

A Preliminary Study of the Impact of Urban Energy Consumption with Urban Form in Taiwan

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1 ABSTRACT

In recent years, because of the energy demanding increment, it will perhaps make energy dried up in the future. To view the status of the Taiwan's energy development, dependence on imported energy has reached up to 99.3% in 2007. It is limited in self-produced energy in Taiwan. Therefore, the energy subject became one of quite important topics. Many experts are beginning to look for renewable or alternative energy to solve the energy shortage. In the urban planning field, planners try to achieve the minimum energy consumption from the urban planning and management. In each kind of urban planning strategy, many scholars said that the compact city may save the energy under the high density centralism. But recently there is the research to point out that if excessively crowded, it will create more congestion costs, parking costs and energy consumption. There are the different characteristics between the different cities. There might be the different variables about energy consumption. The purpose of this study is attempt by the different urban form variables to find the affecting factors of the urban energy consumption. Final result is expected to provide preliminary conclusion to make a plan use urban energy more efficiently and achieve sustainable development.

2 DEVELOPMENT OF COMPACT CITY

Rickaby discusses the relatedness among the urban form, the energy use and the efficiency of the energy use. He discovered that no matter what kind of the urban development can save more energy consumption which compared to the original plan. (Rickaby, 1987) The development of compact city started from the two schools dispute about the development of the urban form between the decentralized person (Decembrist) and the centralized person (Centrist). The centralized person advocated that the high-density urban development, and opposed the urban sprawl. It was most early in 1935, Le Corbusier proposed that enhanced the urban density to solve the congestion. Afterward in 1960, Jane Jacobs positioned to maintain the urban vigor and the urban multiplicity by the high density development.

The compact city appears clearly most early by George Dantzig and Thomas L. the Saaty. These two mathematicians proposed about the spatial form, spatial characteristic and the function indicators of the compact city in 1973. But it still was fuzzy like sustainable development, it also belonged to the descriptive stage. In 1990, the urban environment green book, British policy guiding plan and so on research induced the concept of the compact city gradually. The compact city was one of the urban regulatory policy which proposed at that time. The original intention was that preserved the village land outside of the urban area. Thus the urban spatial development was limited, and there were more and more population. The compact city advocated that the city should raise the density toward the centralism development. At the same time, there were also many researchs pointed out that policy of the compact city, was helpful to reduce the transportation energy consumption because of the centralism. And they promoted to improve the utilization ratio of the public transportation. It reduced petrochemical energy consumption. Therefore they advocated the development of the compact city.

However the later period scholars pointed out that the excessively compact city possibly created the crowded phenomenon, the bad neighborhood effect, the healthy question and so on, instead caused more impacts, energy consumption, air pollution and so on. Therefore recently the scholars starts to ponder the balance point of pro and con of the compact city.

The scholars pointed that urban stucture would impact the transportation energy consumption. Because of different attributes

The different cities has the different form and the scale, must have the different cities management

The impact of the trasportation enrgy consumption would be different with different compactness. And the impact would be different because the city has different the public transportation, landuse zoning, infrustruction and so on. (Yeh kuang-yi, Huang kan-chung, Lee yung-lung, 2003)

However it has not yet the research to point out that the “compact city” would consume transportation energy least under what kind of urban form.

3 STUDY AREA AND METHODOLOGY

This research reorganizes the different urban form variables, and discusses them to development influence of the compact city. Then it carries on the statistical examination, and it attempts to understand that what kind of city can cause the urban transportation energy disbursement to be least.

The covering scope includes the principal element like dense degree and the mix use that most scholars discusses from the compact city. Then it inducts the degree of the public transportation, information degree, knowledge degree, economy development as well as resources use. The expectation could find the urban variables affects urban energy use.

This research collects the data of Taiwan 22 cities to carry on the series scoring to analyze. Then it uses multiple regression analysis, carries on the examination in view of the urban form to influence of the energy use. First it calculates various cities energy use, then introduces the different urban form variable to analyze what kind of the urban form variable would affect the urban energy use. Next it divided to two groups according to the different urban density and the mix use degree, and then establish in each crowd of groups its model, gives to analyzes the comparison.

