Architectural design assessment of Javan leopard rehabilitation facility regarding the occurrence of stereotypical pacing

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Abstract. The Javan leopard is an apex predator with a key role in maintaining the stability of the ecosystem, in which it’s population are declining due to habitat loss, illegal wildlife trade, and human-animal conflict. Although efforts in rescuing Javan leopards are actively made, not all rescued Javan leopards can be released back to the wild. Some must go through rehabilitation process in captivity, due to physical injuries. One issue regarding leopards in captivity is the risk of them developing stereotypical pacing, a repetitive stereotypic behaviour due to stress in confinement as one of the sign of zoochosis. Zoochosis itself is a mental illness in animals. Zoochosis will definitely interfere with the success of rehabilitation process. Therefore, cases of zoochosis such as in zoos must not occur in rehabilitation facilities. A further understanding of animal’s needs and behaviour is needed and must be implemented in the design of the enclosure. Not only to prevent zoochosis, but also to improve and promote the natural behaviour of the Javan leopard. This study aims to analyse how the design of an enclosure correlates to Javan leopard’s behaviour. Through methods of observation and evaluation of rescued Javan leopards at a rescue center in Sukabumi, by studying the overall facility design and the behaviour of the leopards. Results shows that the rescue center enclosure provide more natural environment with live foliage, sunlight, minimal noise disturbance, hiding spots, and able to simulate hunting behaviour during feeding time. The leopards housed shows no significant sign of zoochosis.

Keywords: design assessment, javan leopard, rehabilitation facility, stereotypical pacing

1. Introduction

1.1 Stereotypical Pacing and Zoochosis

Stereotypical pacing is one of the symptom of stereotypic behaviour, a repetitive behaviors that serves no clear purpose [1]. It is a sign of stress in animals, that could lead to an even greater problem called zoochosis. In general term, zoochosis has the meaning of psychiatric illness in animals caused by confinement such as in cages. Zoochosis is almost never encountered in wildlife in its natural habitat
The behavior of chronic stereotypes can alter the function of the brain structure [2]. Such abnormalities are evident in patients with schizophrenia [3]. Schizophrenia itself is a chronic mental disorder in humans.

Stereotypical behaviour such as pacing, are mostly found in captive carnivores [4]. As seen in Figure 2, a tiger is seen to be performing repetitive stereotypical pacing. The tiger is seen to be walking on the same length at the same pace and route, over and over with no clear purpose of doing so. Behaviours like this can be said to be quite often seen in zoo animals, where they are having difficulties to channel their natural behaviour.

![Figure 1. Tiger performing stereotypical pacing behaviour](image)

1.2 Architecture for Wild Animals

In the effort of maintaining the sustainability of the eco system, it is important to rehabilitate and re-release wild animals back to the wild. In doing so, of course a proper rehabilitation facility is needed. This is where architecture as a knowledge can take part in the effort of saving the environment. Different kind of animals would have different behaviours, thus different requirements in enclosure design. When such behavioural need is not fulfilled, a captive animal would develop stereotypical behaviours due to stress in confinement that could lead to zoochosis.

The occurrence of zoochosis, will certainly hinder the chance of rehabilitation success. This is due to the animal not being physically and psychologically fit for release and to be able to survive in the wild. Therefore, an architect must play a role in designing a proper enclosure for specific purposes of keeping an animal in captivity. If the goal is to rehabilitate an animal and release them back to the wild, then an enclosure must be designed in a way for it to fulfil the animal’s need for their natural behaviour. The enclosure must mimic the natural habitat of that animal, as close as possible. Aside from that, the design of the enclosure must also be able to stimulate their natural behaviour and even improve them. In doing so creating an animal that is healthy both physically and psychologically, hopefully fit to be released back to the wild.

