

# STUDY ON THE RELATIONSHIP BETWEEN SOCIO-ECONOMIC CONDITIONS AND RESOURCE USAGE FOR CONCRETE CONSTRUCTION IN JAPAN

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## 1. Introduction

In order to achieve sustainability, it is important to balance three aspects: environment, economy and society. In the past, due to an emphasis on economic growth the environment was sacrificed, so in the future the goal is to balance the three aspects by placing emphasis on the environment. When considering the concrete industry, on the one hand concrete is a fundamental material for infrastructure construction, but on the other hand the process of construction generates an environmental burden. Therefore, reducing the environmental burden while preserving the competitiveness of concrete as a construction material is key for making use of concrete from now on. However, the implementation of sustainability varies depending on regional conditions, and concrete materials and construction are often region-specific, so what may be sustainable in one region under a given set of conditions may not be sustainable in a different region under different conditions (Figure 1) [1].

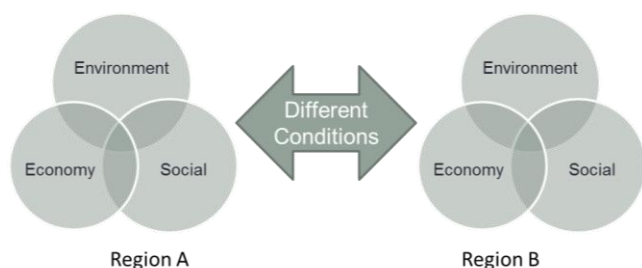


Figure 1 Visualizing regional differences in sustainability

In Japan, diffusion rate of infrastructure constructions is no different in each prefecture. Every prefecture has roadways, bridges, tunnels and so forth. But it is not always utilized efficiently. For example, the number of passing vehicle per day is not the same on every road. If we can get such data, we may understand efficient utilization of infrastructure.

Nowadays, due to increased availability of data online in Japan, collecting data at the regional level is relatively easy. Therefore, this study evaluated the regional differences of sustainable construction by collecting and analyzing statistical data at the prefectural level.

## 2. Research method

### 2.1 Data collection

Table 1 shows the data this study collected in this paper. The data are from 2010 because it is easier to collect data from recent years and it avoids major events,

such as the 2011 East Japan Earthquake.

Table 1. The collected data and data source

Aspect	Indicator	Source
Social	Population	Ministry of Internal affairs and Communications, Statistics Bureau
Economic	Gross prefecture product	Cabinet Office
Resource consumption	Cement, Aggregate	Ministry of Economy, Trade, and Industry

The reason this study chose population as a social aspect is that it is distinctive. Urban areas have very large population and another is small. The reason this study chose gross prefecture product as an economic aspect is the same. Cement and aggregate are the most principal resource in concrete construction, so these are chosen.

The environmental aspect is excluded in this study, that's because analyzing is difficult. For example, there are a few regions snow fall in Japan. Comparing these areas with other areas, the background of construction is very different. So the environmental aspect is excluded.

### 2.2 Analysis method

Diffusion rate of infrastructure is no different, so as a matter of course, the larger population the prefecture has, the more resource consumption is. Therefore, this study normalized every prefecture's resource consumption data per person and examined the relationship between the normalized values and socio-economic conditions. Examining the value is high or low, we can understand how efficiently concrete construction is done. The high value is insufficient, and the low is efficient. In this study, dividing number is adjusted because this study wants the normalized value to show a digit uniformly.

## 3. Results and discussion

### 3.1 Cement consumption

As shown in Figure 2, three things are mainly revealed. Firstly, the larger population prefecture has and the more gross prefecture product is, the lower value converges, about 1.0. Secondly, many prefectures are around national average. Reducing the value in these prefectures makes the national average lower. Lastly, in the low population and gross prefecture product area, the value is diversified. The lowest is about 0.8 and the highest about 3.5, about four times. The prefecture that has the high value is not efficient in concrete construction. Reducing

