# Sustainability Innovation

# Designing A Utility, Biodiverse And Aesthetic City Garden

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# Summary

# Identify the Challenges

1. Biodiversity

Rapid urbanization has turned many natural ecosystems into city ecosystems, which is relatively fragile and unstable. Especially in a place like Shenzhen where natural disasters occur frequently.

In Shenzhen, 4.2 typhoons landed annually, and under typhoon Shanzhu's influence, there are 628 trees fell only in interior Longhua district. Thus, increasing plants' diversity, which has a direct relation with biodiversity, is essential for the automatic repairs by ecosystems.

Meanwhile, a shortage in biodiversity cannot withstand the pests. According to an interview we done to a gardener in Shenzhen Talent Park, he said the main method they used to control pests is pesticide, excessive pesticide can kill any pests. However, overusing pesticides may speed up pests' process of tolerating pesticides and in a monotonous ecosystem like Shenzhen, a outbreak of pests is devastating. Thus, to increase the biodiversity in order to increase the ability of self-repairing is essential.

Likewise, the lack of biodiversity can ease the occurrence of exotic species invasion, which may cause some irrevocable contributions, and the approaches to handle it will cost government and taxpayer a lot.

2. Maintenance

Once the garden is opened to visitors, it would, almost inevitably, fall into a temperate entropy and chaos. We there face the challenges of pest invasion, flower lands sprawled with fast-growing grasses, litter occupying the rubbish bin and playground we've built for children. Apparently, the consequence of not having a fitting maintenance system would make the ecosystem fragile and less sustainable, no longer viewed as a place for recreation, but another waste disposal ground.

To conclude from above, during construction of this unique city garden, one of the focus our crew should take notice of is build our specialized maintenance system. Our crew aim to provide such a thorough and economically feasible plan to make full use of city garden. Among the work to be done to make our garden remain in good health, the drainage system, invasion of pests, weed, litter generated from residents and tourists are four major concerns.

3. Vegetation coverage

Shenzhen is facing several challenges about vegetation coverage: saturated forest covered area and carbon deficit. First, Shenzhen has a forest coverage rate of 40.04% in 2017, which is in the middle of harbor cities in China. Since the red line of

ecology of Shenzhen is 50%, areas that can't be used to plant trees in order to preserve its own natural habitats, Shenzhen's forest coverage is already saturated on the large scale, now we should focus on improving efficiency of trees and planting trees in small scales like city garden. Second, though Shenzhen has a decent vegetation coverage rate, but the contents of water areas, forests area, grassland and crop land are stable and population of Shenzhen, which indicates carbon emission, is increasing. Thus, our eco-carrying capacity is actually overloaded by massive daily carbon emissions, this causes carbon deficit, which means city's ecosystem can't balance the city's activity.

## 4. Sports use

With the development of urban areas, fewer and fewer land can be used for sports use, especially in mega-cities like Shenzhen. Because of the extremely tightness of land resources, there may not have sufficient areas for us to design a city park that covers relatively large area for citizens. However, at the same time, constructing a park that could reach as much people as possible is our priority.

Besides, from our interviews toward diverse groups of people, we found that the ineffective combination of functional and structural planning is a challenging issue that we have to solve. Many interviewees told us that the sport equipments in the park are sparse and hard to find.

In addition, meeting different ages of people's need should be under concern, including elderly people, teenagers, middle-aged, and specific groups of people's demands and interests, whereas It is hard to cover as much citizens' need as possible when we are considering adding whichever the instruments of the city garden.

Moreover, safety concern should also take into account. Lack of enough preparation work is dangerous for the garden users, especially among the vulnerable groups such as children, elderly people, and special groups of people. Despite this, the insufficient light alongside the road at night also contributes to the potential danger of exercise at night.

## 5. Relaxation

In order to maximize relaxation, the city garden needs to overcome the challenges as follows: the garden needs to be very carefully designed by planting plants that are proven relaxing and purchasing recreational facilities; it also requires many workers to put much long-term effort into purifying water and reducing the amount of mosquitoes -- considering that Shenzhen is a city with long rainy season and is occasionally under typhoon, these problems are quite challenging.

Besides, the location of city garden is also tricky, it's hard to choose an appropriate place for all social groups to enjoy and to relax since life traces of different social groups are different, thus their needs of city gardens' locations are different.

## 6. Comfort and convenience

It's hard to satisfy people's diverse needs and expectations of a city garden. According to an interview we done to old people, they suffer a lot from stairs in city gardens, which are exhausting for old people. However, stairs provide a convenient way to exercise for young people.

Besides, Shenzhen now seriously lacks parking lots. According to our survey, 75.5% interviewees think Shenzhen parks need more parking lots.

Finally, an increasing number of young people have no incentive and time to go outside. According to our interview towards kids, they have less free time and would rather spend those free time on internet instead of hanging out to a city garden.

## 7. Special purpose

In most gardens in Shenzhen, pets especially dogs are prohibited to enter. It is inconvenient for people who keep one or more pets (especially dogs) because there is no empty space of grass but the gardens. Therefore, the ban of pet's entry in the garden leads to abandonment for pet keepers playing with their pets during their leisure time. However, pets would egest while visiting the garden. Excess pets waste may cause difficulties for cleaning and maintenance of the gardens. It would not only bring negative impact to the appearance of the garden but also burden for cleaners in there.

All junior and senior high school students have their compulsory work—volunteering for communities. But it is hard for them to get a chance to do volunteer work because the supply of that is much smaller than the demand. So, new gardens can afford much more job opportunities for students. For example, maintenance work for garden such as the pruning for bushes and picking up plastic and garbage could all be done with the help of volunteers. Nevertheless, it may cause some troubles in garden management. The sector of garden should scheme and organize these activities and count the number of participants of activities. In addition, it may have effect to the work for employees in the gardens.