In the process of implementing architectural skill into designing an enclosure for animals, of course the architect itself must be able to understand the needs of the animal itself. In a way, similar to how architects would do interviews with clients on how they want their houses to be designed. Of course, an architect cannot do interviews with an animal. It is important to implement animal behavioural
study into the practice of architecture. This can be done by collaborating with practitioners and experts in the field of animal behaviour study, as well as actually doing field work in animal conservation. The idea seems to be odd, but it does necessary. This would definitely expand the practice of architectural knowledge, even more so break boundaries that architecture is not only for humans but to other species as well. If through building design we can ensure the existence of endangered animals in the wild, wouldn’t that be considered as the implementation of sustainability? We hope so, it is.

2. Literature Study

2.1 Javan Leopards

As previously discussed, one of the symptoms of zoochosis which is “pacing” are often found in captive carnivores. Leopards are among carnivore species who are currently facing massive extinction [5]. Leopards are important predator species, unfortunately its population are declining [6]. There is a leopard species in Indonesia, known as the Javan leopard (*Panthera pardus melas*). Javan leopard is an endemic species exclusive to the island of Java [7], who holds a place at the top of the food chain; making the Javan leopard as an important species in maintaining the stability of the eco system. Javan leopard also has a role in the social and cultural aspect of the local people of Java. They are linked to the legend of Prabu Siliwangi, a respected figure in the history of West Java during the Hindu-Buddhist era [8]. Javan leopards are also commonly used as symbols by police and military forces, as well as in martial arts [9].

Javan leopard is currently critically endangered [10] with only roughly 100 adult individuals left in the wild [8]. The rise of human activities resulting in the decrease of their native habitat and natural prey. This forces Javan leopards to migrate from the forest to the residential area, with the purpose of preying on livestock [11] [12]. It potentially raises conflict between humans and the leopards, making them even more endangered. One effort to prevent the extinction of Javan leopards, is through rescue and rehabilitation programs. Rescued Javan leopards will be housed in an enclosure then rehabilitated, with the goal of re-releasing them into the appropriate and conflict-free habitat through transmigration efforts [13].

Studies regarding leopards in general are currently growing in number [14], but specific research about Javan leopards are low [15]. It is important to understand the behaviour and needs of Javan leopard exclusively in captivity, to increase the chance rehabilitation success and reintroduction to their natural habitat. This can be done by preventing health related issues both physical and psychological in a form of zoochosis, through proper architectural enclosure design.

2.2 Standardization in Designing Javan Leopard Rehabilitation Facility

At the moment, there are no exact standardization regarding Javan leopard rehabilitation facility design. Therefore, I gather key excerpts from several sources to define minimum criteria of a proper rehabilitation enclosure should be. These criteria are based on enclosure design standards for *felidae* species including leopards, issued by Department of Agriculture, Environment and Rural Affairs (DAERA) [16] and The U.S. Department of Agriculture (USDA) [17]. The criteria for enclosure assessment are as followed:

| No. | Name    | Definition                                                                 |
|-----|---------|---------------------------------------------------------------------------|
| 1   | Size    | Minimum size of 28 m² (no detailed explanation of particular width/length) |
| 2   | Height  | Minimum height of 3.5 m                                                  |
| 3   | Roof    | Enclosures must be enclosed with a roof                                  |
| 4   | Enrichments | 1. Climbing elements such as a tree, a branch, and a platform;  
|     |         | 2. Minimum at least one elevated resting place;                           |
|     |         | 3. Advised to provide a pool;                                             |
|     |         | 4. Advised to provide food enrichments.                                  |
2.3 Abnormal Behaviours of Javan Leopards

In order to determine whether or not a leopard is showing signs of zoochosis, we must first characterized symptoms of zoochosis itself. As previously discussed, stereotypical pacing is one of the signs of zoochosis and are mostly found in captive carnivores such as leopards. Specifically for leopards, stereotypical pacing is defined by the leopards moving back and forth in the same direction for more than two time, with no clear intentions of doing so [18].

