A Study on the Method for the Capacity Determination of Water Supply System in Industrial Complex

By

SONG, Young Sun

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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Committee in charge:

Professor Lee, Junesoo, Supervisor ______________________ Junesoo Lee

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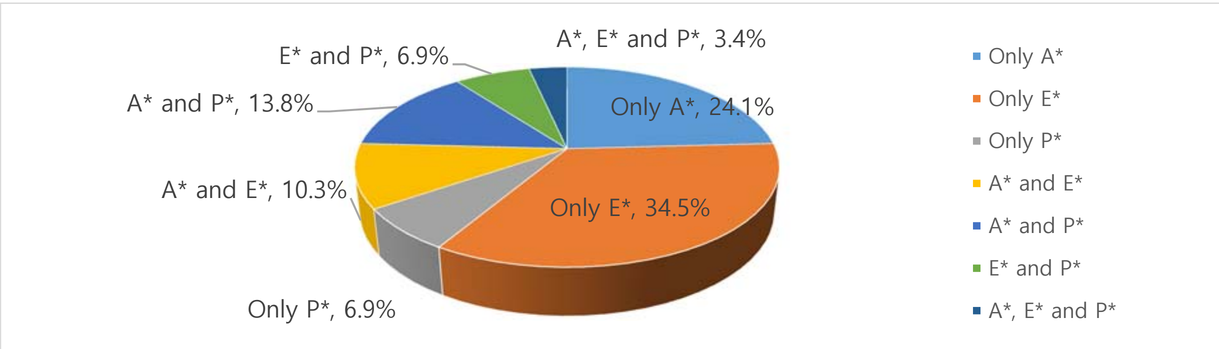
Approval as of May, 2020

Executive summary

In the past, many planners in the field of water use water consumption per land area although the circumstance of the industry is changing as time went on. The reason is that the method is simple to apply. Using 4.5 thousand data, this study examines which factors (land area, the number of employees, amount of product) are most closely related to the water consumption in industrial complexes. At first, whether the land area is statistically significant with water consumption. And then, the statistical significance is analyzed between the land area, the amount of production, the number of employees, and the water consumption. If the analytical values by the two methods are not statistically appropriate to use, the present middle-classification code of manufacture is reviewed by sub-classification or by a small group with sub-classification.

This study is shown that water consumption in each manufacturer was not absolutely dependent on the land area due to the different nature of water consumption in each industry. For each code of manufacturing, a single variable (A(land area), E(number of employees), P(amount of product)) or many variables affects water consumption. Therefore, the sole application of land area unit when forecasting future industrial water use may not only lead to errors in the reliability of the forecasts but also affect the sizing of water supply facilities or sewage treatment facilities.



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1. Introduction

1.1 Background

Urban planners design industrial complex or attract anchor facilities for urban self-sufficiency and rapid growth. In addition, they provide urban services by combining construction and information and communication technologies to improve the competitiveness of cities and quality of life. All combined, these would constitute what people call ‘smart city.’ Smart City is the fastest growing market for the next decade since it is most closely linked to our lives. However, there is a problem to be solved behind this urban growth. Smart Water, one of the main agendas of Smart City, suggests that water management, water supply and city flood management are needed. In addition, in the United Nations Sustainable Development Goals (SDGs), which are to be implemented as common goals in the international community by 2030, water including use and distribution issue is contained among the Goals. Water is necessary not only for human survival but also for the formation and maintenance of cities. However, since water is a finite resource and there is a seasonal shortage by region, the stable supply and distribution of water for everyone are not always achieved.

Regarding the current world's water environment, the World Resource Institute (WRI) released five national water stress groups and rankings. Most Middle Eastern countries, which contains a quarter of the world's population, has been classified as 'Extensively high water stress group', experiencing shortage of water usage. Korea also ranked 53rd out of 164 countries in the ‘Medium water stress group.’ In fact, Korea has experienced severe spring and winter droughts in Gang-won, Chung-cheong, and parts of Gyeong-gi provinces. In order to secure reliable water resources, dams are needed, but additional construction of dams is very difficult due to opposition from local residents and environmental groups. Efforts to secure available resources through reuse of sewage, collection of rainwater, and construction of underground dams is required as well as efficient management of water pipes. The excess water in some areas generated by these efforts can transfer water resources to shortage regions. Of course, considering that water movement is a very sensitive issue, the methods of future demand forecasting should also be reliable and most important of all. It will lead to accurately determining size of water supply plant and the project cost.