📄 采访
📄 问卷星调查
📄 对老人的采访

# Identify a Root Cause

Our group divides all causes of problems in to two main categories: limited natural resources and divergent human needs. With these two main types, a city garden with a harmony between humans and nature in mega cities like Shenzhen is resulted. (Though previous judges think we should put our emphasis on second, more important root cause, lacking any part of this full image makes this incomplete and not comprehensive.)

1. Mismatch between the huge population and the limited resources in Shenzhen. Shenzhen, famous for its inviting climate, remarkable scenery and being full of youthful vigor, has welcomed people from all over China and even the world, and become one of the most populous cities in China, with over twelve million people in total. Yet the area of the city itself does not quite meet the standard of "ideal" to serve such a large population, which leads to carbon deficit and exorbitant housing prices. Thus with its dense economic activities -- you could often see a whole avenue with high-tech companies on both of its sides, and there is a busy shopping mall every few blocks -- there would be a high opportunity cost of using even just a square inch of land for a little green space. Besides, while the afforestation rate in Shenzhen is about 40.04% in 2017, and the ecological redline being 50%, the green coverage rate is almost saturated. These factors makes improving the green coverage rate (which constructing a city garden most certainly would lead to) extremely challenging.

2. The wide divergence of needs among different social groups.
Once a public facility planed setting up, its functions design should be reasonable for a wider social groups. That means these functions should fit people requests, and they all should be feasible. However, it is impossible for designers to satisfied all people's requirements. The designers of the facilities have to trade off, and beyond that, designers must have sane choice.
We have interviewed people from different economic class in Shenzhen, from a cleaner in a small community to a supervisor to a big enterprise. Predictably, they offered diverse opinions on our design of city garden. Their requests some are similar and some are disparate. Some of them asked for employments, but some just only wanted recreation. They all had distinct thoughts on how we should design the garden, and what thing that we can set in it. In addition, with their dissimilar demand, they all had their own suggestions for us. Obviously, how to utilize their advice reasonably is a big challenge for us. We should balance their needs and make several decisions. Meanwhile, we should also focus on feasibility for our

decision in different perspective, for instance, what impact of our decision would be brought to the ecosystem of surrounding environment, or the whole area of Shenzhen, and how about the communities nearby.

# Generate Solutions

Plants design:

For the herb and shrub layers, we want to add some flowering plants to make our city garden more colorful. The first flower we consider is the Frangipani. This kind of flower is usually seen in white with a yellow center, but are also available in many hues of pink, orange and yellow. And frangipani thrive with little care, but will benefit from food and water in the summer months. Plus the lifespan of this kind of flower is quite long, so the maintenance cost of it is not high. The second kind of flower is Jacaranda. The flowers of it is purple and blue and they brimming the branches when the spring has come. The flowering time of Jacaranda is often last for two months. Also make sure you have enough space. These plants grow to a height of 10 to 15 metres, and their spread can be equal to their height. The third one of the flowering plant will be the Bird-of-paradise, the split leaves give this flower's morphology as a bird. They are able to withstand full sun, drought and neglect and still send out beautiful orange and purple blooms. When given a bit of care they thrive, and can be an amazing asset to the subtropical garden. Thus the cost of maintenance is low. Although the flower only blooming for two weeks, a healthy, mature plant can produce up to 36 flowers spikes each year. In ideal conditions, plants can bloom year-round. And the lifespan of it is for 5 to 8 years, so we have to prepare for some additional plants to replace it after it die. The last plants I choose for the flowering plants is the Royal poinciana, it is often higher than 20 metres. The red flowers of it cover this attractive tree in November and December. These trees quickly grow to a medium size, with a canopy that spreads attractively outward. But this kind of tree is susceptible to borer and fungus attack. Thus the caring cost is not low.

Biological pests control:

In order to control the balance of the biodiversity and the order in the parks, we can utilize a special technic called biological pest control. Biological control, bio-control, or biological pest control is a method of suppressing or controlling the population of undesirable insects, other animals, or plants by the introduction, encouragement, or artificial increase of their natural enemies to economically non–important levels. Those organisms used to keep up the governance of the area themselves are not only predating insects and pests; they also fit into and well cooperate with the operation of the whole environment itself.

One way of bio pest control is to introduce the natural enemies of the pests and excess organisms in the area. There are many examples of successful classical biological control programs. One of the earliest successes was with the cottony

cushion scale (Icerya purchasi), a pest that was devastating the California citrus industry in the late 1800s. A predatory insect, the Australian lady beetle or vedalia beetle (Rodolia cardinalis), and a parasitoid fly were introduced from Australia. Within a few years, the cottony cushion scale was completely controlled by these introduced natural enemies (Metcalf et al. 1973). Damage from the alfalfa weevil, a serious introduced pest of forage, was substantially reduced by the introduction of several natural enemies like imported ichnemonid parasitoid Bathyplectes curculionis. About twenty years after their introduction, the alfalfa area treated for alfalfa weevil in the northeastern United States was reduced by 75 percent (Metcalf et al. 1973). A small wasp, Trichogramma ostriniae, introduced from China to help control the European corn borer (Pyrausta nubilalis), is a recent example of a long history of classical biological control efforts for this major pest. Many classical biological control programs for insect pests and weeds are under way across the United States and Canada.

However, the introducing the natural enemies into the environment is not the best way to take control; that's because the subsequent operation of those organisms are not pretty easy. The best way is to find out plant like common nepenthes or plants that have smell to expel insects. What's more, to keep the biodiversity as far as possible, we can divide the park into several parts. For example, the part with most plants and least visitor can allow insect to live in so neither human nor insects will affect each other.

1. The drainage system can be done with the Shenzhen government. This is mainly because that the government used improve its drainage system all year round. So the government must have a lot of experiences of digging up the roads and arrangement.