Stereotypical pacing is indeed an abnormal behaviour in leopards, however we must be able to determine correctly whether or not a leopard is performing stereotypical pacing. In order to do so, aside from knowing the definition of it, we must also know the definitions of normal leopard behaviour. It would be unwise to mistakenly identify a normal behaviour as abnormal behaviour. Description of a some of the normal leopard behaviour as followed [18]:

| No. | Name     | Definition                                                                 |
|-----|----------|-----------------------------------------------------------------------------|
| 1   | Attack   | Cat launches itself at (modifier) with extended forelegs and attempts to engage in physical combat |
| 2   | Flee     | Cat runs away from (modifier)                                              |
| 3   | Forage   | Cat searches for food or other edible substances. Can include the subsequent acquisition of food |
| 4   | Out of Sight | Cat is not visible to the observer                                    |
| 5   | Patrol   | Cat is alert and walks around in a calm, deliberate manner, periodically stopping to perform investigative or marking behaviours |
| 6   | Play     | Cat interacts with something in a “non-serious” manner (i.e. where there is no intention to harm - Solitary Play might include: chasing, pawing, pouncing, wrestling with and throwing an (object) into the air, or pawing at its own tail |
| 7   | Threaten | Cat directs aggressive behaviours toward (modifier) without making any physical contact with it. Can include baring the teeth, snarling, arching the back, piloerection, ground slapping, striking at with the paw, extending claws, and producing various vocalizations (spitting, hissing, growling). |

3. Analysis and Results

3.1 General Analysis Method

The location of the research is at Cikananga Wildlife Center in Sukabumi, in which it is one of the largest rescue center in Indonesia and currently rehabilitating rescued Javan leopards. The sampling method used is done purposively, it relies on the number of available Javan leopards for research. Currently there are three Javan leopards being rehabilitated at Cikananga Wildlife Center. Purposively, the number of sample and population is the same which is exactly three individuals, all male rescued wild Javan leopards. These individuals are housed in a new specifically built enclosure, one building with seven new enclosures.

Behaviour observation will be conducted through both direct and indirect observation. Direct observation is conducted in the early morning and late afternoon, the times where these leopards are sought to be active. Though direct observation time is limited to around 30-60 minutes, and I am advised to stop the observation when the leopards are no longer able to be seen; to reduce the chance of disturbance to the leopards.

Indirect observation on the other hand, is conducted using camera trap placed in each enclosure. The use of camera trap allows the leopards to behave more naturally, as they would become defensive or even aggressive when there is human observer around. Camera trap also allows for better observation during their peak hours, night time towards sunrise; where manual observation would be almost impossible to do due to the pitch-black condition.
3.2 Results on Enclosure Design Assessment

Building assessment is conducted based on the criteria mentioned earlier, in order to determine whether or not the enclosures are suitable for rehabilitation purposes. Results showed that the building provide a total of seven enclosures with different sizes, all of which are larger than the minimum requirement. These enclosures are spacious, allows natural sun light and the exchange of air flow. There are live vegetation inside the enclosures, bushes that provides cover for the leopards and tall trees that acts as climbing elements as well as elevated resting place. The ground cover of the enclosures consists of grass, dirt, and a small area of concrete in the smaller enclosures. Each enclosure are equipped with a pool, that has live fish intentionally added. The purpose of adding live fish to the pool is to stimulate natural hunting behaviour of the leopards.

The surrounding condition of the enclosure, are observed to be suitable to provide comfortable enrichment for the leopards. There are no high frequency artificial noises (machinery/automobile noises), audio measurements conducted using sound level meter shows that the average sounds around the area is 20-40 dB; the equivalent of rustling leaves and bird calls. Another contributing factor is the minimum presence of humans, as the enclosure is a restricted area with authorised personnel only allowed to be near the building. The design of the enclosure also allows barrier of sight, putting human presence as low as possible even when the leopard keeper/observer are working.