3.1 Study Area

Tainan County is located in the Southwest part of the island, an average density of 547.79 persons/km, and total area is approximately 2016 km². The study areas are 22 cities in Taiwan. (See Figure 1)



Fig. 1. Study Area

3.2 Variables and Indicators

3.2.1 Compactness

There are a lot of ways to measure the compactness. The most complete way is the research from Burton in 2002. Burton measured the compactness in UK towns and cities. He said the better measures of compactness are needed for three reasons (Burton, 2002) :

1. To assist research on the impacts of compactness, and thus to guide policy;
2. To enable measurement of progress towards sustainability;
3. For use as planning tools.

And he pointed out the compact city was usually described as one or other or all of three types of city, two that are related to ‘product’:

1. the high-density city,
 2. the mixed-use city,
- and one that is related to 'process':
3. the intensified city.

However, this research only discuss single year. It means that this research needs to ignore the 'process' and only discuss the 'product': the high-density and the mixed-use .

3.2.2 Energy

Peter W. G. Newman & Jeffrey R. Kenworthy (2007) used Gasoline use to measure the energy consumption.

Therefore, this research take the statistic of every gasoline station in Taiwan 22 cities to be the data measuring the energy consumption.

3.2.3 Urban Form

Urban form includes spatial elements and non-spatial elements. Except for compactness to describe the spatial attributes, this research still bring non-spatial elements into measuring the urban form. The variables are urban service function, development degree of transportation, information circulation, and knowledge education level. The indicator of urban service function is industry and commerce factory number. It can describe the activity of the city. The indicator of the development degree of transportation is the utilization ratio of transportation. Because there were more people use public transportation, and there were less energy consumed. The indicator of the information circulation is the rate of internet surfer. It was research pointed out that the rate of internet surfer was higher, the city was more advanced. It has the possibility to express to reduce more energy consumption. Table 1 is all variables and the indicators.

Dimension	Variable	Indicator
Compactness	Density	Population per hectare
		Develop household of number the land per hectare
	Mix Use	The proportion of Housing and non-housing
		Entropy
Energy	Energy Consumption	Average each gasoline and diesel oil consumption
Urban Form	Urban Service Function	Industry and commerce factory number
	Development Degree of Transportation	The utilization ratio of Transportation
	Information circulation	The Rate of Internet Surfer
	Knowledge education level	Above 15 years old of education level structure - technical college population and above

Table 1: Variables and Indicators of this research

4 ANALYSIS AND RESULT

According to the indicators in table 1, and collecting Taiwan 22 data. It mainly divides into two parts, the first part surveys the Taiwan different compactness to realize the attributes in different cities, and analyze the energy consumption impact belong to urban compactness and urban form. The second part according to the compactness height classification. The purpose is to realize the difference of the impact of the energy consumption and urban form under the different compactness height classification.

4.1 Compactness of Taiwan Cities Development

There are twenty-two cities in Taiwan. The urban compactness and the average energy per person consumption, as we can see in Figure.2 and Figure.3.

By Figure.2, the higher compactness cities mainly distributes in the north and south two main cities.

By Figure.3, the higher energy consumption cities mainly distributes in the north and south two main cities. But it is not the same cities with the higher compactness cities in Figure.2. To compare these two figures, it appears that the higher compactness cities in Figure.2 instead is the average each person of energy use is lowest in Figure.3.