2. The examples of Cordate telosma , lavender , common nepenthe , and geranium. Those plant all have the ability to expel insects. However, some of them are not really suitable for the environment is this city. Shenzhen is always rainy, and typhoon is also a patron to Shenzhen. So plants like common nepenthes can't be placed in Shenzhen due to its special appearance. What's more, plants like Cordate telosma might do harm to human with its fragrance. So we have to set them away from people. Arrangement below can help planting these plants appropriately. What's more , the subsequent caring for those plants are also convenient because workers actually have special tools to help them do the work.


Drainage system:

In order to derive the primal solution to decrease possible surface runoffs and collect valuable water resources, effectiveness and feasibility have been taken into consideration.

The two-layer floor operates as the method mentioned in the following: The first layer contains multiple pores to allow rainwater infiltrate, and the second layer has a certain incline to drive the water into the city's sewer system. This two-layer,

sponge-like floor design could effectively help our city garden to prevent root system necrosis in plants. Later, the saved water could be used to accomplish multiple tasks including watering plants in the garden and all sorts of activities. The design has theoretically proved itself effective to deal with water retention and water runoffs in the city, something that has been a headache for experts for a long time.

Despite its effectiveness, budget cost is also under our concern. Through planning and investigation, our crew are certain that this kind of two-layer floor is economically feasible. The cost for such floors would be only adding another layer of floor tile, and not to mention the cost saved from unnecessary artificial cleaning and the water resources saved to water plants. In the long run, this kind of floor design may even bring profit to the city garden.

Flooring design:

1. track design

Considering the hard work for sustainability of our city garden, we choose to design a park that could somehow maximize the utility of the park with limited places and resources. Building up green way is an effective land saving method for constructing an urban garden. Concerning the fragmented design and large population of the central of Shenzhen, green way can serve as not only the green linear space which demand less area, but also the stabilizer which ensure certain places for people to running or jogging. From our polls online, we found that running or jogging are parts of the most universal types of sports among the voters.

Therefore, in our model of the future city park, we decide to design a specific kind of green way which is made up by the combination of elastic rubber particles. Constructing the road in this way, we could produce environmentally friendly products that function ventilation at high temperatures. Additionally, considering its durability, this kind of plastic track can be used all day long with good elasticity, good impact absorption, good compression resistance, good wear resistance, flat adhesion, strong durability at the same time.

Besides, compare to other fitness area in the city, its integrated and continuous design can better meet people's need and attract them to establish healthy behaviors easier, especially in those dense areas.

2. green way materials

In order to ensure the ability of the city garden to provide constant good services sustainably for users in the near future, we consider to use some specific species of materials to constitute the road of our city garden. We choose pebbles and preservative-treated timber to construct the road of the garden. Wood is the only renewable primary construction material. In terms of energy consumption, greenhouse gas air and water pollution as well as ecological resource mining, wood layout is far superior to brick and concrete layout and steel layout in environmental protection, making it a globally recognized green construction. By mixing

preservative-treated timber with pebbles in the design of the city garden in sequence, we could combine aesthetics and pragmatically values to establish a modern city garden.

In one hand, after special anti-corrosion treatment, the timbers obtain the capability to prevent corrosion, insects invasion, and the risk of deformation after long term sunlight exposure. In this way, they are easy to maintain and preserve for longer time, and environmentally friendly to the environment and suitable for the city garden with large potential groups of users including the elder people and children. Additionally, for the sake of wood's breathable and porous attributes, they are the proper materials for constructing the road of the city garden.

On the other hand, using pebbles have aesthetics appeal that make the garden more attractive.

Parking lot:

The problem that most city gardens in Shenzhen, especially the popular ones, have insufficient capacity to accommodate all cars coming at the same time, was suggested by many respondents of our interviews. This may be a potential cause for traffic jams in the particular area, and making residents unwilling to go to that garden.

What we plan to do to solve this problem is, build a multi-storey car park on the ground.

The main reason we chose this instead of underground parking lot is that Shenzhen is a city with intricate underground metro system, especially in densely populated neighborhoods, where we plan to build our city garden. This makes building an underground parking lot extremely difficult.

For the first floor of the multi-storey car park, we plan to use it as a book-bar or cafeteria, with soundproof glass walls so that people can enjoy the view without the noise of the cars going by. Being built next to the only way out of the parking lot, this could also stimulate spending.

Stray animals shelters:

In order to solve the problem of homeless animals that is currently existing in the society. Our group plan to set up a special area in the park for taking in homeless dogs and cats. We will divide the area into to spaces, one for the cat and one for the dogs. Every animal (family)will have their respective spot—a cage for them to sleep at night. The size of the cage depends on the number of animals that live in it together. The animals would only be required to kept in cages at night, they can move freely in the special 'animal area'. Moreover, the dogs are only taken out for walk in the park in special time period everyday with dog leash holding by the keepers.

About the regulation of the area, the park would recruit special employee to take care of the animals and to clean the area they live in. We can also incorporate the

element of volunteer services in taking care of the animals. People can come help with taking care of the animals and earn corresponding credits.

Volunteering work:
A reasonable arrangement of working time for volunteers and workers is significant. Volunteers and garden employees can work alternatively so that it could attain the best possible of labor. For instance, volunteer could work in the garden on the day off for garden employees. Additionally, some maintenance work for garden such as the pruning for bushes and picking up plastic and garbage could all be done with the help of volunteers. If there are activities held in the garden, volunteers could come and help as well. The organization of voluntary can contact with the managerial sector in garden so that they could record volunteer hours.

