A Survey Study on the Assessment of Customer Interruption Costs Using Macro Economic Methodology in Korea

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Abstract - This paper presents an assessment of the customer interruption costs using a macro economic methodology of Korean customers by cities and provinces. The customer interruption cost is considered a very useful index in quantifying reliability worth from a customer point of view. This paper reviews the methodology to evaluate the customer interruption costs and ratio to the average revenues per electric energy sold for public, service agriculture, fishery, mining, manufacturing and residential sectors by cities and provinces in Korea.

Keywords: customer interruption costs, macro economic methodology, average revenues per electric energy sold

1. Introduction

Recently, in accordance with the restructuring of the power industry in Korea, service reliability of power systems has emerged as a major issue in this field. In addition, severe competition among energy industries demands energy suppliers to consider the conditions related to service reliability. Because customers can switch to an alternative energy source in consideration of price, enhancing service reliability is not necessarily considered as a mandatory strategy. Therefore, to effectively deal with such an issue, it is essential to determine the reaction of customers to service reliability and interruption costs. In the past, the issue of service reliability in the power industry was focused on ensuring high reliability at all times. However, as cost hikes accompany high reliability, implementing flexible plans in consideration of customers is a new trend with in the industry.

For example, if distribution system facilities are expanded, customers will have a more stable power supply due to improved service reliability, which is an advantage, while the facility investment needed will be passed on to the customers as increased electric charges, which is a disadvantage. As improved service reliability brings the reduction of interruption costs, it is possible to carry out an economic evaluation of a system facility plan from the customers' standpoint by quantifying the interruption costs with some methods.

For this reason, the issue of customer interruption cost is becoming a major factor in the optimal planning and operation of power supply in relation to reserve rate and service reliability. Research on the assessment of customer interruption costs and the introduction of facility plans have been reported for quite some time in Western countries ([1][2][3][4]) and also recently in Japan ([5][6][7]), but there has been no specific evaluation on this in Korea to date. This paper assessed the customer interruption costs with a macro economic evaluation of Korean customers by cities and provinces. Therefore, it can be utilized as a reference to research dealing with reliability worth from a customer point of view.

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2. Main Discourse

2.1 Necessity of the evaluation of interruption cost

In recent years, the level of power service reliability in advanced countries and in Korea is quite high. Accordingly, to raise the reliability level higher than the current level, the investment necessary to expand power facilities becomes drastically higher. However, the level of advantage the customers get from improved reliability is not as great compared to the amount of investment necessary. This is because the increase of investment for facility expansion raises the cost of power supply, which in turn causes an increase in electric charges to the customers. From that point, it is not advantageous to customers. Therefore, it is important to plan and operate power facilities in consideration of a balance between the advantages the customers will get from the improved reliability and the cost increase the customers should bear. In other words, it is important to decide the size of power supply facilities that minimizes the total costs customers must pay, which are the sum of power supply costs and

customer interruption costs. It is essential that a plan to consider service reliability be established. For this, it is necessary to review and evaluate the interruption costs from the customers' standpoint.

2.2 Interruption cost evaluation methods

Research on the evaluation of interruption costs have been carried out in Britain, France, Italy, Canada, the U.S.A and Japan since they were initially implemented in Sweden. Various methods have been used to evaluate the interruption costs but they can essentially be classified into two. The first type is the macro method, which evaluates the interruption costs in relation to the national economy. The second type is the micro method, which calculates the interruption costs by customer type based on surveys of the individual customers.

The macro method was conceived on the point that economic loss occurs after power interruption as economic activities are halted, that is justifiable economic value is lost due to power interruption. The simplest method is calculating the interruption cost macroscopically by dividing GNP by total power consumption. A more detailed method is also used. By using tables related to economic activities, this method calculates the interruption costs of each economic sector by dividing the value added obtained in the sector by the power input of the sector. These methods are rough but they also have their merits. With these methods, it is possible to calculate the interruption costs of a country as a whole or by sector. However, evaluating the interruption costs of individual customers with the values obtained by these methods does have certain problems.

Conversely, with the micro method, it is possible to calculate the interruption costs of customer groups but not of individual customers. The result can be problematic from an objectivity standpoint. As a result, it is necessary to carry out large scale surveys. And actually interruption costs are calculated based on large scale surveys in Sweden, Britain, France, the U.S.A, Canada and Japan.