Therefore, continuous research should be required on these related fields. Every year, water for living is surveyed by region wand the results are accessible. However, in the case of industrial water supplied to industrial complexes, it is difficult to investigate and secure data due to companies avoiding the release. As the changing environment (smartization, environment-friendly and high-efficiency production environment, joint installation of environmental facilities infrastructure) of industrial complexes is not reflected, we can only rely on the raw units to review the atmosphere.

1.2 Objectives

This study examines which factor is most closely related to the water use in industrial complexes. The direct inspiration of this study is the research by LH. LH has been conducting related research on industrial complexes every five years since 1998. In a recent study (2015, LH), they conducted time series analysis. The results showed that there was a decrease in the land area, increase in building total floor area, and increase in the number of employees per factory's area as time went on. In other words, they explained the land is being used and pressured by increasing the building floor area.

Based on the results of these studies, the question of whether it is appropriate to apply the water consumption unit per land area in determining the water supply scale of industrial complexes has been raised. So, using the 2016 K-water's basic survey data on industrial complexes, SPSS statistical analysis program is used to analyze the relationship between land area, number of employees, amount of product, and water consumption. This study aims to derive statistically significant key factors and resulting proper formula. In addition, this study covers the limitations of this study and ways to improve the future investigation of industrial complexes. The project consists of five parts.

First, this study sets the background and scope. Second, the international and domestic study trends examined to set and the study directions. Third, it examines whether the area, amount of product, employees and water consumption have statistically significant correlation. Fourth, if the results reviewed by the two analyses (regression for land area, regression for the others) are not appropriate, another analysis is conducted considering the significance by subdividing the mid-class sectors or grouping them into sub-classes. Based on the data with significance, the study would present the functional formulas for each manufacture code through the regression analysis. Lastly, this study presents additional suggestions water consumption surveys of industrial complexes.

2. Literature Review

This study introduces domestic and foreign precedent studies related to the forecast of water demand in industrial complexes. The arithmetic mean of area units in Cheong-ju Industrial complex was presented in Kim's research (1987). Industrial water raw units in Korea are surveyed by many institutions, although it is difficult to apply due to difference the characteristics of each region (Kim, 1990). In order to estimate industrial water of Daejeon 1st and 2nd Industrial Complex, the unit of land area and number of employees were applied (Lim, 1999). As a result of calculating the correlation between the changes of land area, industrial water consumption, industrial electricity consumption and amount of product in Gwang-ju industrial complex, significant results were not found (Park, 2001). Industrial water was predicted using demand function based on price elasticity. In this study, it is suggested that the application of land area unit(water consumption unit per land area) may not forecast water demand because it cannot reflect changes in other factors such as output and water price (Min, 2005).

Regarding government research, it was shown that the use of industrial water by industry (middle classification) varies greatly from company to company, resulting in severe dispersion of the amount of product, employees, land area, and water consumption among the same manufactures. In addition, it includes uncertainty so that it cannot be uniformly estimated for industrial water demand (The Ministry of Construction and Transportation, 2005). One study surveyed 330,000 companies in industrial complexes. After eliminating outliers, this study presented water unit per each four factors of per amount of product, number of employees, land area, and building area (The Ministry of Land, Transport and Maritime Affairs, 2007). Regarding cases of public institute research, based on the site visit survey of 1,500 companies and national approval statistics, the minimum, maximum, average, and standard deviations of land area, employees, amount of product, building area, and annual average water volume for each manufacture code were presented. In addition, based on the data collected four times from 2006 to the present, the changes in the number of employees, land area, building area, and amount of product were analyzed and presented. While the output per employee increased, the factory's land area decreased to 88.7% and, conversely, the building area in the same period increased by 54.1%. In addition, the number of employee per 1,000 square meters of factory area is also increasing by 10.3%, and water unit per land area is increasing by 58%, so manufacturing companies in Korea use less factory's land area but rather use land by compressing the land area (LH, 2015). The Ministry of Land, Transport Affairs (2016) surveyed four factors (land area, employees, amount of product, water consumption) for more than 4.3 thousand companies with manufacture business. After eliminating outliers, the water unit per land area for each manufacture code was presented.

