

Methodology for Sustainable Development of Eco and Zero Carbon Cities

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Abstract – Sustainable development is considered the main factor for setting eco- cities. Different interactive relationships between the main elements for sustainable development and the actual situation of the different cities were taken into consideration at this study. The main objective of sustainable development is, how to meet and achieve the required standard specifications of eco –cities in urban planning. A case study was conducted for two cities, the first one was Masdar city in Abu-Dhabi, Emirates and the second was Gangneung city in South Korea. This study discusses the methodology of turning the existing cities to green cities by applying the main requirements and standards of the green cities. These requirements are based on physical, economical, social and environmental aspects. Turning the existing cities into green cities may be achieved by maintaining and developing the available natural limits and resources. Economical studies are based on different factors such as, standard of living and land values. Social studies included the size of community, rates of unemployment and illiteracy. The environmental studies included water resources, renewable energies and natural topography of the concerned cities.

Keywords: Sustainable development; Eco-cities; zero-carbon cities; Green cities.

I. INTRODUCTION

There are a lot of cities suffers from high levels of pollution which it is considered a huge problem. The main objective of this study is how to overcome this problem by applying different methodologies. The obtained results considered the main outlines which enable the urban designers to set up eco-cities. These objectives may be achieved by determining the required standards for green cities, using renewable energies also by studying the different experiments applied by different countries related to this issue. There are some questions need to answer:

- What are the standards required to design green cities?
- What are the advantages and disadvantages of green cities?
- What are the main requirements that must be in the eco cities?

II. METHODS

The main objective of sustainable development is to achieve the required standard specifications for eco-cities in urban planning. This study applied the historical inductive methodology to get the recommended requirements for eco-cities. Analyzing available readings and data enable researcher to satisfy the required standards for urban planning of eco-cities.

Using descriptive and analytical methodology helps the urban designer to study both the international and Arabic experiments for designing eco-cities. The main objective of applying this methodology is to maintain and preserve the sustainability of the concerned cities in the future. Applying comparative methodology helps the designer to compare between the existing experiments to get the required and ideal standards for turning these cities into eco-cities. Deductive methodology may be used after applying the previous methodologies to satisfy the main principles of sustainability. The interactive relations between main elements for sustainable development and the actual situation of the different cities were considered in this study. There are three types of green cities, the first type is eco-city, the second is sustainable city and the third is low carbon green city.

The concerned methodology studied two cases, the first one was an Arabic case and the other was an international case. The study gives a modifiable and applicable methodology required for any existing city. Fig. 1 illustrates the applied methodologies

in this study. The main conditions of green cities are shown evidently in Figure 2. While Figure 3 presented the typology of green cities.