2.3 Evaluation of the interruption costs

The research on customer interruption costs carried out in other countries has been discussed so far. In the latter part of this paper, the interruption costs in Korea are assessed based on that research. First, the interruption costs were calculated by using a macro method of dividing the GNP by electric energy sold. With this method, we obtained the interruption costs of 1,933 won/kWh for the year 2001. When this is compared with the average revenues per electric energy sold (77.06 won/kWh) in the same year, it is 25 times greater.

In Table 1, the ratios of the customer interruption costs to the average revenues per electric energy sold by cities and provinces, which is calculated by using the macro method, are shown.

Table 1 Customer interruption cost by cities and provinces in 2001

Region	Value added (million won)	Electric energy sold (MWh)	Interruption costs (won/kWh)	Ratio to the average revenues per electric energy sold
Seoul	109,664,320	33,321,290	3,291	42.7
Busan	29,746,563	13,423,022	2,216	28.8
Daegu	15,453,547	10,544,475	1,466	19.0
Incheon	21,904,507	14,963,885	1,464	19.0
Gwangju	10,452,415	4,639,097	2,253	29.2
Daejeon	10,174,711	5,771,636	1,763	22.9
Ulsan	24,285,718	17,695,778	1,372	17.8
Kyonggi	116,034,495	48,583,251	2,388	31.0
Kangwon	10,466,513	10,227,934	1,023	13.3
Chungbuk	17,394,526	11,647,860	1,493	19.4
Chungnam	20,307,188	13,835,151	1,468	19.0
Jeonbuk	14,336,807	11,247,612	1,275	16.5
Jeonnam	22,436,939	15,653,924	1,433	18.6
Gyeongbuk	36,155,922	25,925,964	1,395	18.1
Gyeongnam	34,680,573	18,295,403	1,896	24.6
Cheju	4,569,820	1,955,072	2,337	30.3

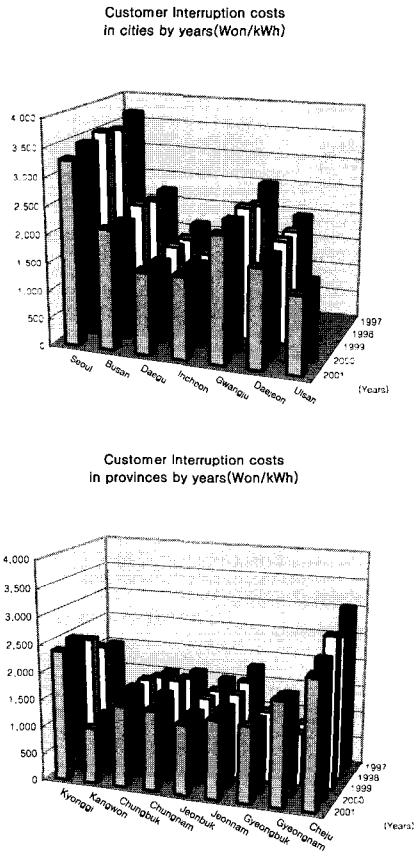

Fig. 1 Customer interruption costs in cities and provinces by year

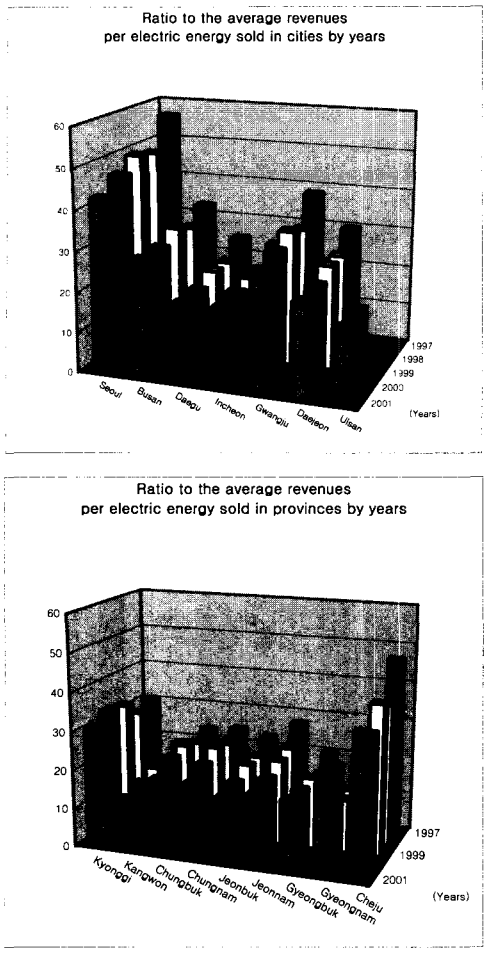

Fig. 2 Ratio to the average revenues per electric energy sold in cities and provinces by year

The data presented in Table 1 is also analyzed by year. Fig. 1 and Fig. 2 show the interruption costs, and the ratio to the average revenues per electric energy sold in cities and provinces by years, respectively. First of all, the customer interruption costs in cities and provinces show a steady decline each year. This is because electric energy sold per GDP (value added) went down each year as high efficiency power equipment have shown.