The Ohio industrial water surveyed the number of employees and water consumption and applied the method of predicting the number of employees by SIC code similar to the Korean standard industrial classification system in Korea (IDWR Report, 2011). Industrial water estimates can predict the number of employees, the amount of product, and annual sales. It was also shown that the coefficients applied to predict industrial water may not be accurate due to the variability of many influencing factors (USGS Guidelines, 2015). Industrial water uses economic models including value-added and employment using growth scenarios to account for uncertainties about the future economy (Rinaud, 2015). Data from 2000 to 2012 was used to forecast industrial water demand for the 2013 and 2014 for Jang-eon city in China. The research was shown that it weighted employees, industrial investment, GDP, electricity consumption, and amount of product in the order, reviewed for similarities in historical data, and applied stepwise regression analysis (Bohan, 2017). When forecasting industrial water in Hamburg, water consumption will increase in proportion to future employment or sales (Johann, 2017).

In summary, there is a volatility depending on the type of industry and various factors, including number of employees, land area, amount of product, and economic growth level in determining the industrial water supply scale. It is necessary to reflect the conditions in which changes in the characteristics of industrial complexes should be reflected. However, in this study, except for the economic growth scenario, I would examine the statistical review, analysis, and suggestions on impact factors of each manufacturing code by the present classification standard of manufacturing.

3. Methodology

3.1 Methodology

The methods of this study for determining the supply size of water for industrial complexes is to derive the influencing factors of how the land area, employees and amount of product of more than 4.5 thousand companies from the 2016 survey influences on water consumption. First of all, this study concerns whether land area is statistically significant with water use. Then, the statistical significance is analyzed between the land area, the amount of production, the number of employees, and the water consumption. If the analytical values by the two methods are not statistically appropriate to use, the present middle-classification code of manufacture is reviewed by sub-classification or by a small group with sub-classification.

Comparing the results of the review of the above methods, we select the water consumption and the statistically significant factors, finally presenting the equation function.