A. Final Methodology for Eco-City Planning

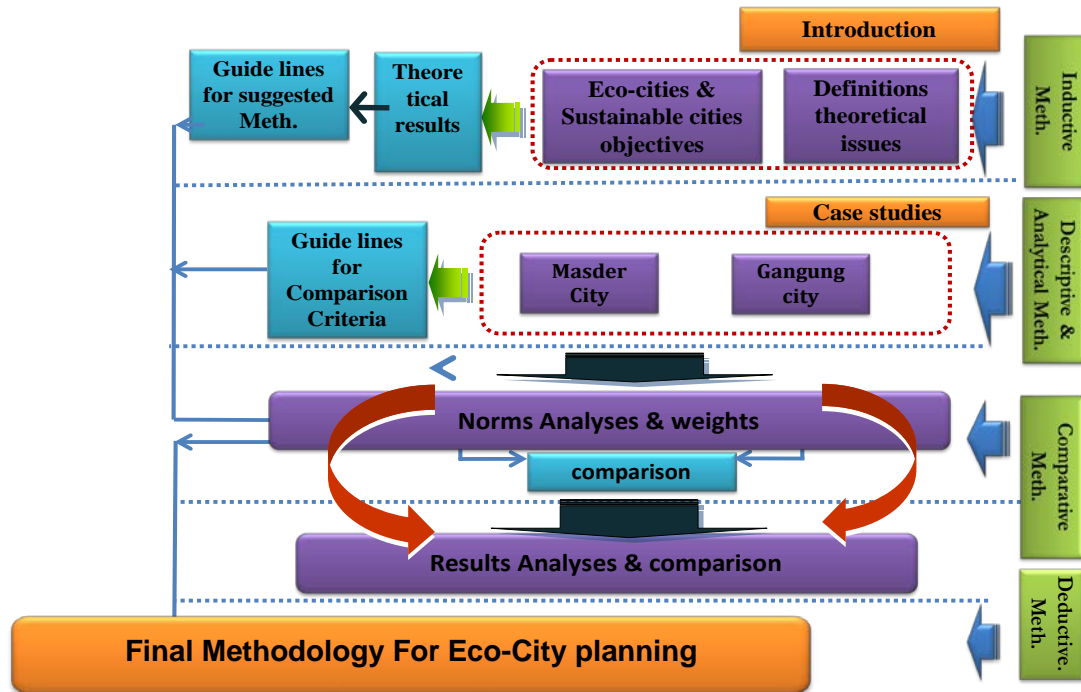


Fig.1. Final methodology for Eco-city planning

B. The Main Required Conditions of Green Cities



Fig.2. The main conditions of green cities

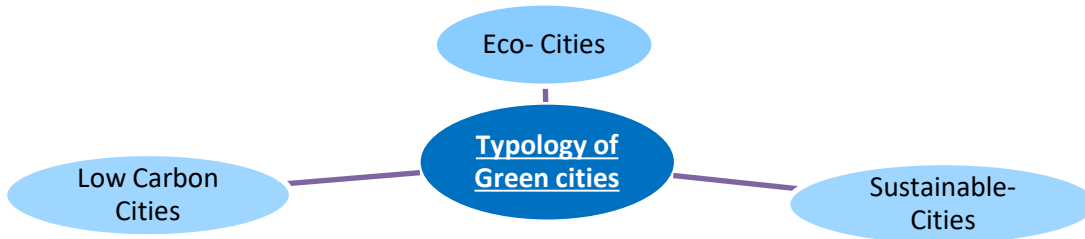


Fig.3. Typology of Green cities

III. RESULTS AND DISCUSSION

Green cities are considered ideal guides for eco-cities. Protection against direct pollution and preserving the surrounding environment are considered huge challenges for the whole world now. Relationships between natural resources "elements" and urban planning are based on 3Fs which are: forms, features and forces. That may be achieved by applying 3Es, which are: ecology, economy and environment. Shortage and reduction of the required green areas and enlarging usage of different energies lead to pollution problems.

The factors governing the choice of Masdar city in Abu-Dhabi, Emirates and Gangneung city in South Korea were based on many considerations. The first consideration was using renewable energies widely in the concerned cities. The second consideration was applying the environmental conditions during urban planning of such cities. The third consideration was using low pollution transportation facilities in these cities. The last consideration was constructing the green buildings in a wide range in the concerned cities.

A. Masdar City

This city is located at Abu –Dhabi in Emirates and Emirates located between Oman and Kingdom of Saudi Arabia. Masdar is located about 11 miles from international Abu-Dhabi airport to the southern east from Abu-Dhabi city. This city is designed for resident population about 50000 residences and the expected daily workers coming to the city about 40000 that means the total population of the concerned city about 90000 capita. This city has special historical properties and identities such as: narrow streets, natural shaded areas, high density of buildings, ability to live in low standard of living, large green areas and services areas are near to urban areas.

Masdar city is considered a good example for zero-carbon cities. To achieve the aimed goals of Masdar city the following issues were considered:

- Using renewable energies widely such as: solar and wind energies for generating the required electricity.
- Recycling wastes and reusing these wastes for generating fueled energy.
- Recycling wastewater and reusing this water after treatment process in irrigation of green areas.
- Using transportation facilities of low pollution such as: the electric cars and electric train.

The above-mentioned conditions and solutions will be discussed as follows:

1) Using Renewable Energies

Table.1 compares the main differences between the existing traditional cities and zero-carbon cities. Table 2 depicts the different sources of renewable energies.