To evaluate the interruption costs and the ratio to the average revenues per electric energy sold, cities and provinces were divided by using a table of regions and the following formula was formulated.

$$Interruption\ cost\ by\ regions = \frac{Value\ added\ by\ regions}{Power\ Interrupt\ by\ regions} \quad (1)$$

Also, in this paper, the customer interruption costs for public, service, agriculture, fishery, mining, manufacturing, and residential sectors were calculated by using the following formula (2).

$$Interruption\ costs\ by\ economic\ activites = \frac{Value\ added\ by\ economic\ activites}{Power\ Interrupt\ by\ economic\ activities} \quad (2)$$

Referring to formula (2), the value added was defined as the goods and services produced by economic activities in the country minus the cost of raw materials except for the residential sector. And the customer interruption costs were calculated by using the gross domestic production (value added) in each area of public and commercial sectors in the region based on related tables by industry. As for the residential sector, the interruption cost was defined as the value of domestic labor [essential activities for subsistence] of the daily activities of a regular household. In other words, the interruption cost to residential customers was calculated as follows. First the amount of housework impeded by power interruption was estimated. Then it was converted into a monetary value based on the estimated value of a full time housewife's monthly labor cost. The data compiled by the Korean Women's Development Institute was used as the basis of the calculation. According to the data, the size of the domestic labor force is about 6.76 million and the monthly value of domestic labor per household is 1.02 million won. The total yearly cost is 6.9 trillion won. And the customers engaged in the service sector were classified into wholesale and retail, food and lodging, transportation and warehousing, communication, finance and insurance, real estate service, and social service and individual service industries. The customers engaged in the public sector constituted the general public administration. Table 2 shows the estimated values of interruption costs calculated by using electric energy sold and gross domestic production in the region (value added) by customer type in 2001. And in this paper, the interruption costs and ratio to the average revenues per electric energy sold in cities & provinces by customer type in the year 2001 is calculated and shown in detail in Fig. 3 and Fig. 4, respectively.

Table 2 Customer interruption costs by customer type in 2001

Customer type	Value added (million won)	Electric energy sold (MWh)	Interruption costs (won/kWh)	Ratio to the average revenues per electric energy sold
Public	11,930,465	9,424,826	1,266	11.7
Service	209,719,900	73,303,991	2,861	26.5
Agriculture & fishery	24,526,577	5,985,147	4,098	94.2
Mining	812,699	1,074,284	757	12.3
Manufacturing	182,143,159	128,731,878	1,415	23.0
Residential	68,931,673	39,211,228	1,758	19.2

