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A Basic Study on City Gas Consumption Difference according to the exclusive dwelling area

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Abstract: Currently, since the total energy amount has been increased continuously, the effort for energy efficiency of apartment building is necessary. Although the previous studies have been focused on the issue. Almost studies are about the simulation by applying the energy analysis tools and a lack of studies have been conducted the data analysis about real city gas amount of apartment building. Therefore, the objective of this study is to analyze the city gas consumption difference according to the exclusive dwelling in apartment building. To address this issue, the descriptive, correlation, analysis of variance (ANOVA) statistics are used in this study. As a result, in the case of annual total amount, the city gas is increased as the size of the exclusive dwelling area is increased. In the future, the findings of this study can be used as a basic material to develop the prediction model of city gas in apartment building.

Keywords: City gas; Apartment building; Exclusive dwelling area; Analysis of variance

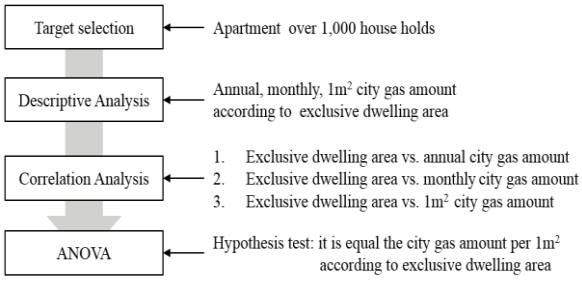
Ⅰ. INTRODUCTION

Currently, the total 208,120,000 TOE final energy was consumed in domestic land based on 2012 and 37,877,000 Toe among this was consumed in building (household and commerce). This is a tremendous amount taking up 18.2% of final energy consumption amount and shows efficiently using energy is very important in buildings.

Thus, this research selects apartment complexes more than 1,000 generations and understands energy consumption status targeting apartment houses in Ulsan then analyzes correlation of city gas consumption amount by exclusive dwelling area. This is expected to be utilized in development of forecasting model of city gas consumption amount of apartment houses and basic data of energy efficiency plan of apartment houses in the future.

In this study, an Analysis of Variance (ANOVA) is used to analyse the city gas consumption. The ANOVA analysis set a null hypothesis that average gas consumption amount by exclusive dwelling area is same to verify whether it is true.

FIG. 1. RESEARCH METHODOLOGY



To achieve the objective of this study, data collection, such as city gas consumption amount, total generation number, exclusive dwelling area was taken from complex basic information of information management system of apartment houses. Fig. 1 shows the method of this research.

Ⅱ. LITERATURE REVIEW

As shown in Table 1, Ulsan consumes 25,529,000 TOE, 12.27% of 208,120,000 TOE which is total energy consumption amount, so is the city that consumes the energy the most showing the highest consumption amount at megapolis level and 37% of it is consumed for industry. We can see that population distribution and living basis has features of industrial city.

TABLE 1. END-USE ENERGY AMOUNT CONSUMPTION (UNIT: 1,000 TOE)

Content / Province	Industry	Transportation	Residential and Commercial	Public	Total
Seoul	1,133	4,576	8,844	1,014	15,568
Busan	1,656	2,458	2,133	222	6,470
Daegu	1,284	1,266	1,726	159	4,434
Incheon	3,980	4,605	1,931	182	10,697
Gwangju	426	900	1,010	66	2,403
Daejeon	410	795	1,187	120	2,513
Ulsan	22,673	1,743	818	295	25,529
Total	115,155	36,938	37,256	4,483	208,120

In addition, 86.3% of 422,177 generation in Ulsan uses city gas and this shows high city gas penetration rate following Gwangju, Seoul, Daejeon, Incheon in the country steadily increasing. Therefore, analysis of city gas consumption amount becomes an index that can see energy trend of housing facility and through variance in city gas consumption amount, we can analyse various variables that affect other consumption amount. Therefore, as a target

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area, Ulsan is selected in this study.

Ⅲ. DATA ANALYSIS

A. Descriptive Analysis

To analyse gas consumption amount by exclusive dwelling area, we conducted technical statistics analysis regarding sum of gas consumption amount for a year by exclusive dwelling area in complex 1 and 2 except those with 0 gas consumption amount. Like shown in Table 2, yearly average of 40.80m^2, 59.97 m^2, 81,87m^2, 84.96m^2 114.60m^2 is relatively 575.84m^3, 728.99m^3, 891.86m^3, 896.06m^3, 1097.62m^3 as size of each exclusive dwelling area increases thus we can see that average gas consumption amount increases.