# Identify the Criteria

1. COSTS

Do the expenses (constructing and maintenance's fee) and opportunity costs of this design match the utility (convenience, biodiversity, satisfaction) it brings? When designing a project has a cost as great as a city garden, the cost performance is the top consideration. The cost of a city garden has two aspects, one is direct cost, the construction fees and maintenance fees, another one is indirect cost, as known as opportunity cost, the opportunities been given up in order to construct our city garden. The first aspect is relatively easy, it judges the price of the raw materials and other capitals. However, in a highly developed city like Shenzhen, every Acre of land can either be home to thousands of people or brings a great proportion to our GDP. Thus, we will try to avoid that our city garden takes the space of next Tencent company, we will rate each solution's location requirement and other limited resources requirements, specifically, a solution's ability to be compacted in a small land.

2. SATISFACTION

Does the design satisfy multiple needs of a wide range of social groups and a large number of people?

According to the design thinking, satisfying all users' needs is our top goal. After all, a city is paid by taxes collected from citizens and therefore should be designed for citizens. It's actually hard to define the users of a public facilitate like city garden, they can be anyone! We did a survey to people we can get contact to, and then did some interviews of people from different social groups, including children, old people, collar workers, engineers, sanitation workers and public security, we will based on their needs to determine how many needs and how specific this solution satisfies.

3. ENVIRONMENT

Does the design help with the city's biodiversity, environmental stability or environmental friendliness?

Considering we are working on an environmental project, the contribution of a solution to the city ecosystems is a decisive factor. We divide all possible benefits a solution can offer into three big categories: biodiversity, environmental stability and environmental friendliness. Biodiversity is for the number of species a city garden has and how good a city garden can perform as a city habitat. This category is the most obvious factor. The second indicator is environmental stability which rates how a city garden can help increase the resistance of a city when facing disasters or

even catastrophes. In a city having much environmental challenges such as typhoons, floods and storms, this category is important. The last indicator is environmental friendliness, this aspect includes all other benefits such as heat island effect and global warming.

## 4. DURABILITY
Does the design easy to function normally for relatively long time period?
This criterion is the most important part in practicality. A normal phenomenon of city gardens is that after a period of time, many parts in the city garden can't function well and less people have the desire to visit that garden. Thus, we will judge each solution's ability to normally function for a relatively long time.

## 5. AESTHETICS
Does the design have aesthetic values, cultural characteristics or promotional theme?
Last but not least, we will judge one design by their aesthetic values. No matter how useful a design is, nobody is going to use it if it's so ugly that disgusts people. Since this criterion is tricky, good designers can design the most challenging solution beautiful, thus, we broaden aesthetic values to cultural characteristics and promotional theme. By this, we can evaluate each solution more comprehensive and fair.

# Evaluate the Solutions

1. A special drainage system: 6+3+6+8+3=28
One-time purchase (good durability); relatively cheap materials; help Shenzhen recovers from heavy rainfalls; No apparent aesthetical values.
2. Plants that expel insects: 6+6+7+7+7=33
Only plants
3. Different layered plants + blossoms all year round: 6+7+8+7+8=36
Plants have life spans around 5-8 years, thus this is also a one-time purchase + high durability; relax by enjoying afforestation is a common hobby; directly increase biodiversity and cities' gene pools; our carefully designed plants roundabout is definitely aesthetical
4. Flooring materials 6+5+4+7+6=28
We use a combination of several materials to design 2 types of floors, which save money; According to our survey, only a small number of people clearly state that they need a relaxing floor but this design do benefit all users; our floor design has high durability but run ways need frequent maintenance; partly aesthetic
5. Volunteers work: 8+7+5+4+5=29
Absolutely low costing(based on the definitions of volunteers); doing something in order to help the society is a common need; Volunteering works about vegetation maintenance helps with environment; not easy to keep functioning since demands are unstable; Contributing to the park's promotional theme
6. Parking lot: 7+8+2+6+6=29
This service will charge a little and it satisfies Shenzhen citizens top need according to our survey though constructing a sophisticated sky parking is high costly; No clear correlation between it and the environment (it's above the ground thus helps reduce subsidence); book bar helps with cultural characteristics.
7. Stray animals' shelter: 6+5+6+6+7=30
Food and drink for stray animals are highly costly but donations are expected; Shenzhen now deadly needs a stray animals shelter, many people care about these small lives; Helps with homeless animals thus is bio diverse; volunteers are expected; contributing to promotional themes

📄 evaluate the solutions

# Make an Action Plan

1. Design Phase

1.1 Scope meeting

Before our planning and construction, the park department will gather all the representatives of potential stakeholders and schedule a meeting. (e.g. nearby residents, government officials, people working nearby…) The meeting is aiming to know the residents' will and thoughts better, and to determine the essential parts and priorities of the construction.

1.2 Risks Assessment

After the scope meeting, the park department will identify an initial constructing design plan. The department of external connection will then contact experts to assess our initial plan. Further modification can be made if necessary.

1.3 Design

After risks are assessed by the expert and the design plan was modified. Our design group will carry out the final design plan, which we would also invite architects for assistant.

1.4 Approvals

After carrying out the plan, we need to receive approvals from ppl. By using 3D modeling matching with VR technology, we would provide our representatives of the public a rough picture and experience of the park. We will also send out reports to government officials to receive government approvals. (The report must contain our 3D diagrammatic figure, and our initial constructing plan, and also our result of potential risk assessment conducted previously by the experts.)

2. Ore-construction plan

2.1 Establish a manager group

In order to implement our plan and make sure the final park is going to be well-functioning to all levels, it's important to establish a manager group first, supervising all works and inviting professional advisors about bids, measurement, investigation, laws, taxes and insurances.

2.2 Inviting for bids

Since it's impossible for a single company to build an entire city garden, inviting all related companies for bids is important. We decide to use public bidding and

corporate with professional construction company and professional tree planting company. Companies will make rough plans and we can then sigh contracts.

## 2.3 Licenses Application

Application for different licenses are important for both safety and legality. For early approval for designs, we need to apply for land use certificates, constructive units' application, earthquake department's advice and approval, fire department's advice and approval and validity of other programs about money and supply for workers.