In entirety, the Javan leopard rehabilitation facility at Cikananga Wildlife Center can be considered suitable for the purpose of leopard rehabilitation. It fits the minimum requirements needed, even at certain aspects extend beyond the criteria. There are a balanced proportion between artificial built environment (concrete walls, metal bars), as well as the natural aspects. A more detailed assessment on the enclosure design can be seen in Table 3.

| No. | Name  | Minimum Requirement | Results |
|-----|-------|---------------------|---------|
| 1   | Size  | 28 m²               | Various enclosure sizes range: 36 m², 46 m², 110 m², and 260 m² |
| 2   | Height| 3.5 m               | 5 m     |
| 3   | Roof  | Must cover all      | All enclosures are enclosed with roof made of steel |
| No. | Name                               | Minimum Requirement                          | Results                                                                 |
|-----|------------------------------------|---------------------------------------------|-------------------------------------------------------------------------|
| 4   | Climbing elements                   | Tree, branch, or platform                   | Provide natural trees, branches, logs, and hanging platforms             |
| 5   | Elevated resting place              | One elevated resting place                  | One hanging platform per enclosure with leopards in them.               |
| 6   | Advised to provide a pool           | One pool                                   | One pool per enclosure.                                                |
| 7   | Advised to provide food enrichments | One kind of food enrichment                | Multiple food enrichments: Live fish in pool, hanged, and tied meat to stimulate hunting behaviour. |

3.3 Results on Leopard Behaviour

Based on the observations, during their inactive hours the leopards are generally out of sight hiding in their dens. This would mean that they are exhibiting natural behaviour, that they would be resting; as they normally would in the wild. During their seemingly active hours (nearing sundown to sunrise), the leopards shows mostly behaviours of patrol and forage. At first glance, these behaviour can be mistaken as pacing. However, these behaviours are random in pattern (leopards would walk calmly, occasionally stopping, sitting, and investigating the surroundings). Unlike pacing, these behaviours serve a purpose; be it to look for food or simply reacting to their surroundings.

During the four weeks observation of these leopards, they generally do not showcased any stereotypical pacing; with the exception of the leopard named “Ciemas”. During one occasion only, Ciemas is found to be actually performing stereotypical pacing. As seen in Figure 3, Ciemas is found to be performing the same repetitive behaviour. The behaviour occurred on 9 January 2019.

![Figure 3. Javan leopard “Ciemas” pacing](image)

His behaviour is in lined with the definition of “pacing”, thus it can be said that he is indeed performing stereotypical pacing. Although he never showcased this behaviour in previous camera trap entries or during direct observation, it can not entirely be ruled out that this is a daily repetitive behaviour. It appears that Ciemas was behaving uneasy and channel it by pacing, due to external provocation. During the same time he is seen pacing, several pigs has escaped from their enclosures and are seen wandering freely within the center. The next day while checking the camera traps, I do stumble on a pig that were hiding near Ciemas’ enclosure. In the four weeks observation, he never
showcased pacing behaviour before and after 9 January 2019. Therefore, it can be assumed that he was being uneasy and pacing because he senses pigs near his enclosure. It is yet to be verified, but it is possible since he is never seen performing pacing afterwards. From four weeks of observation, Ciemas only shown to be pacing one time.

Another leopard that showcased pacing is named “Dimas”, he is seen performing pacing on two occasions: on January 15th and 25th of 2019. It is unclear what drove Dimas into committing pacing, though in general he wasn’t pacing as heavily as Dimas. The occurrence of pacing in both leopards are rather low; only three times in the span of four weeks of observation. I realize that I cannot guarantee they did not commit stereotypical behaviours outside the boundary of direct observations and camera trap findings, as limitations during research are unavoidable.

Based on the findings, it can be assumed that the leopards did not suffer from zoochosis. The existing stereotypical pacing appears to be a triggered response to external stimuli, rather as confinement stress that occurred on a daily basis. This argument is also backed up by the fact that all three leopards are showing predominant natural innate behaviours. These behaviours includes being uncomfortable in the presence of humans, with responds either by threatening, attacking, or fleeing. The leopards also appear to not interested in engaging in human interaction, unless they are being intentionally provoked.