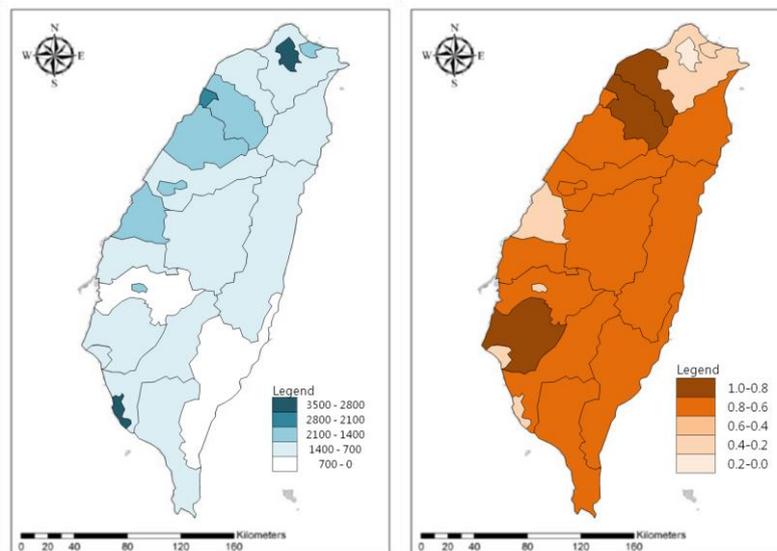


Fig.2 (left): Urban Compactness in Taiwan. Fig.3 (right): Average Energy per person Consumption in Taiwan

The compactness of various cities will divide into two groups, a group for the high compactness city, and a group for the low compactness city. In order to understand different compactness and the energy consume relations. (See Table2)By different compactness, in the high compactness, the many urban energy use is low. Therefore, whatever the compactness is higher or lower, the compactness and the energy consumption is negative correlation.

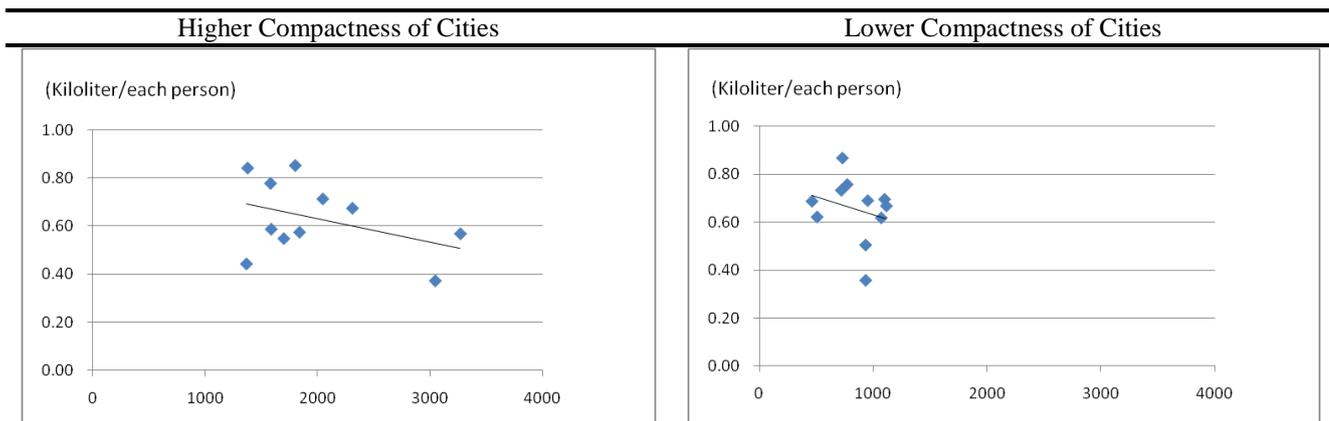


Table 2: The relation of Compact City energy consumption and the Compactness

4.2 Identification of Factors Affecting the Urban Energy Consumption of Urban form

4.2.1 Urban service function

By Table 3, its energy use is high. Extrapolated that the reason is the industry and commerce number are few, causes the trip times to increase. The trip times increase, the trip length to increase, causes the energy consumption to increase. They are negative correlation.