## 2.4 Engineering investigation

Then constructive company should do some engineering investigation about the land ; tree planting company will investigate the environment to decide how to plant vegetation which can survive long. Constructive companies may consider problems like influencing residents, soil removal, specific locations (like whether it's close to metros, schools or hospitals). Though we do not decide a real-life location for our city garden, but it is supposed to locate on a crossroad, thus, traffic problems following blocking that crossroad should be considered.

## 2.5 Construction plan

Having a comprehensive understanding of the city garden, the constructive company then is able to make a construction plan, explaining with details how they are going to build this city garden, including demolition, clearing land, humping spare land, drainage systems, paving pathways, building sky parking, playgrounds, and stray animals shelters, and constructing overpasses. Besides, arrangements of workers should also be listed, like their temporary shelters, their foods and drinks. After finishing facilitates construction, vegetation will be planted. A good construction plan can avoid most troubles during construction.

## 3. Construction
## 3.1 Construction

The details are listed in construction plan. But there are still important measures to take during real construction. First, the construction should be on only from 8 A.M to 7 P.M in workdays since our park is going to be placed near residential areas, most people stay at home during workday nights, weekends and summer, winter holidays. Second, there are always potential problems during construction, thus, having an emergent department in charge of sudden problems can help.

## 3.2 Experimental debugging

After finishing construction, careful debugging must be placed, otherwise, serious problems may cause uncontrolled problems. This should include these basic aspects: first, methanol remaining, which is harmful for human bodies; second,

sturdiness of stray animal shelters' cages, if stray animals break out, then the whole residential area will be in a mess, not to mention possible diseases on homeless animals; third, the quality of sky parking and overpasses, this is the most important factor, if a sky parking collapse, then consequences are devastating, may cause people lose their lives. Thus, professional measure companies will be hired to rate the sturdiness of built sky parking, animal cages and the overpasses and the level of methanol remaining.

## 4. Maintenance

### 4.1 Completion acceptance

After constructive companies make sure the city garden is already well finished, they pass the city garden back to us, we then pass city garden to government departments judging whether they are qualified. Government's evaluation includes traffics, fire safety, earthquake safety and other major factors. Finally, we make sure the city garden is well finished. And we should invite examiners to rate vegetation's' conditions. Till now, the construction is officially stopped.

### 4.2 Financial settlement

Then, we should document all profiles and contracts. Finally, bureau of finance will appraisal the completion bill and pay all companies. Urban construction archive bureau will put this construction on records.

### 4.3 Undertook by administrative department

Administrative department will undertake the finished city garden and does a trial operation. If the result turns great, the city garden is going to be put into real operation.

## 5. Test and re-prototype

We visualize our city garden by drawing a ichnography first, but only a planar plan doesn't show enough details and may not be clear enough for users to understand. Thus, we use Mine Craft to build a three-dimensional model of our city garden (Considering the limitation of MC, many specific plants' species do not exist in the model, thus we use similar plants to replace them in this MC model. Besides, we invite some friends to help us finish this model,a technical problem. Considering they haven't participated in our discussion, some details may not absolutely follow our descriptions and planner plan.).

### 5.1 test

Our test will include three phases, internal approval, specific social groups approval, universal approval.

### 5.1.1 internal approval

Our group and our instruct teacher will evaluate our city garden according to the criteria we identified before, and discuss whether our city garden scores high enough, or whether there are details able to be improved. This can evaluate the environmental and intangible (invisible) part of our city garden which may not reveal through users' feedback.

## 5.1.2 Specific groups approval

One of the biggest feature of our city garden is its utility, the ability to satisfy a variety of needs, many details of our city garden are designed to satisfy those needs. In order to get a clear, comprehensive and deep understanding of specific groups, we will use detailed interviews to understand how our city garden satisfies their needs. "How" questions are used often in this phase of approval.

## 5.1.3 Universal approval

We will design an on-line questionnaire to see how our city garden satisfies all potential users. A large data will be obtained through this method to draw a relatively comprehensive image about how our city garden can satisfy users.

## 5.2 iteration

Considering that users may get bored and confused by small changes of different versions, we will improve our city garden by interviewing a small group of people who have high representative after the first questionnaire. Adjustments of planner plan will be made first, then comes the new MC model. Until a relatively good comments been made, this version will be the final one.

## 5.3 roll-out phase

Finally, a VR model will be presented to the public on a exhibition near the site of this city garden, this informs the future users of this city garden (A promotion).

📄 [Mind map of our action plan](#)

# Prototype and Test

## Prototype Design

1.        Introduction

1.1     Location

1.1.1   Crossroad

Our city garden is designed on four quarters of a crossroad mainly for two benefits: one is the transportation convenience; another one is the parking space provided. Our city garden specifically designs two sky parkings for car drivers to park their cars which also helps people who drive cars there park their cars, further satisfies people's needs.

1.1.2   Near a bigger park

A city garden that is near to a bigger park means a small gene pool is near to a larger gene pool, which forms a mega population of similar species connected by natural corridors and provides an extra space for visitors to relax (divide the uses of parks and gardens).

1.1.3   Near neighborhoods quarters

According to our interviews and surveys, collar workers tend to focus on their work and relax in their living communities with their families. Besides, according to our survey, 79.8% of people tend to visit city gardens during weekends and after dinners.

1.2  Regionalization

We design a city garden which includes a roundabout (flower clock), greenery garden, four individual sectors and overpasses connecting those four sectors. Four sectors have its own purpose, two are for sky parking, one is for sport area and one is for stray animals' shelter and volunteering center. These four areas satisfy different social groups' needs and utilize the land with high efficiency.