Table 1: Comparison between Traditional and Zero-Carbon Cities

	Item	a- Traditional City	b- Zero-carbon City
1.	Transportation facilities	Using traditional fuel +7%	Using electric energy as a fuel. -7%
2.	Accumulative wastes	Collecting wastes in certain areas. +13%	Recycling wastes in regenerating energy. -12%
3.	Used energies	Using petroleum and gaseous products. +80%	Using renewable energy as a source of energy. -24%
4.	Designed buildings	Traditional buildings.	Saved energy in lighting and ventilation purposes. -56%.
5.	Green areas	Traces	Wide green areas. -1%
*	Total expected pollution	-About 1.10 million ton of Co ₂ pollutants	- Zero Co ₂ pollutants.

Table 2: Sources of Renewable Energies

	Item	Expected percentage (%)
1.	Energy coming from heating pipes (ETC)	14
2.	Central solar energy (CSP)	26
3.	Recycled wastes	7
4.	Photocells energy (PV)	52
5.	Wind energy	1
*	Total renewable energies	100

2) Recycling Of Wastes

- About 50% of wastes may be reused after recycling process in different industrial purposes.
- About 33 % of wastes are used to regenerate required fuels and bio-gases which are considered an alternative source of energy.
- About 17% of wastes are used as fertilizers for plants.

3) Water Conservation And Reusing

This objective can be achieved by:

- Reusing of 80% of gray water after treatment process.
- The other alternative resource is water desalination of sea water.

4) Using Transportation Facilities Of Low Pollution

This objective can be achieved by:

- Using the electric cars in wide range.
- Using bikes for short distances instead of using cars.
- Making certain routs for walking on feet "side walks".

B. Applied Conditions In Masdar City For Reducing Of The Temperatures

Masdar city applied some restricted conditions to avoid the bad effect of high atmospheric temperatures such as:

- Using green areas in wide range.
- Using water fountains inside public buildings.
- Protecting the facades of buildings from the direct effect of sun rays.
- Using special materials for walls and roofs of buildings to reduce the bad effect of direct sun rays.

1) Outdoor Spaces Of Masdar

- About 54 large portable shades constructed in the concerned city in addition to using photo- cells technique for optical purposes.
- Applying large areas for green parks.

2) Indoor Spaces Of Masdar

- Green areas were applied indoors to reduce the ambient temperature.
- Using water inside the indoor spaces to reduce the temperature of the space.
- Using solar sheets for protecting the roofs of buildings from the direct effect of sun rays and also generating electric energy.

3) Main Layers Of Masdar City

Masdar city is divided into five layers which are as follows:

- The first layer is the buildings level.
- The second is the pedestrian level.
- The third layer is the service level.
- The fast transportation level is the fourth level.
- The last level is the infrastructure level.

C. Gangneung City In South Korea

The second case study in this research is Gangneung city in South Korea. Gangneung city has a good topographic position as depicted obviously in Fig.4. This city has a lot of natural hills which are covered by snow and it has low temperature degrees. The average temperature degree in summer is about 12.5 °C. The total area of this city is about 1040 km² and the total population of the concerned city about 213200 capita.

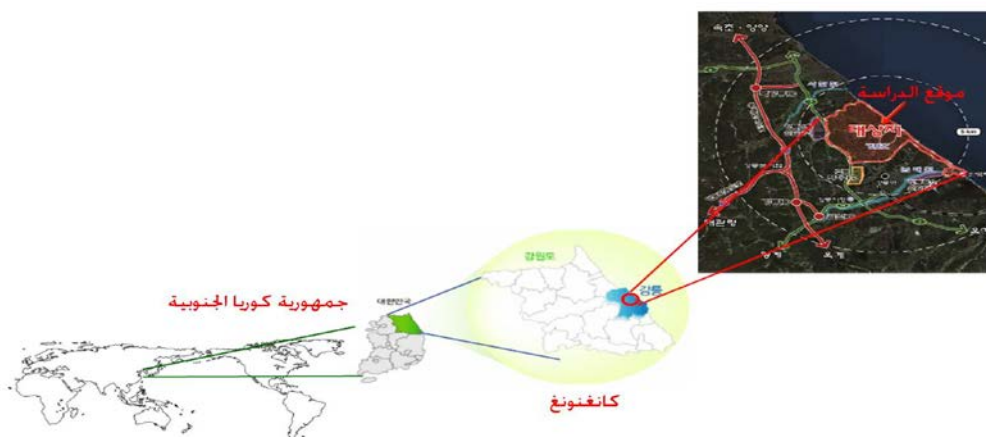


Fig.4. General Layout of Gangneung City

1) Natural Properties of Gangneung City

- The extended beaches along Gyungpo lake in the city.
- Historical aspect of this city beside green development.
- Fast transportation facilities like, trains inside the city which move in circle of diameter about 10 km and busses which moves in circle of diameter 14 km. This city is confined with pine forests.
- Using natural energy resources in a wide range in the city.