4. Discussion and Recommendation

Although the building fit the criteria needed for a leopard rehabilitation facility, certain aspects are still in need of improvement. During the four weeks observation, it is known that enrichments given to the leopards are able to stimulate a more active behaviour. One of which is the behaviour of jumping and climbing. At first, the leopards can only jump upwards as high as three meters (exactly at the point of the concrete wall). However, through behavioural enrichments over the span of four weeks, the leopards are able to learn to jump and climb much higher than before. This proves that with proper enclosure design and enrichments, natural behaviour in captive animals can be improved. It raises concern regarding the safety of both the leopards and the keepers, because now the leopards are able to jump and climb all the way to the top of the enclosure reaching the roof. I would recommend that the enclosure would equip a “cat fence”. A cat fence is a structure placed on an angle, at the very top of the wall. The angled structure would hinder the climbing momentum of the leopards, thus preventing them from reaching the roof of the enclosure.

Landscape design is considerably played a major role, in the process of leopard rehabilitation. The landscape environment within the enclosures, are not designed. Vegetations are able to grow exponentially out of control. This would result in several issues, one being the overgrown vegetation are blocking the viewing access to observe the leopards. Secondly, the overgrown vegetation might interfere with the leopard’s behaviour by limiting their movement. It is advised that the vegetation can at least be controlled, perhaps the use of “landscape fabric” can contribute in separating areas. In doing so, certain plants would not be able to grow in certain areas. Incorporating natural landscape and artificial is also a wise addition, since the majority of climbing elements are by utilizing tall trees. Tall trees tend to break or even fell down, when excessively climbed on. This would result in uncontrolled vegetation and safety issue to the leopards. Perhaps implementing artificial climbing elements (such as artificial tree or logs) that are stronger and sturdier, would create a balanced between man made and natural environment inside the enclosures. The implementation of cat fence, landscape design, artificial climbing elements can be seen in Figure 4.
Other aspects for consideration are mainly technical regarding the working environment around the enclosures. What seems to be an issue is that everything is manually handled and scattered in different places around the enclosure. For example, in order to get into the enclosure the door must be opened from above. Meaning one must go to the top of the enclosure to open it, and come back down to enter. There is also no other access into the enclosure aside from the enclosure door. This would mean if one must place something inside the enclosure (be it enrichment or food), one must first draw the leopard from one enclosure into another enclosure, so that he/she can enter the leopard enclosure manually and safely.

At the moment it is not a big issue, there are multiple keepers that can help each other in doing so. However, it is advisable to create a system to make the working environment a much efficient and less time consuming. This can be exemplified regarding door entry, perhaps a pulley system can be implemented at the exact location of entry. By doing so, a keeper can pull the pulley lever to open the door as he is entering the enclosure; instead of opening the enclosure door at one place, then go to another place to enter it. Other aspect regarding enclosure entry, perhaps it would be more efficient if a keeper doesn’t have to go inside the enclosure so often. For the purposes of hanging meat as food enrichment, perhaps a small sliding window opening can be placed either on top or the side of the enclosure. This way a keeper would only need to open the sliding window to hook meat on to a rope and hang it into the enclosure, without needing to get inside the enclosure.

Aside from technical recommendations, another possible aspect for consideration is regarding the enclosure’s aesthetics. The barrier of the enclosures consists of a plain concrete wall midway, and a metal mesh bar all the way to the top. Perhaps it would be better to create a finishing to the wall, that suits appropriately the natural environment. Instead of a plain concrete wall finishing, perhaps it would be better to implement rock texture. Other enclosures for different animals within this rescue center has implemented wall finishing in that manner, therefore it can be done with this leopard enclosure as well. It is understood however that this is a newly built enclosure, hence there are still on-going process regarding certain aspects of it. It can be agreed upon that improvements as discussed would make a great addition to the enclosures, in regards of efficiency and aesthetics.

5. Conclusion
There are three individual rescued Javan Leopards at the Cikananga Wildlife Center, housed in a newly built enclosures that are suitable as a leopard rehabilitation facility based on referred criteria. Two leopards showcased stereotypical pacing, with total amount of them committing it is only three times during the entire four weeks of observation. The leopards generally showcased normal behaviours and due to the low occurrence of stereotypical pacing, hence it can be assumed that these
occurrences is responds to external influences rather as confinement stress. Although the rehabilitation facility is considered to be suitable, improvements are still regarded as necessary.

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