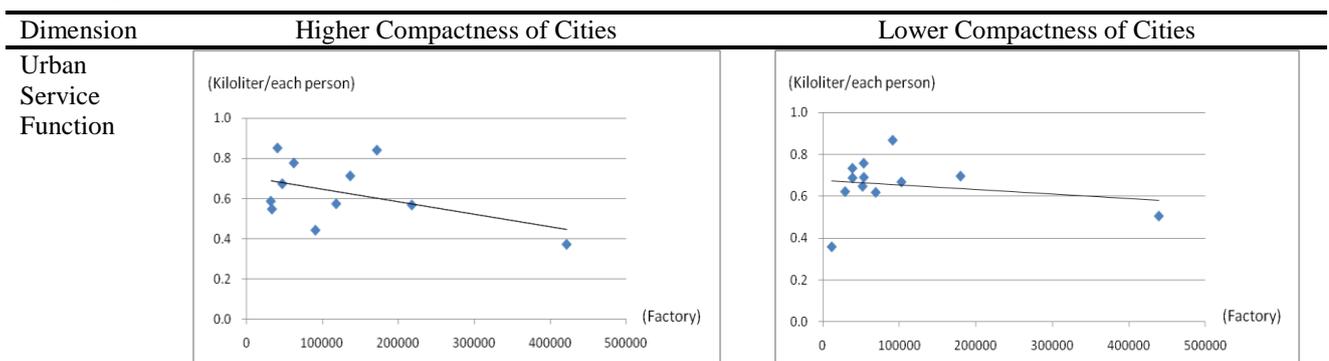


Table 3: Identification of Factors Affecting the Urban Energy Consumption of Urban form

4.2.2 Development degree of transportation

By Table 4, regardless of compact highly or low, the utilization ratio of public transportation is high, the energy use would be quite few.

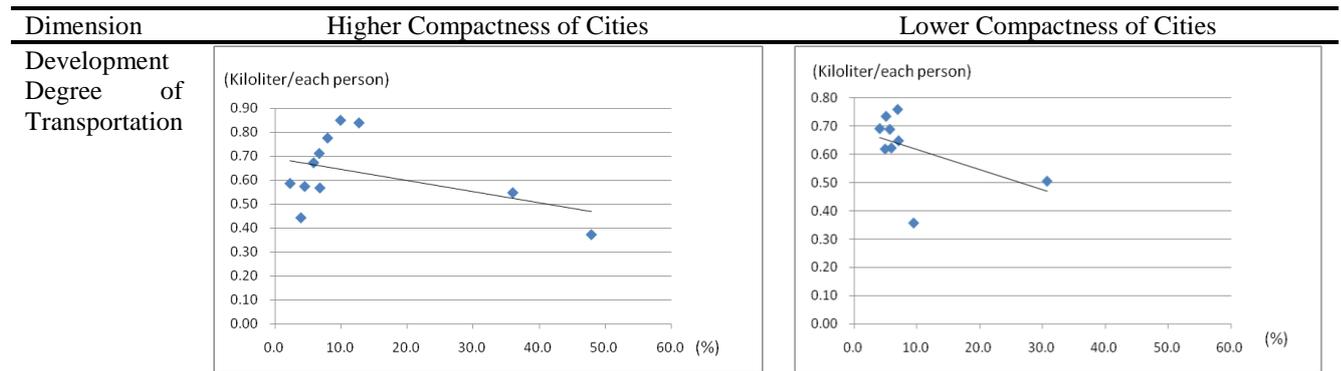


Table 4: Identification of Factors Affecting the Urban Energy Consumption of Urban form

4.2.3 Information circulation

By Table 5, under different compactness, different information circulation has the different energy consumption. In the high compactness cities, information circulation is higher, the energy use are more. In the low compactness cities, information circulation is higher, and then the energy use is less.