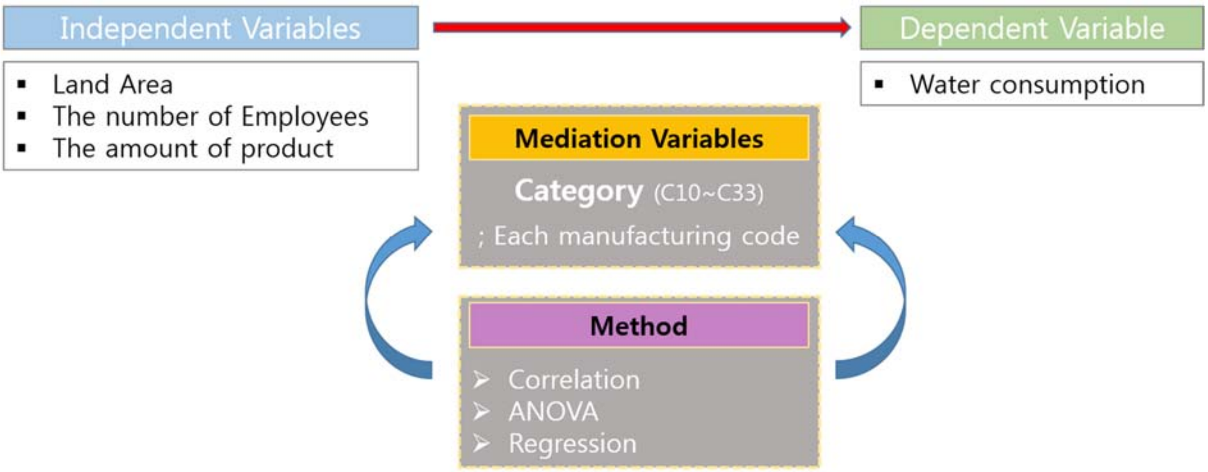

Figure 1. Model structure & method

3.2 Analysis Data

This study used data on land area, employees, amount of product and water consumption of 4.5 thousand companies from K-water's survey of industrial complexes in 2016. The minimum number of samples required to obtain a reliable regression model is at least 30 obtain one useful model equation (Milesand shevlin, 2001). Therefore, the surveyed data were applied in this analysis in order to secure the maximum number of samples, even if all four items (land area, employees, amount of product, water consumption) for every manufacture code were not surveyed.

(The number of : #)

Manufacturer		# companies	# product	# employees	# area	water usage
C10	food products	201	170	201	199	178
C11	beverages	31	25	31	31	27
C13	textiles	219	181	219	219	196
C14	wearing apparel, clothing accessories and fur articles	54	44	53	53	53
C15	leather, luggage and footwear	32	26	31	30	31
C16	wood and of products of wood and cork	48	35	48	46	44
C17	pulp, paper and paper products	81	65	80	81	66
C18	Printing and reproduction of recorded media	72	55	72	71	68
C19	coke, briquettes and refined petroleum products	30	18	29	30	25
C20	chemicals and chemical products	254	178	254	254	221
C21	pharmaceuticals, medicinal chemical and botanical products	34	22	34	32	32
C22	rubber and plastics products	252	190	251	249	219
C23	other non-metallic mineral products	92	64	92	91	81
C24	basic metals	217	154	217	215	184
C25	fabricated metal products,	959	725	958	944	855
C26	electronic components, computer; visual, sounding, communication	451	345	449	441	419
C27	medical, precision and optical instruments, watches	185	119	185	179	164
C28	electrical equipment	405	261	404	397	367
C29	other machinery and equipment	969	706	964	963	855
C30	motor vehicles, trailers and semitrailers	349	269	346	346	299
C31	other transport equipment	111	76	111	110	102
C32	Manufacture of furniture	40	31	40	40	38
C33	Other manufacturing	54	28	54	54	`52
sum		**5,140**	**3,787**	**5,123**	**5,075**	**4,524**

Table 1. Date Surveyed by manufacture code

3.3 Theoretical Background

Correlation Analysis

The relationship between variables is called correlation, and the measurement of the degree or intensity of the relationship is called correlation coefficients. Correlation analysis is a method that shows the degree and direction of the change when one variable changes, and how linearly related the two-interval and scale variables are.

Coefficient of determination

Coefficient of determination (R^2) is the ratio of the variation explained by the sample regression equation. If all observations are fully explained by sample regression, all residuals (errors) are zero and R^2 is one. Conversely, if $R^2 = 0$, it means that the regression equation does not account for any variation in the observations.

ANONA

Variance analysis can be performed using the variances with the coefficient of determination and hypothesis testing of the regression coefficient. If the calculated F-value exceeds the threshold (0.05), the null hypothesis is rejected and the alternative hypothesis is adopted. In other words, the independent variable has significant explanatory power for the variation in the dependent variable.

Regression analysis

Correlation is examined to determine whether there is a relationship between the two or more variables and is expressed specifically in a formula that describes the relationship. Finding specific relational formulas is referred to as regression analysis. Regression analysis is a statistical technique for determining the precision of the influence of an independent variable (cause) on a dependent variable (result). Regression analysis is based on the causal relationship between the observed variables. This should be a logical basis to support the fact that changes in the dependent variables are caused by changes in independent variables. The purpose is to find regression formulas that are expressed as a function of independent variables that well describes the dependent variables.

In this study, simple regression analysis between the land area and water consumption was applied. In addition, stepwise regression was used between multiple factors (the land area, the employees, amount of product) and the water consumption since it was necessary to increase the coefficient of determination and to identify the significant independent variables. This method is possible to seek the advantage of using a number of independent variables to find the validity of the explanation and increase the forecasting power of the dependent variables, and it prevents that meaningless independent variable that may impede the suitability or feasibility of the regression model.