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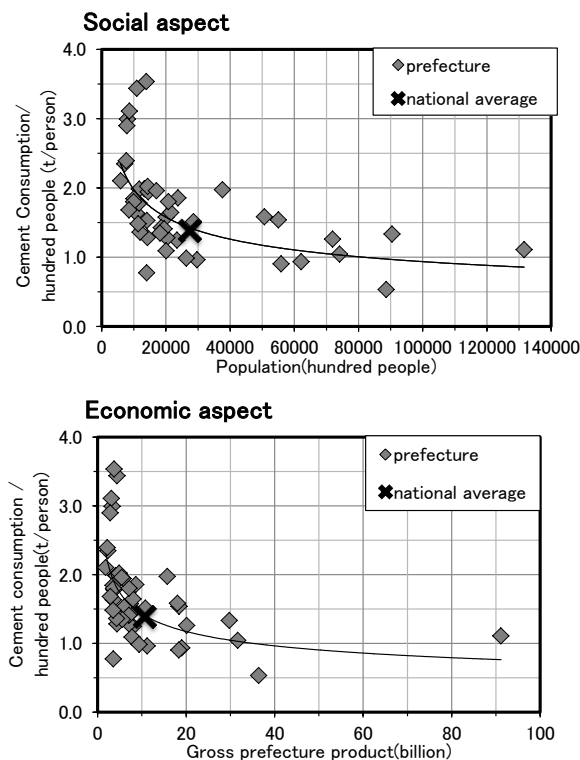


Figure2. Comparison of normalized value of cement consumption and each aspect

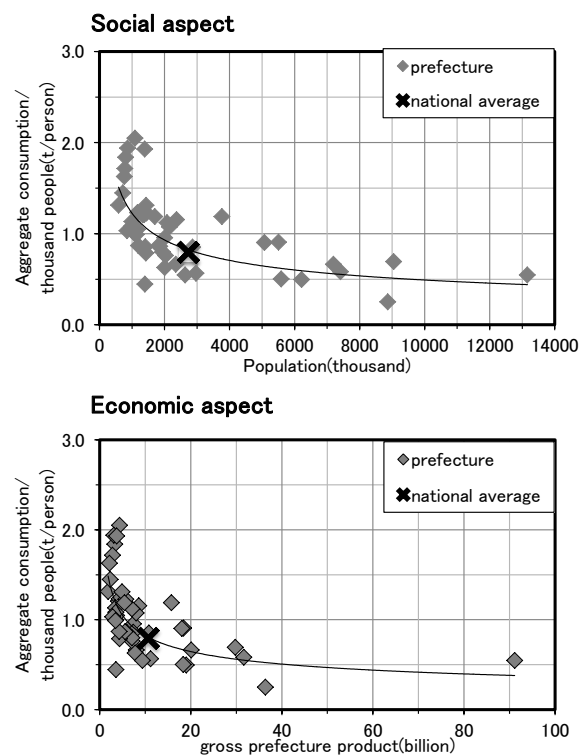


Figure3. Comparison of normalized value of aggregate consumption and each aspect

the value in the prefectures is strongly needed

### 3.2 Aggregate consumption

As shown in Figure3, aggregate consumption is almost the same as cement consumption. The lowest is about 0.5 and the highest about 2.0, about four times. Reducing the value in higher area is strongly needed for efficient construction.

### 3.3 Discussion

There are the prefectures that have the same value but difference of population. Possible factor is that urbanization is common in these areas. Transportation infrastructure is developed in urban prefecture such as subway, airport and so forth. So people can live comfortably. And there are the prefectures that have the same population but difference of value. What's thought to be the factor is the difference of population density. In Japan, population density is greatly diversified. Low population density leads to inconvenient life, so infrastructure development is not efficient.

## 4. Conclusion

In this study, the relationship between socio-economic conditions and resource usage for efficiently concrete construction in Japan is revealed. The lower normalized value is, the more efficient construction is. And the normalized value of resource consumption in the low standard prefecture is diversified, so reducing the value in the higher area is strongly needed. These results lead to taking specific actions to reduce the value in future studies.

## Reference

- [1] Henry, M., Kato, Y., "Sustainable concrete in Asia: approaches and barriers considering regional context," Construction and Building Materials, in press.