D. The Applied Strategy In Gangneung City To Be Low Carbon City

This strategy is based on six factors which are as follows:

1) Transportation Facilities

This factor may achieve by applying the following:

- Using bikes and electric cars, also making side walks for pedestrians.
- Using metro as a general transportation utility.
- Enlarging the pedestrians and bikers routs around and inside the city.

2) Energy Resources

- Using renewable energy resources such as: solar and wind energies.

3) City Buildings

- Applying the green buildings technique in the city to save energy.

4) Wastes

- Recycling the wastes and regenerating energy for heating and lighting purposes.

5) Water Resources

- Managing the available water resources to make a balance between human demands and the environmental requirements.

6) Increasing The Green Areas

- Increasing green areas inside the city in addition to developing the existing pine forests leaded to reduction the carbon level in the city.

E. Main Environmental Standards Required For Eco Cities

Figure 5 shows the main environmental standards in Gangneung City.

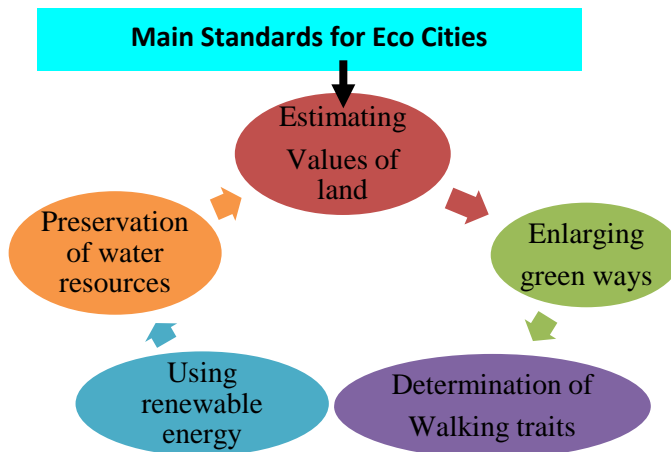


Fig.5: Main environmental standards in Gangneung City

Figure 6 clearly illustrates the proposed strategy to transferring the existing cities into a sustainable green or eco cities. Table 3 and table 4 present complete analysis for the two concerned cities according to the environmental standards but table 5 presents a comparison between the two concerned cities. It was observed that, Masdar city is satisfying the required environmental standards by a total percentage of Masdar city of 91.25%; this is because this city is constructed under the zero carbon standards. On the other side, the total percentage of Gangneung city= 77.25%. This existing city has a certain human and urban natures and needs a lot of effort to reach the required level.

Figure 7 clearly illustrates the comparison between Masdar city and Gangneung city.

Zero carbon cities the following steps have to be taken into consideration:

- Using transportation utilities of low carbon emissions like bikes –electric cars, electric busses and electric trains.
- Getting the different daily requirements easily by walking.
- Increasing and widening the pedestrian routes inside the city.
- Applying green buildings technique in urban planning which depend on the renewable energy resources.
- Reusing rain water and recycled wastewater in irrigation works after treatment.
- Reusing and recycling solid wastes to generate fuel for heating purposes.
- The applied design must be matching with the predominant attitude of the city.
- Using the renewable energy resources for generating the required electricity.
- Using Solar radiation directly for lighting purposes along the whole day. Also, solar energy is used for lighting these buildings at night by using solar cells which are distributed in the roofs.
- Adding green areas in the city and developing the existing green areas.
- Applying restricted conditions which enable humans to protect the surrounding environment from direct contamination.