Multicollinearity analysis

The close correlation between the independent variables makes it difficult to identify each of these individual effects, resulting in a failure to provide independent information. The higher the coefficient of determination (R^2), the higher the explanatory power of the regression equation, but the large P-value of the independent variable may mean that individual factors are not significant. In this case, multicollinearity might have occurred among independent variables. Analyzing the Variance inflation factor (VIF) and Tolerance (1/VIF) allows the evaluation of multicollinearity, which can be suspected if the VIF value is greater than 10 and the tolerance limit is 0.1.

4. Analysis and findings

4. 1. Analysis of 23 manufacture code

The surveyed data were analyzed according to the methodology described above. First, as planners depended on the land area unit method for forecasting water demand in industrial complexes, I analyzed the correlation coefficient (Pearson Correlation) to check whether the land area or the other factors are related to water consumption using the SPSS program. The analysis results are shown in Table-2.

Code	Manufacture	Amount of product	Employees	Area
C10	food products	0.186	0.626	0.547
C11	beverages	0.431	0.232	0.584
C13	textiles	0.468	0.630	0.490
C14	wearing apparel, clothing accessories and fur articles	-0.126	0.405	0.459
C15	leather, luggage and footwear	-0.043	0.181	0.237
C16	wood and of products of wood and cork	0.864	0.579	0.104
C17	pulp, paper and paper products	0.851	0.626	0.914
C18	Printing and reproduction of recorded media	0.962	0.870	0.338
C19	coke, briquettes and refined petroleum products	0.996	0.985	0.626
C20	chemicals and chemical products	0.034	0.609	0.799
C21	pharmaceuticals, medicinal chemical and botanical products	0.963	0.229	0.526
C22	rubber and plastics products	0.956	0.812	0.253
C23	other non-metallic mineral products	0.413	0.937	0.922
C24	basic metals	0.875	0.364	0.417
C25	fabricated metal products,	0.383	0.557	0.687
C26	electronic components, computer; visual, sounding, communication	0.642	0.645	0.890
C27	medical, precision and optical instruments, watches	-0.027	0.453	0.673
C28	electrical equipment	0.481	0.586	0.725
C29	other machinery and equipment	0.816	0.714	0.029
C30	motor vehicles, trailers and semitrailers	0.866	0.534	0.670
C31	other transport equipment	0.063	0.836	0.795
C32	Manufacture of furniture	0.903	0.926	0.853
C33	Other manufacturing	0.311	0.683	0.208

Table 2. Correlation between water consumption and many factors in manufacture code

Under 0.5	0.5~0.6	0.6~0.7	0.7 ~ 0.8	Over 0.8
12EA C10, C11, C13, C14, C15, C20, C23, C25, C27, C28, C31, C33		1EA C26		10EA C16, C17, C18, C19, C21, C22, C24, C29, C30, C32

Table 3. Correlation range between water consumption and amount of product

Under 0.5	0.5~0.6	0.6~0.7	0.7 ~ 0.8	Over 0.8
7Ea C11, C14, C15, C21, C24, C27, C28	3Ea C16, C25, C30	6Ea C10, C13, C17, C20, C26, C33	1Ea C29	6Ea C18, C19, C22, C23, C31, C32

Table 4. Correlation range between water consumption and employees

Under 0.5	0.5~0.6	0.6~0.7	0.7 ~ 0.8	Over 0.8
8Ea C13, C14, C15, C16, C18, C22, C24, C29, C33	3Ea C10, C11, C21	4Ea C19, C25, C27, C30	3Ea C20, C28, C31	4Ea C17, C23, C26, C32

Table 5. Correlation range between water consumption and land area

The adoption was decided by comparing the results of simple regression analysis based on each manufacturing sector (x) and water consumption (y) and the results of multiple regression analysis based on three x variables (land area, amount of product, employees) and water consumption (y).