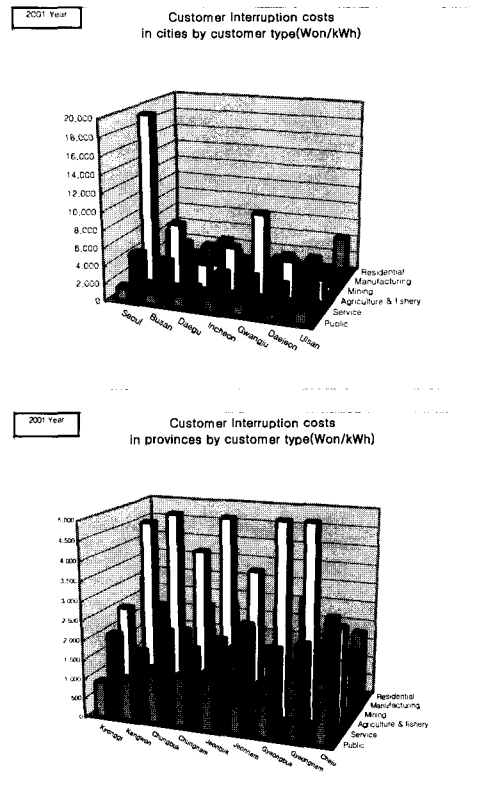

Fig. 3 Customer interruption costs in cities and provinces by customer type

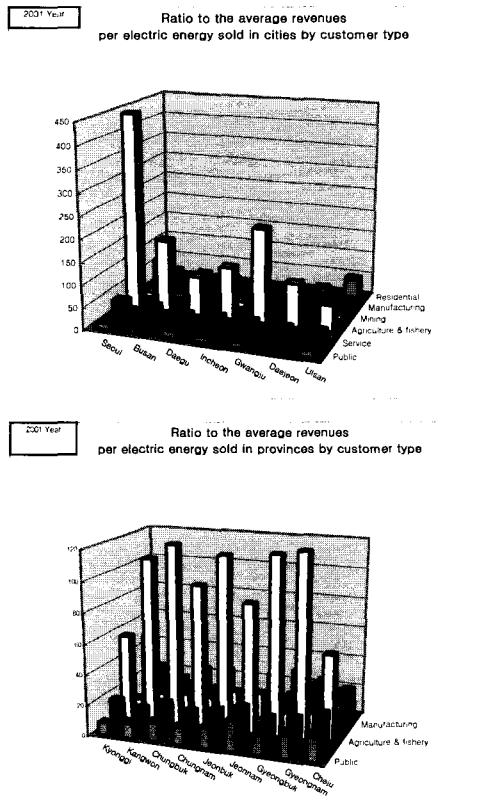

Fig. 4 Ratio to the average revenues per electric energy sold in cities and provinces by customer type

As can be seen in Table 2, Fig. 3 and Fig. 4, the industries with higher customer interruption costs per kWh are the agriculture and fishery and service industries. The industries with lower customer interruption costs per kWh are the mining and public industries. In the case of the former, while the loss of capital facility such as raw material is not high, the cost of lost value added is high. In addition, in the case of the latter, while the loss of value added is low, the loss of capital facility is relatively high and thus the interruption is high overall. However, to find out the interruption costs by industry type in more detail, it is necessary to investigate actual situations of individual businesses and office buildings. Also, higher customer interruption costs by cities & provinces are the Seoul and kyonggi regions and if concretely analyzed, customer interruption costs in the Metropolitan area are higher than in the lower population density areas.

2.4 Comparison of the interruption cost by customer type between foreign and domestic countries

In this paper, evaluation of the interruption costs in Korea by customer type is compared with that in other foreign countries. For example, interruption costs of residential areas represent 2,484 won/kWh [U.S.A], 1,968 won/kWh [Canada], 24,090 won/kWh [Japan] and 1,758 won/kWh [Korea], respectively. Table 3 depicts the comparison table of interruption cost and ratio to the average revenues per electric energy sold by customer type, which is done in the respective country. One dollar is equal to 1,200 won.

Table 3 Comparison of the interruption costs by customer type in respective country

Country	Customer type	Interruption costs(won/kWh)	Ratio to the average revenues per electric energy sold
Canada(1987) [2]	Residential	1,968	21
	Service	20,148	280
	Manufacturing	3,252	69
	Public	2,868	71
	Agriculture & fishery	42,648	530
U.S.A(1996) [3]	Residential	2,484	19
	Service	54,984	417
	Manufacturing	9,132	69
Japan(1994) [5]	Residential	24,090	93
	Service	13,800	69
	Manufacturing	2,140	11
Korea(2001)	Residential	1,758	19
	Service	2,861	27
	Manufacturing	1,415	23
	Public	1,266	12
	Agriculture & fishery	4,098	94

3. Conclusion

In this paper, the macro approaches are applied to obtain the customer interruption costs by cities & provinces and customer type. This is because the method of evaluating customer interruption costs based on the gross production index of the region is most likely to derive more effective results. The results of this paper can be summarized as follows.

(1) The customer interruption costs in Korea by cities & provinces as a whole is about 13-43 times the average revenues per electric energy sold.

(2) When the ratio to the average revenues per electric energy sold for the service, agricultural and fishery industries were compared with those for the mining and public industries, the former is higher than the latter. The former is about 26 and 94 times, respectively and the latter is 12 times. And the ratio to the average revenues per electric energy sold for manufacturing industry and residential sector are 23 and 19, respectively.

(3) The interruption costs for Seoul and Kyonggi in the Metropolitan area are higher than in other areas. The former is about 2,000-3,000 won/kWh and the latter is about 1,000-2,000 won/kWh

(4) The interruption costs for the service, agriculture and fishery industries are higher than those for the mining and public industries. The former is about 3,000-4,000 won/kWh, and the latter is 700-1,300 won/kWh. The reason why the former is higher is that the loss of value added is relatively high.

Furthermore, as far as we know this paper is the first attempt to specifically find out the customer interruption costs in Korea. Even though this study has some limitations, when it is compared with the basis of calculations used in the studies done in other countries, it is not too far off.

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