Table.3: Analysis of Masdar City according to Environmental Standards

Green Tissue (25%)		Social Utilities (25%)		Circulation (25%)		Environmental Reservation (25%)	
Green Areas (6.25%)	5.25%	Public Services (6.25%)	5.75%	Hierarchy Road Classes (6.25%)	6%	Means of Transportation (6.25%)	6%
Naturals Resources (6.25%)	5%	Suitable Housing (6.25%)	6%	Privacy & Security (6.25%)	5.75%	Wastes Recycling (6.25%)	6%
Open Spaces (6.25%)	5.25%	Recreational Areas (6.25%)	6%	Public Transportation (6.25%)	6%	Renewable Resources (6.25%)	6%
Rain water (6.25%)	5.75%	Cultural Centers (6.25%)	5.25%	Visual Road Forming (6.25%)	5.25%	Water Network & Drainage Network (6.25%)	6%
Summation	21.25%	Summation	23%	Summation	23%	Summation	24%
Total	91.25%						

Table.4: Analysis of Gangneung City according to Environmental Standards

Green Tissue (25%)		Social Utilities (25%)		Circulation (25%)		Environmental Reservation (25%)	
Green Areas (6.25%)	6.25%	Public Services (6.25%)	0.25%	Hierarchy Road Classes (6.25%)	.25%	Means of Transportation (6.25%)	3.75%
Naturals Resources (6.25%)	5.5%	Suitable Housing (6.25%)	0.75%	Privacy & Security (6.25%)	%	Wastes Recycling (6.25%)	4.25%
Open Spaces (6.25%)	5.25%	Recreational Areas (6.25%)	%	Public Transportation (6.25%)	0.75%	Renewable Resources (6.25%)	4.75%
Rain water (6.25%)	4.75%	Cultural Centers (6.25%)	0.75%	Visual Road Forming (6.25%)	0.75%	Water Network & Drainage Network (6.25%)	6%
Summation	22.25%	Summation	19%	Summation	17.75%	Summation	18.75%
Total	77.25%						