A simple regression analysis was performed for the land area (x) and water consumption (y) in C10 (manufacture code).

Test Type	Regression Analysis
Type of variables	x : Area (*Ratio*) / y : annual use of water (*Ratio*)
Hypotheses	H_0: Area does not affect annual use of water in industrial complex. (x does not affect y)
	H_1: Area affects annual use of water in industrial complex (x affects y).
Level of Significance	$\alpha = 0.05$ (5%)

For this regression model, R Square is 0.299, in which 29.9% of the variation in y is explained by X variable. Meanwhile, the Adjusted R-Square is 0.295

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.547[a]	.299	.295	63308.953	1.831

a. Predictors: (Constant), area
b. Dependent Variable: annualuseofwater

Since p-value from ANOVA table is 0.000, which is smaller than α = 0.05 (5%, the level of significance), the regression model is good fit.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	298146812439.667	1	298146812439.667	74.387	.000[b]
	Residual	697396098174.492	174	4008023552.727		
	Total	995542910614.159	175			

a. Dependent Variable: annualuseofwater
b. Predictors: (Constant), area

$\hat{y}$= a+bx = 2835.858+2.437x (this function is used to predict y for any given x).

$\hat{y}$= βx = 0.547x (x affects y with strength of 0.547).

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2835.856	5189.904		.546	.585		
	area	2.437	.283	.547	8.625	.000	1.000	1.000

a. Dependent Variable: annualuseofwater

The p-value is 0.005, which is smaller than α = 0.05. The null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. To sum up, it indicates that the land area affects annual use of water in industrial complex. However, the coefficient of determination was very low and there was a limit in explaining the analyzed formula, so multiple regression analyses was conducted with the other factors.

Test Type		Regression Analysis (stepwise)
Type of variables (all Ratio)		x_1 : Area , x_2 : employees, x_3 : amount of products y : annual use of water (*Ratio*)
Hypotheses	H_1	H0: Area does not affect annual use of water. (x1 does not affect y) H1: Area affects annual use of water. (x1 affects y)
	H_2	H0: Employees does not affect annual use of water. (x2 does not affect y) H0: Employees affects annual use of water. (x2 affects y)
	H_3	H0: Amount of products does not affect annual use of water. (x3 does not affect y) H0: Amount of products affects annual use of water. (x3 affects y)
Level of Significance		$\alpha = 0.05$ (5%)

For this regression model, R Square of model 1 is 0.352, in which 35.2% of the variation in y is explained by X_2 variable. And R Square of model 2 is 0.410, in which 41.0% of the variation in y is explained by X_2 variable and X_1 variable. Since the R square went up to 0.410 when we included both independent variables, we see that both variables explain the variation in y better when combined with one another.

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.593[a]	.352	.347	61016.547	
2	.640[b]	.410	.402	58392.914	1.729

a. Predictors: (Constant), employee
b. Predictors: (Constant), employee, area
c. Dependent Variable: annualuseofwater

Since p-value from ANOVA table is 0.000, which is smaller than $\alpha = 0.05$ (5%, the level of significance), the regression model is good fit.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	308836677159.036	1	308836677159.036	82.953	.000[b]
	Residual	569621902979.931	153	3723018973.725		
	Total	878458580138.968	154			
2	Regression	360179253085.262	2	180089626542.631	52.816	.000[c]
	Residual	518279327053.706	152	3409732414.827		
	Total	878458580138.968	154			

a. Dependent Variable: annualuseofwater
b. Predictors: (Constant), employee
c. Predictors: (Constant), employee, area

(Model 1)

$\hat{y} = a + b_1x_1 + b_2x_2 = -3701.228+542.961x_2$

$\hat{y} = \beta_1x_1 + \beta_2x_2 = 0.593x_2$

(Model 2)

