trapped, injured cat: if the cat trap is placed at a steep angle, then the cat can fall into the trap easily (#27: Reliability) but the cat may get injured from falling too high (#4: Length of stationary object)
- Easily released, escaped cat: if a two-way trap door is used, then it would be faster to release the cat upon capture (#25: Loss of time) but the cat would be more likely to escape (#27: Reliability)
- Lighter trap, overcrowded trap: if a single trap unit is used then it would be light and convenient (#2: Weight of stationary object) but the trap would be overcrowded with cats (#39: Productivity)

Inventive principles and proposed solutions: Based on the identified system parameters from the previous section several inventive principles out of the 40 inventive principles from the matrix of contradiction (Yeoh, 2014; Yeoh *et al.*, 2015) were recommended to aid the proposal of solutions for this project. Out of all the inventive principles only 5 of them were used for the proposed solution namely segmentation, asymmetry, beforehand cushioning, equipotentiality and dynamisation.

RESULTS AND DISCUSSION

The results and discussion for this study involved the proposal of the solution based on the inventive principles identified from the TRIZ process. This section involved 3 major parts namely the mechanisms used in the design, final product and cost estimate of the entire product.

Mechanisms in the design segmentation (capturing unit first cage and storage unit second cage): The proposed trap is designed such that it has two individual parts, namely a capturing unit and a storage unit. By doing this, the capturing unit would not be overcrowded and is capable to continuously serve its purpose to allow more cats to enter. The storage unit will be made larger so as to store up to a maximum of 4 cats. This would also allow the cage to last longer and not get damaged since the storage unit is away from most of the mechanisms from the capturing unit.

Asymmetry (external frames at second trap door of second cage): The external frames at the second trap door serves to disallow the cat from exiting the storage unit (second cage). This would cause the swing door to only swing one way instead of two ways, hence causing somewhat like an asymmetrical swing pattern of 90° instead of 180° due to the external frames restricting the rest of the swing.

Dynamisation (door hinge): In this design, there are two door hinges used, namely at the first cage to close the door when the cat steps in and another located at the back door of the second cage for the user to open and retrieve the trapped cats.

Beforehand cushioning (compression springs): In the cat trap design, the compression spring is used as a cushion of the platform to absorb the impact force. The spring will support the plates to retain in a certain height but it will sustain a downward force which is from the weight of the cat. The springs would absorb the shock which is caused by the weight of cat to protect the cat from sustaining any injury (minor or major) from the sudden impact.

Equipotentiality (pulley): In this project a single-wheel pulley was used. It works by a circular lever with the wheel rotating freely on the axle. A fixed pulley is fastened to one spot and does not move around. It provides no gain in force, distance or speed but it changes the direction of the force. A fixed pulley acts as a first class lever. The fulcrum is the axle (the point at which the pulley is supported).

In the project's design, the pulley serves as a trigger to raise the platform in the first cage where the cat stands at. The cord is connected at the entrance gate passing through the pulleys and then to the platform. When the cat leaves the platform the inclined entrance gate will descend again which tightens the connection cord while the platform is raised.

Final product: For the final design and product parts the targeted number of cats to capture was four

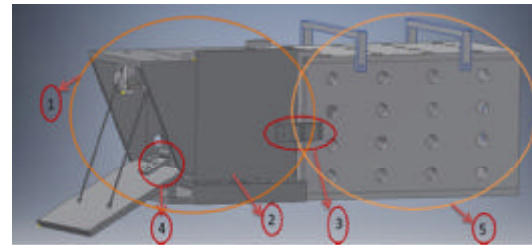


Fig. 2: Parts of the cat trap (1-5)

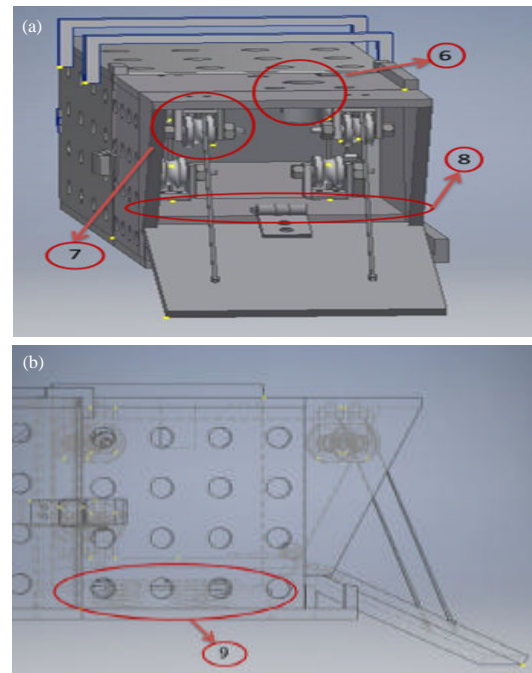


Fig. 3: Parts of the cat trap (6-9)

cats. Figure 2 presents some of the indicated parts (parts 1-5) of the cat trap. The explanations of each part are as such:

- 1 = The first cage where cat will step in
- 5 = The second cage which stores up to four cats. It is movable and can be replaced
- 2 = The gap which allows other pests such as rats and cockroaches to escape since the cat trap is mainly designed to only capture cats
- 3 = The toggles and latches used to connect both cages together as shown in Fig. 2

Figure 3 shows other important parts (parts 6-9) of the cat trap. The definition of some of them are as such:

- 6 = Alternative cylinder-shaped hole to allow small critters like rats to escape
- 8 = The plate that the cat steps on

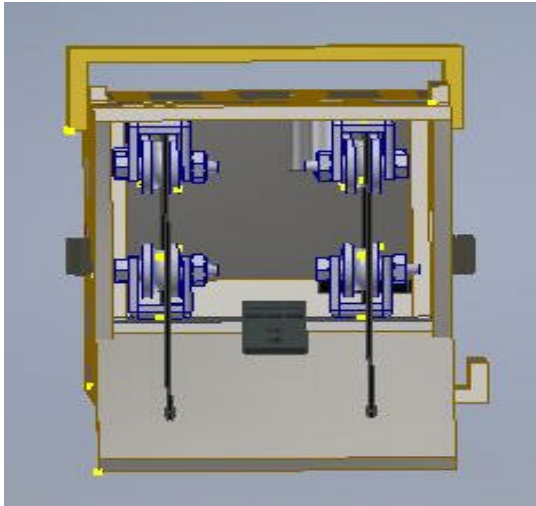


Fig. 4: Front view of the cat trap

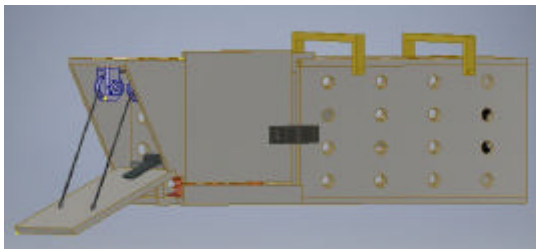


Fig. 5: Side view of the cat trap

Steps on how the cats can be caught are shown as such: the cat steps in Part 1 as shown in Fig. 2. Once it steps on the first plate in Part 8 (Fig. 3) the plate would descend due to the pulley mechanism (Part 7) with the help of a cord (fishing line) and door hinge (Part 4) between the two plates in the front (Fig. 2). The plate outside is then pulled by the cord attached to it with the help of the pulley system in order to close the first cage of the trap. For safety purposes under the plate (Part 8) there are four springs (Part 9) which function to absorb the shock from the plate and also cushion the weight of the cat so the cat would not be injured by a sudden fall.

By putting the catnip in the second cage the cat will go inside the second cage and enter through a one-way door. Hence, once the cat enters the second cage it is unable to exit from the inside due to the blocking of the external frames.

The cat has now exited the first cage and is in the second cage. Without the weight of the cat acting on the first plate (Part 8) in the first cage the outside door will descend back to its original position for the next target.

Final visualization of the design and cost estimate: Figure 4 and 5 shows the front view and the side view of

Table 1: Bill of materials and cost estimate

| Materials | Quantity | Price (MYR) |
|-------------------------------------|----------|-------------|
| Handle (PC) | 2 | 1.50 |
| Pulleys | 6 | 6.50 |
| Nylon fishing line | 1 | 5.80 |
| Door hinges | 2 | 2.50 |
| Screws | 4 | 0.30 |
| Bolt and nuts | 20 | 0.27 |
| Locker | 1 | 5.00 |
| PC plate (1.2×0.3×0.005) | 2 | 0.25 |
| PC plate (1.2×0.29×0.005) | 2 | 0.25 |
| PC plate (0.3×0.3×0.005) | 2 | 0.25 |
| PC plate (0.6×0.3×0.005) | 2 | 0.25 |
| PC plate (0.6×0.29×0.005) | 2 | 0.25 |
| PC plate (0.2×0.3×0.005) | 1 | 0.25 |
| PC plate (0.36×0.29×0.0064) | 1 | 0.25 |
| Triangle PC plate (1/2×22×20×0.005) | 2 | 0.25 |
| Hooks | 2 | 1.00 |
| Toggle and latches | 2 | 0.36 |
| Epoxy | 1 | 10.00 |
| Total | | 80.62 |

the finalised cat trap. Table 1 shows the bill of materials and cost estimate of the entire product. The overall product's cost is estimated to be about MYR 80.

CONCLUSION

Polycarbonate material is proposed as the material used to build the cage and further engineering analyses proved that this material has a high enough compression strength, shear strength and also tensile strength to withstand heavy loads. Moreover, polycarbonate is relatively environmentally friendly as it can be recycled and reused. The pulleys are used to close the door when the cats step into the second cage. The springs are used as cushion for the plate for the cat to stand on. The door hinge is used in this design to ease the rotational movement of the door and limit its angular rotation to avoid slamming. Bait such as catnip can be used to attract only cats to enter the cage.

Besides that the one-way door mechanism is used in this design to allow a single direction of movement and prevent the cat from escaping. The cat trap is expected to catch a maximum of 4 cats. Overall, the proposed trap is sustainable cost-effective and humane and indeed addresses the issue as an effective method in controlling the stray cat population.

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