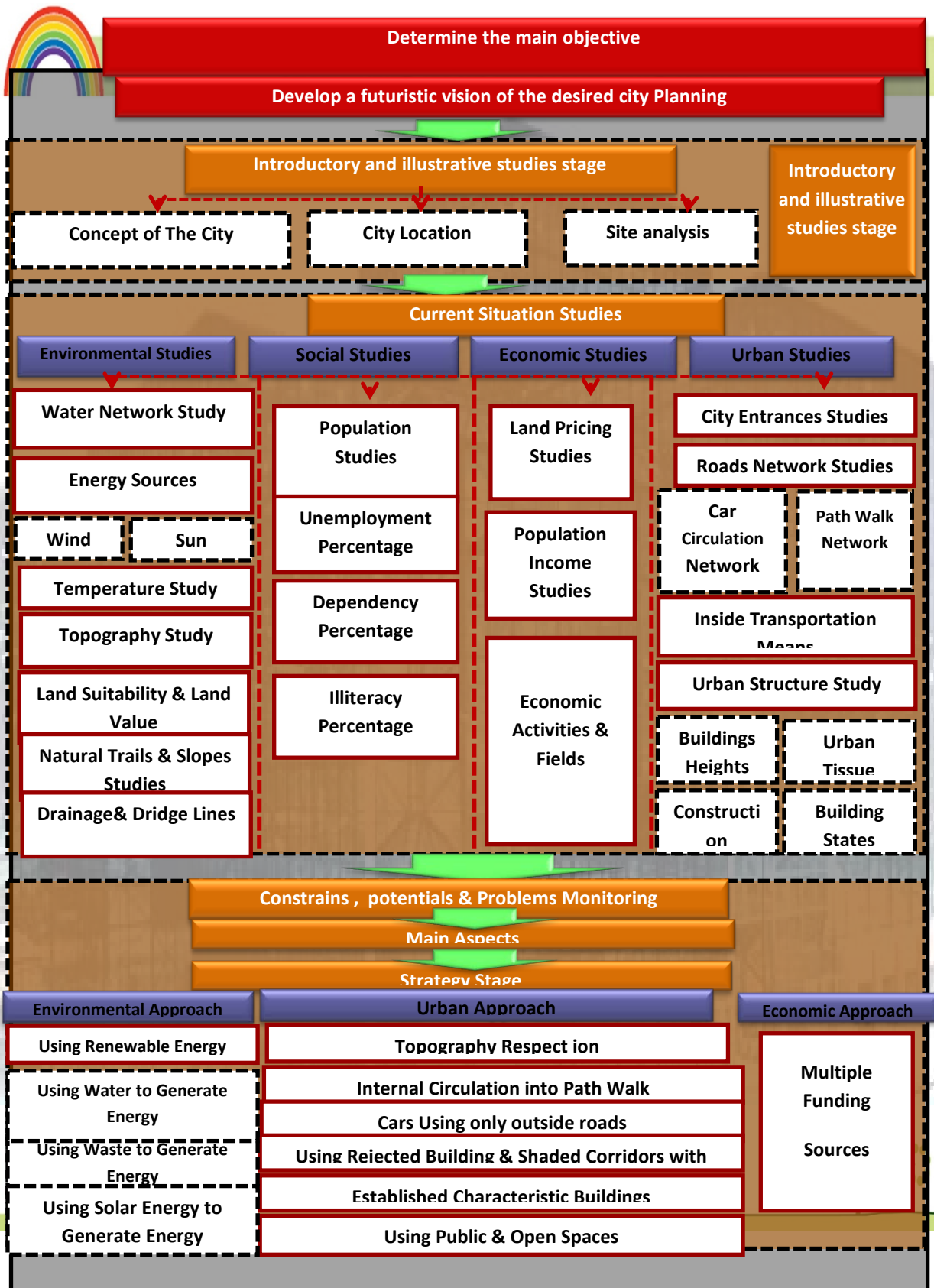


Fig.6.The applied methodology for transferring the cities into green cities

Table.5: Comparison between Masdar City and Gangneung City

	Green Tissue	Social structure	Circulation	Environmental reservation
Masdar city	21.25%	23%	23%	24%
Gangneung city	22.25%	19%	17.75%	17%

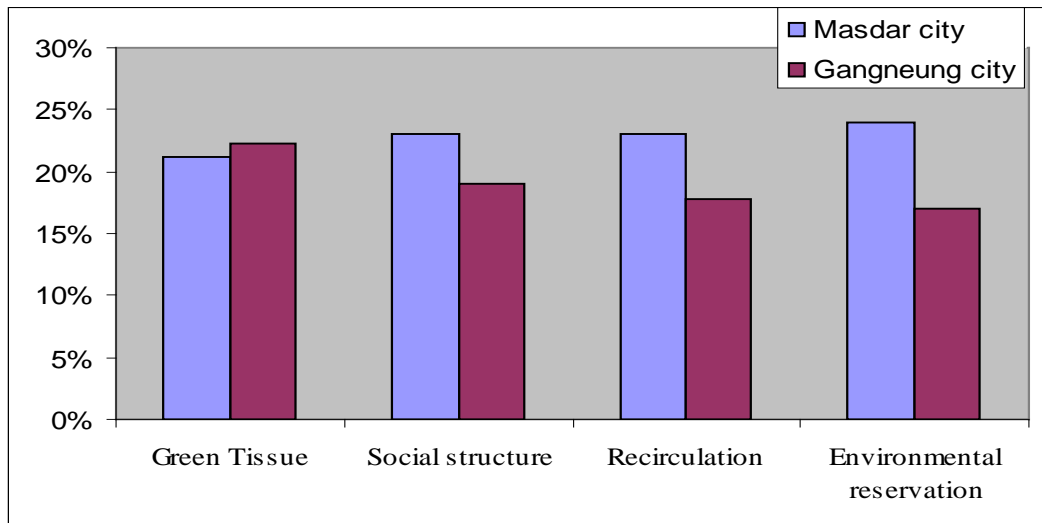


Fig.7. Comparison between Masdar city and Gangneung city

IV. RECOMMENDATIONS

To develop eco-cities, the following recommendations are preferably to be followed:

- Using transportation facilities of low pollution.
- Using and applying modified architectural techniques to gain high efficiency.
- Increasing the green areas to reduce the level of carbon.
- Making future studies before planning of eco-cities.
- Applying the suggested methodology in this study in the design of eco cities.

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