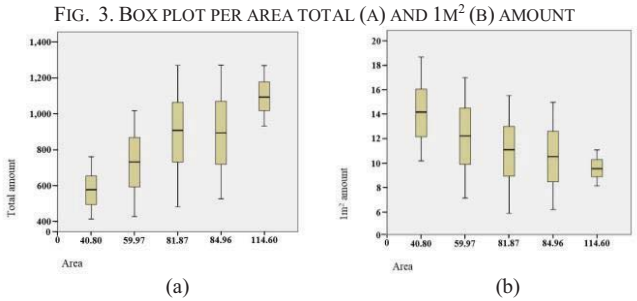
TABLE 2. DESCRIPTIVE ANALYSIS PER AREA (ANNUAL AND 1M^2 AMOUNT)

Statistics \ Area		40.80	59.97	81.87	84.96	114.60
Sample		78	451	169	625	94
Annual	Average	575.84	728.99	891.86	896.06	1097.62
	Median	577.88	732.51	907.99	894.08	1093.31
	St.Dev.	95.59	162.15	225.41	207.81	97.09
	Min.	415.30	428.21	482.73	527.34	931.74
	Max.	761.26	1,018.00	1,269.77	1,270.69	1,268.78
	Range	345.95	589.79	787.04	743.36	337.04
	Skewness	-.016	-.017	-.09	.023	-.021
	Kurtosis	-1.23	-1.11	-1.06	-1.18	-1.17
1m²	Average	14.11	12.15	10.89	10.54	9.57
	Median	14.16	12.21	11.09	10.52	9.54
	St.Dev.	2.34	2.70	2.75	2.44	.84
	Min.	10.18	7.14	5.90	6.21	8.13
	Max.	18.66	16.98	15.51	14.96	11.07
	Range	8.48	9.83	9.61	8.75	2.94
	Skewness	-.016	-.017	-.092	.023	-.021
	Kurtosis	-1.234	-1.114	-1.069	-1.180	-1.173

Box plot of Fig. 3(a) indicates distribution of collected data and average location of gas consumption amount yearly and it also shows that average increases by each exclusive dwelling area.

However, gas consumption amount per 1m^2 of each exclusive dwelling area shows the opposite trend. As exclusive dwelling area increases, gas consumption amount by 1m^2 were 14.11m^3, 12.15m^3, 10.89m^2, 10.54m^3, 9.57m^3 showing the analysis that they are decreased like shown in Box Plot of Fig. 3(b).

FIG. 3. BOX PLOT PER AREA TOTAL (A) AND 1M^2 (B) AMOUNT



(a) (b)

B. Analysis of Variance

To examine if the difference on gas consumption amount is statistically meaningful in exclusive dwelling area, this research conducted hypothesis test (one way variance analysis). Thus, we supposed variance of each group was same after setting antihypothesis, average gas consumption amount by 1m^2 of exclusive dwelling area is different, and a null hypothesis, average gas consumption amount by 1m^2 of exclusive dwelling area is same, to examine if average gas consumption amount by 1m^2 of exclusive dwelling area is same and set significance level at 5%. As a result of analysis, like Table 3 below, F value between groups was 64.385 existing outside acceptance region (-1.96, 19.6) denying the null hypothesis accepting antihypothesis, that is to say, it brings the conclusion that average gas consumption amount by 1m^2 of exclusive dwelling area has difference.

TABLE 3. NORMALITY TEST

Area	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
40.80	.088	78	.20	.951	78	.19
59.97	.064	451	.18	.964	451	.10
81.87	.068	169	.38	.960	169	.13
84.96	.068	625	.15	.958	625	.92
114.60	.104	94	.87	.954	94	.45

Ⅳ. CONCLUSIONS

As a result of analysis, yearly average of 40.80m^2, 59.97m^2, 81,87m^2, 84.96m^2, 114.60m^2 increases relatively to 575.84m^3, 728.99m^3, 891.86m^3, 896.06m^3, 114.60m^3 in average gas consumption amount as the size of each exclusive dwelling area increases but gas consumption amount by 1m^2 was shown to have opposite trend. Thus, as exclusive dwelling area gets bigger, gas consumption amount by 1m^2 decreased to 14.11m^3, 12.15m^3, 10.89m^3, 10.54m^3, and 9.57m^3.

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