1.3  Connection

1.3.1   A run way connects four sectors

Considering that according to our survey, a large proportion of people who visit city gardens go there to stroll and joy, thus we design a run way passing all four sectors and people can pass the roads on overpasses. During one cycle, they can play skates and sliding plates in multi-use playground, look at cute animals playing and take a rest at book bars at the floor one in sky parking. This run way helps people enjoy the scattered city garden as a whole.

1.3.2   Overpasses

Overpasses can connect four parts without intervening traffic and subsidence of

nearing lands. Overpasses are really inexpensive and easy to construct and maintain, since it only needs anchorages, cables and roadways. If further regular checks are guaranteed, this bridge can sustain for a long period. Besides, overpasses are physically strong and can stand against terrible weathers like typhoons and it's concision look provides decoration space.

## 2. Garden Design
### 2.1 Plant Use
#### 2.1.1 Biological pests control
#### 2.1.2 Increase the land using efficiency of plants
##### 2.1.2.1 Different layered plants
For this, I decided to borrow the idea of the stratification int he forest. The forest floor, herb, shrub, under story, and canopy. Due the the limited resources in Shenzhen, we only focus on the herb, shrub and the under story layers, and only choose the plants that can live well in the subtropical area.
Thus, or the under story layer, we choose the fern(shield fern, cliff fern, bracken fern, filmy fern and water fern) and some fungi. For the herb and shrub layers, we choose some flowering plants, frangipani, jacaranda, bird of paradise and royal poinciana.
##### 2.1.2.2 Plants change
While considering the complexity of the changing of the plants, we diced to choose the plants that can reproduce quickly like the ferns or have a long life span like the trees mentioned above. We also choose the plants that can tolerant the bad climate or weather like the bird-of-paradise. Due to the frequent typhoon destruction in Shenzhen, we recommend that it is better to storage some kind o plants in some other gardens.
#### 2.1.3 Flower clock
We design a roundabout based on plants' flowering periods, which is called a flower clock. The outermost round is composed Jatropha integerrima, Catharanthus roseus and sweet chariot, they are all flowers blossom all year round, this makes sure audiences have flowers to look no matter time of the year. The next layer composes of two sets of plants, one is winter blooming set, another one is summer blooming set, and I also implant one all-year blooming flower in both sets to make sure during non-flowering period, this layer won't be too plain. The summer layer includes Zygocactus truncatus, Cyclamen persicum Mill., and Hibiscus rosa-sinensis, Hibiscus rosa-sinensis is the all year blooming species. The summer set includes Serissa japonica ( Thunb. ) Thunb., sunflowers and Hibiscus rosa-sinensis. The third round includes Hibiscus rosa-sinensis and Bougainvillea spectabilis Willd., these two plants are all-year blooming plants and this round is above the ground, thus visitors can see them far away. The center core is above the third round which is above the ground, few giant Ligustrum lucidums are planted here. This part is the most eye-catching part. All flowers mentioned above are traditional Chinese flowers, symbolizing good lucks and flourishing.

2.2 Utilities

2.2.1 Stray animals shelter

Our stray animals shelter includes cats and dogs, considering the fact that these two pets are the most common and largest in population been abandoned. There are two night shelters (sleeping cages) for them to rest at night and two separated playgrounds for each of then to play at the daytime. A trainers center, also a volunteering center, is at the middle of this sector, devides the entire dogs area (a night shelter and a playground) and the entire cats area (a night shelter and a playground). These animals are not allowed to get contacted with visitors unless they are ranked as harmless, visitors can then adopt these trained homeless animals. The daily costs of this shelter is raised through a donations. The great number of pedestrians provide enough attentions and thus, we expect funding is enough to balance costs.

2.2.2 Volunteers work about animals and vegetation

We divide our volunteers works into two categories, one is animals caring, another one is about vegetation. Animals caring is taking care of harmless animals (without contacting with untrained animals alone, unless with professional trainers), volunteers can help feed animals, clean animals' playgrounds and give animals shower. Vegetation works includes many gardening works, allowing citizens to involve in maintaining their city garden. They can trim bushes, adding fertilizers, water plants and paint anti fouling paints.

2.2.3 Sky parking

We plan to build multi-storey parking lots above ground so that we can avoid soil subsidence; and we would build them at two sides of our city garden, so that anyone coming from any ways wouldn't have to bother taking a detour. The first floor of the parking would be a café-like lounge with a whole wall of sound proof glass, enabling customers to enjoy the view of the garden outside. The building itself would be covered with vines and, of course, there would be fences on each floor. Building two parking lots benefits the society a lot - according to our survey, the lack of parking lots is what people complain about the most.

2.3 Basic structures

2.3.1 A special drainage system to deal with heavy rainfalls

In order to reduce runoffs, prevent root necrosis, and to save valuable water resources, our crew has designed a two-level sewer system to reach our objective. By laying an extra floor to the ground, the park is able to store water more efficiently and with greater ease. Construction workers will be assigned to build the extra floor panels. There will be maintenance staffs cleaning the floors periodically, reassuring the quality of the collected rainwater.

2.3.2 Flooring materials design

After investigating and researching many materials for the construction of the city garden, we choose to use pebbles and the preservative-treated timber to build up

the pathway which connects our city garden. Set them in geometric forms and distribute them uniformly. Those materials are the most environmentally friendly to some extent. For example, wood is renewable and far superior to concrete layout, which is widely accepted by its green attribute. Besides, its anti-corrosion property deserves to be recognized. The timbers can prevent corrosion, insects invasion, and deformation after long time sunlight exposure, so they are more suitable for a wide range of people, especially for the old and children. Moreover, the breathable and porous attributes of wood benefit it's surrounding a lot, and pebbles can offer an aesthetic appeal that could attract more people to visit the garden.