$\hat{y} = a + b_1x_1 + b_2x_2 = -6629+410\ x_1+1.219\ x_2$

$\hat{y} = \beta_1x_1 + \beta_2x_2 = 0.448\ x_2+0.282x1$

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-3701.228	5535.519		-.669	.505		
	employee	542.961	59.614	.593	9.108	.000	1.000	1.000
2	(Constant)	-6629.708	5350.985		-1.239	.217		
	employee	410.617	66.468	.448	6.178	.000	.737	1.357
	area	1.219	.314	.282	3.880	.000	.737	1.357

a. Dependent Variable: annualuseofwater

The p-value in the Coefficient table for employees(x_2 variable) is 0.000, which is smaller than α = 0.05 (5%, the level of significance). The null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. To sum up, it indicates that number of employees significantly affects water consumption

The p-value in the Coefficient table for area(x_1 variable) is 0.000, which is smaller than α = 0.05 (5%, the level of significance). The null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. In other words, it indicates that the land area significantly affects water consumption. However, there is a limitation in explaining the formula because it was shown that has a low coefficient of determination. Therefore, further consideration is required to sub-classify or small-group with subclass the C10 (manufacture code) to obtain a coefficient of determination of 0.6 or higher. In this way, 23 manufacture codes from C10 to C33 were analyzed in the same way, and the analysis results for each code are as follows.

C11 (Manufacture of beverages) was adopted by showing a higher coefficient of determination of the results of the multiple regression analysis, although both single and multiple regression analyses were statistically significant.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.584	0.341	0.001	A*+E*	0.866	0.852	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 6. Analysis result of C11

C13 (Fabric manufacturing) is statistically significant for both simple and multiple regression analysis, but the coefficient of determination is low and required to be sub-classify or small-grouped for review.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.490	0.240	0.000	(M1) E*	0.630	0.397	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 7. Analysis result of C13

C14 (Manufacture of wearing apparel, clothing accessories and fur articles) is statistically significant for both simple regression analysis and multiple regression analysis, but the C14 needs to be sub-classify or small-grouped for review due to its low coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.459	0.210	0.001	(M1) A*	0.531	0.282	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 8. Analysis result of C14

C15 (Manufacture of leather, luggage, and footwear) is not statistically significant in both simple regression and multiple regression analysis. Therefore, it is required to be sub-classify or small-grouped for review

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.237	0.056	0.217	-	-	-	N.G

※ A*: Area, E*: Employees, P*: Amount of products

Table 9. Analysis result of C15

C16 (Manufacture of wood and of products of wood and cork) adopted multiple regression analysis because the simple regression analysis was not statistically significant.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.104	0.011	0.511	P*	0.867	0.752	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 10. Analysis result of C16

C17 (Manufacture of pulses, paper, and paper products) adopted a simple regression analysis that is easier to apply though both simple and multiple regression analysis has high coefficient of determination and are statistically significant.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.914	0.835	0.000	(M1) A*	0.917	0.841	0.000
-	-	-	-	(M2) A*+P*	0.960	0.922	0.000
-	-	-	-	(M3) A*+P*+E*	0.968	0.938	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 11. Analysis result of C17

C18 (Printing and production of recorded media) is not suitable for applying simple regression analysis (x variable: land area) due to a low coefficient of determination, but results from simple regression analysis (x variable: employees) or multi regression analysis (x variable: the amount of product) are possible for applying.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.338	0.114	0.005	**P***	**0.962**	**0.925**	**0.000**
E*	**0.870**	**0.756**	**0.000**	-	-	-	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 12. Analysis result of C18

C19 (Manufacture of coke, bindets, and defined petroleum products) are not suitable for simple regression analysis with a low coefficient of determination but results from simple regression analysis(x variable: employees) or multiple regression analysis (x variable: the amount of product) are possible for applying.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.626	0.392	0.001	**P***	**0.996**	**0.991**	**0.000**
E*	**0.985**	**0.970**	**0.968**	-	-	-	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 13. Analysis result of C19

C20 (Manufacture of chemicals and chemical products) is statistically significant in both simple regression and multiple regression analysis, it was adopted simple regression analysis due to a high coefficient of determination.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.799	0.638	0.000	A*+E*	0.696	0.485	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 14. Analysis result of C20