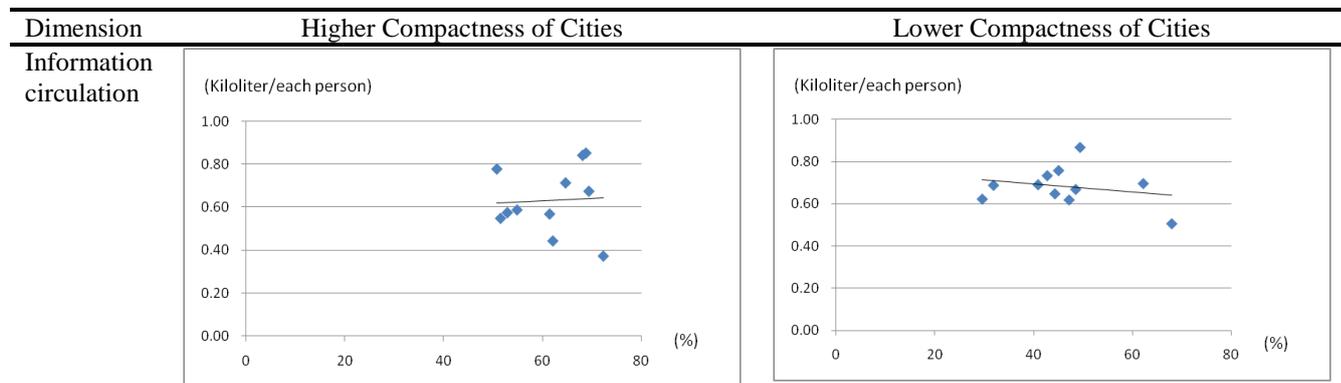


Table 5: Identification of Factors Affecting the Urban Energy Consumption of Urban form

4.2.4 Knowledge Education Level.

By Table 6, regardless of compact highly or low, knowledge education level is higher, the energy use will be few. The cities of high compactness are quite obvious. They are negative correlation.

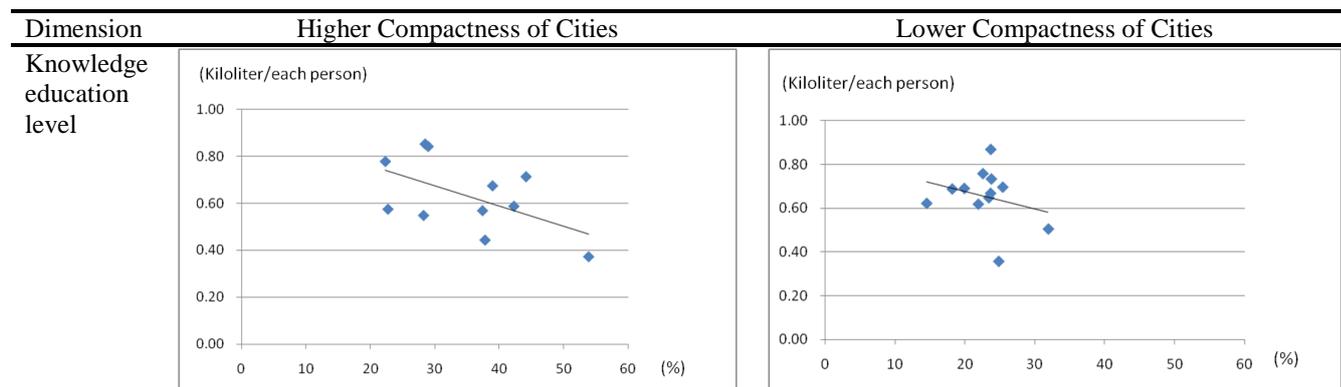


Table 6: Identification of Factors Affecting the Urban Energy Consumption of Urban form

5 CONCLUSION

According to the above result and the analysis, it may understand that the different urban form truly would affect the energy use. But in different compactness situation, it also will have the different influence energy consumption. In order to achieve sustainable development, it should probably consider the more urban

variable in the future. Although this research is a preliminary study. For sustainable development, reducing more energy consumption is saving more energy.

Transportation is one of the major energy consumption department. Many experts advocate to use alternative energy. However, this research prove that various urban form and compactness would consume different energy. Therefore, when urban planner will make the urban planning, they should consider the energy consumption impact of the urban form and compactness. Then the city can achieve the sustainable development.

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