### 2.3.3 Rubbish control

There will be a rubbish bin every 100 square meter. Our rubbish bins are environmental friendly rubbish bin, since rubbish will be classified according to materials into plastic, stainless steel, ceramic, wooden, concrete and paper. This classification is more easily understood for citizens and easier to recycle. There will also be policies about rubbish, we will set a penalty clause, everyone who throws rubbish outside rubbish bins will be punished for 50 yuan; anyone who spills outside the specific spittoon on each rubbish bin will be punished for 200 yuan. Money collected will be paid to people who help throw rubbish into the rubbish bins and for maintenance of the garden.


To visualize our design, we make both planner plans and a Mine Crafts 3D model. Please check the attachments.


📄 ichnography of our city garden
📄 A Mine crafts model introduction for our city garden


# Feedbacks learnt from users


I. Internal evaluation:
In this part, our group does an internal evaluation to measure whether this city garden is good enough according to 5 criteria we established before.
costs: This criterion, we rate our whole city garden with 6 out of 8, because most parts of our city garden involve financial consideration design. Vegetation composes of all cheap and common plants, volunteering work has no major cost, book bar is run by parking fees collected from sky parking and our drainage system stores water to water plants. However, in order to make sure that we satisfy a wide range of social groups' needs, many infrastructures are packed into this small area, and basic constructive fees are resulted. Thus, overall, we give our city garden 6 out of 8.

satisfaction:

We give our city garden 8 out of 8, because one of our core designing principle is to satisfy as many social groups as possible. According to our early investigation, most people have emergent desire for more parking space, so we design sky parking for them. Some young people now need a place where they can read, study, play video games and do sports, some we design a book bar at the floor of our sky parking. Many people want to get involved in nature, but they are annoyed by insects and gardeners use a lot of pesticides to prevent pests, so we use biological pests control to reduce pests. Shenzhen currently has no long-lasting stray animals shelter, so we design a small animal shelter, also provide potent animal adapters a way to adopt stray animals. According to or classmates and survey we done, a convenient street sport area is really great for all people who do sports, so we design a sport place for every pedestrian to enjoy. Overall, we satisfy a wide range of social groups' needs in this small crossroad block, thus we think our city garden worths a full score in this criterion.

Environment:

We give our city garden a 7 out of 8 for this criterion, because many features in our city garden are designed to help Shenzhen becomes a more eco-stable city facing increasing natural disasters like typhoons. Our plants design, which separates plants into different layers to make every acre of land be used in highest efficiency and biodiversity (emulating rainforests), which helps city recover from natural disasters like typhoons. We also use biological pests control to make sure pests are under controlled even without pesticides use, this solves the problem of overusing pesticides and avoid super pests formation. We design a special drainage system to help water releases from soil avoiding accumulation. This prevents plants from rotten roots and store water for later use. Stray animals shelter helps save homeless animals in big cities, Shenzhen. Most homeless animals died because of lack of clean water and food, however, after our animals shelter been set, many of them can be saved and adopted by new owners. This enriches city's gene pool and enhances city populations' biodiversity. However, designing a sky parking may encourage people to drive more cars, which release more greenhouse gases and waste more energy. Overall, our cit garden is still very good for an environmental-friendly city garden.

Durability:

We give our city garden 6 out of 8 in durability, because most designs have specific considerations, but some inevitable designs are not long-lasting. Our runway uses special woods which are avoid rottenness and damaging to increase its life span. Our drainage system is highly sustainable, it can function well for a long time with little maintenance. Volunteering works are especially hot because schools' requirements, thus, an always high demand helps keep this section function well and long. But vegetation has natural lives spans, and replacing them with new generations require lots of money. Thus, overall, our city garden gains 6 out of 8 in this criterion.

Aesthetics:

We give 7 out of 8 in this criterion, since our city garden has aesthetic values, cultural values and promotion themes. Our vegetation species choose is beautiful and having matching colors. Our volunteer station represents Shenzhen spirits, "if you come, if you devote, then you are Shenzheners". Our animals shelter contributes to our city garden's promotion theme, an humanity care for all species. But considering aesthetics is still a subjective word though we broadens its boundaries to reach a more comprehensive definition of it, our group decides not to fully use our own understanding, we rate 7 out of 8. (further quantitative research results are expected.)

II. Qualitative feedback

1. Car parker:

We interview Mr. and Mrs. Chen, two high Tech companies workers, having needs for parking, for their advice of our sky parking. Here are some quotes from their interviews(translate from Chinese by our group):

①. The design seems not reasonable to support the weights of the entire floor and cars.

②. Though sky parking does provide space for parking, our sky parking does not maximize land use efficiency, besides, parking there is not convenient .

③. The entrances and exits arrangements are not reasonable, putting two at the same direction of our sky parking may cause jams.

2. Strollers and relaxers:

We interview one financial worker whose company is currently working on a park program. Here are some quotes:

①. Some people may not choose to walk besides big sky parking, or main streets.

②. These four greenery are relatively small, walking from one to another, people need to use overpasses, which is inconvenient for old people or disabled people.

③. In our geometry design, the size of our city garden is linked to the length of roads. However, longer the roads are, more noises, waste gases and lights are resulted.

3. Animals shelter and free pets moving area

We interview a pets raising classmate and three other dogs raisers for their opinions on our designs.

①. A pet raiser classmate, Zhang: "It's really regrettable when I visit beautiful and decorated parks but I cannot share those with my Lili (her dog)".

②.Mrs. Yu, a dog raiser: "Though I would really love to adopt a homeless poor dog instead of buying one, but I still think it's not humane to randomly catch dogs to cage them with your own values and deprivate their freedom".

③.Mr. Zhu, a dog raiser: "Raising energetic creatures like dogs, a large open space is necessary. Especially after a day of hard work, playing with excited dogs in small

apartments are exhausting."

III. Quantitative feedback:
We design an on-line questionnaire to see people's reactions to our prototype. 87 people fill this questionnaire, including many social groups, students, teachers, collar workers, engineers, gardeners etc.
1. According to our survey, 72.41% people think our city garden satisfies their needs to a certain degree.
2. In our questionnaire, 43.68% people think their needs to stroll and enjoy nature are satisfied, 20.69% people think their sport needs are satisfied, 18.39% think their needs to park cars are satisfied and 10.34 think their needs to sport are satisfied. (6.9% choose other needs types).
3. According to our survey, 88.51% of people think they would like to visit this garden in their free time.
4. In our questionnaire, 63.22% of people choose to visit our city garden 0 to 2 times a week; 22.99% choose to visit 3-4 times; 13.79% choose to visit more than 5 times a week.
5. According to our survey, 78.16% of people think this kind of highly compacted pocket garden is going to be a further trend in city gardens design.
6. In our questionnaire, 73.56% of people think this city garden is able to help Shenzhen become more environmentally stable facing natural disasters like typhoons.
7. According to our survey, 64 people from 74 who are financially independent think this city garden is worthy of taxes they pay.
In our questionnaire, 63.22% of people think this city garden has high aesthetic values.

# Improvement for next iteration

According to feedback we gained from users, we establish an iteration plan.

I. Coherent design
Our city garden's sections are all scattered and not coherent, though we connect them by overpasses, it's still inconvenient for young kids and old people to climb many stairs. Besides, the sense of isolation still exist. Thus, considering advice from one of our interviewer, financial worker Mr. Wu, moving roads underground and fuse four independent sections together. Then, constructing a man-made lake at the center of our design.

II. Children facilitates

We did not include recreation facilities for children, which most city gardens do. Originally we planned to place the children's park somewhere inside or near the gym. However, as this is designed as a general and basic plan for the park, and that there are no corresponding facilities found in Minecraft, we did not include this anyways. For further improvements, we could move some of the facilities for adults and make them somehow denser and make space for the children, or we could simply place them somewhere outside of the gym.

III. Sky parking design
According to Mr. and Mrs. Chen we interviewed, our sky parking buildings still lack significant land use efficiency. To solve this problem, we build an iteration which arranges parking space slant, help maximize our use of lands, also convenient people to park cars here. We also decide to place exits and entrances at different side of our building, this avoids jams caused by same side exits and entrances.

# Team Credits

周子期 Ziqi Zhou / Team leader
I held all on line group discussion (over 15 hours), including preparing materials and following up processes (Deliver all information about IS project and interpretations and requirements of each parts of our paper to my group mates). I separate the garden design into 8 lines, and assign each of them to one group member. I assembly the entire paper and polish it. I help design drainage system, biological pests control and sky parking. I complete two main root causes, five criteria and their explanations, explanations of evaluating the solutions, action plan and the overall design and details of the city garden prototype. I also interview children for their expectations and needs for a city garden. I narrate our Mine Crafts model video and finish Feedback from users and Improvement for next iteration.

周可洋 Keyang Zhou
Keyang Zhou did some researches on existing garden design, and analyzed them in-depth. Besides, she also investigated some specific groups of people who provided valuable information for the degin of the city garden. She planned the design of runway and investigated some established cases in Shenzhen individually during the pandemic. She took part in every online meetings and shared many valid and testable ideas during the research. Additionally, she wrote down part of final draft of solution and action plan in the project.

陈思言/Chen Siyan
The designer of overall ichnography to the city garden and graphic design of each part. I am in charge of writing voluntary part in the paper.
Some interviews are done by me about people's point of views (adult workers in different occupation) on the city garden before we design. And I interviewed some people about our design of parking lots.

陈可 Chen Ke
I am responsible for the chosen of the plants species for how to increase the biodiversity and the tenacious of the Shenzhen city ecosystem.

廖庄苡 Zhuangyi Liao
She participates in our planner plans design. She is in charged of sky parking designs. She actively participates in all group activities.

吴雅涵 Yahan Wu

She designs the first on-line questionnaire. She helps design our pet shelter. She engages in our first interview to old peopel.

柳博文 Bowen Liu

He is in charged of our Mine Crafts design. He designs our biological pests control system.

邹妤 Yu Zou

She designs our drainage system.

# Judge Comments

" Review Comments:

I applaud the team for a well-researched and comprehensively done project, including excellent visualizations and plans. I really appreciated reading this line in your report - "After all, a city is paid by taxes collected from citizens and therefore should be designed for citizens." It was good to see the team bringing in the diverse range of potential users as well as safety concerns from inadequate lighting in public space but it was unfortunate to not see subsequent discussion on how these concerns were addressed in the design.

I like the detailed mind map and the description of the proposed action plan. It is very well thought through. Consider using the modeled plan (Minecraft etc) to happen well before the end of the design phase as it allows the team time to turn around design changes much more quickly. Typical projects proceed to the other stages only after the design has been sort of finalized (for instance, who you want as a manager will depend on whether you are building a MLCP (and the type of design elements going into it))

It appeared that the solutions strayed from the original goal to improve urban biodiversity by catering to everyone's needs. By trying to accommodate everyone, the project might have reduced the quality of the core offering.

I want to highlight two additional unconnected points from the report that would benefit from more research. I would have like to see examples of cases where donation funded activities have proven effective in the long term. This would have given more validity to the analysis of the animal shelter. The idea of natural corridors are not very relevant in urban settings, especially at the scale we are currently discussing (smaller parks with large urban areas around it)

There are some very valuable insights in the surveys you have done. I like the fact that iterative improvements have been considered and described further.

It is worth thinking whether every public demand needs to find a solution in your design. For instance, there is enough research to suggest that car parks actually make congestion and traffic worse – instead gardens could be considered/built in a way that benefits people in a relatively small area. And they can either, walk, bike or take a public transport option to get there. Or another option is to integrate gardens into areas that are already near existing car parks.

Overall, I like how the team has approached this problem and encourage them to apply their critical thinking skills on this (and other similar social problems). Good luck.

"