C21 (Manufacture of pharmaceuticals, medicinal chemical and botanical products) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.526	0.277	0.003	(M1) P*	0.965	0.932	0.000
-	-	-	-	(M2) P*+A*	0.982	0.964	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 15. Analysis result of C21

C22 (manufacture of rubber and plastics products) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.253	0.064	0.000	(M1) P*	0.956	0.914	0.000
-	-	-	-	(M2) P*+A*	0.931	0.930	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 16. Analysis result of C22

C23 (Manufacture of other non-metallic mineral products) is statistically significant in both simple regression and multiple regression analysis, it was adopted simple regression analysis due to a high coefficient of determination.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.922	0.850	0.000	-	-	-	

※ A*: Area, E*: Employees, P*: Amount of products

Table 17. Analysis result of C23

C24 (manufacture of basic metals) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.417	0.174	0.000	(M1) A*	0.910	0.828	0.000
-	-	-	-	(M2) A*+P*	0.928	0.861	0.000
-	-	-	-	(M3) A*+P*+E*	0.931	0.868	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 18. Analysis result of C24

C25 (Manufacture of fabricated metal products) is statistically significant for both simple regression analysis and multiple regression analysis, but the C14 needs to be sub-classify or small-grouped for review due to its low coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.687	0.472	0.000	(M1) A*	0.530	0.281	0.000
-	-	-	-	(M2) A*+P*	0.555	0.308	0.000
-	-	-	-	(M3) A*+P*+E*	0.579	0.335	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 19. Analysis result of C25

C26 (Manufacture of electronic components, computer; visual, sounding, communication) adopted a simple regression analysis that is easier to apply though both simple and multiple regression analysis has high coefficient of determination and are statistically significant.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	p-value	Factor	R	R Square	p-value
A*	0.890	0.792	0.000	(M1) A*	0.892	0.795	0.000
-	-	-	-	(M2) A*+P*	0.902	0.814	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 20. Analysis result of C26

C27 (Manufacture of medical, precision, optical instruments, watches) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.673	0.452	0.000	(M1) A*+P*+E*	0.784	0.614	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 21. Analysis result of C27

C28 (Manufacture of electrical equipment) is statistically significant for both simple regression analysis and multiple regression analysis, but the C14 needs to be sub-classify or small-grouped for review due to its low coefficient of determination.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.725	0.525	0.000	A*+P*	0.605	0.360	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 22. Analysis result of C28

C29 (Manufacture of other machinery and equipment) adopted multiple regression analysis because the simple regression analysis was not statistically significant.

Simple Regression Analysis : Not adopted				Multiple Regression Analysis : Adoption			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.029	0.001	0.403	(M1)A*	0.916	0.839	0.000
-	-	-	-	(M2)A*+E*	0.948	0.899	0.000
-	-	-	-	(M3) A*+E*+P*	0.949	0.900	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 23. Analysis result of C29

C30 (Manufacture of motor vehicles, trailers and semitrailers) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Not adopted				**Multiple Regression Analysis : Adoption**			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.670	0.448	0.000	(M1)A*	0.890	0.792	0.000
-	-	-	-	(M2)A*+P*	0.910	0.828	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 24. Analysis result of C30

C31 (Manufacture of other transport equipment) is statistically significant in both simple regression and multiple regression analysis, it was adopted multiple regression analysis due to having a high coefficient of determination. There are possible for applying both X variables (land area or employees).

Simple Regression Analysis : Adoption				**Multiple Regression Analysis : Not adopted**			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.795	0.632	0.000	A*+P*+E*	0.083	0.007	0.934(N.G)
E*	0.836	0.698	0.000	-	-	-	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 25. Analysis result of C31

C32 (Manufacture of furniture) adopted a simple regression analysis that is easier to apply though both simple and multiple regression analysis has high coefficient of determination and are statistically significant.

Simple Regression Analysis : Adoption				**Multiple Regression Analysis : Not adopted**			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.853	0.728	0.000	(M1) E*	0.938	0.880	0.000
-	-	-	-	(M2) E*+A*	0.954	0.910	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 26. Analysis result of C32

C33 (Other manufacturing) is statistically significant in both simple regression and multiple regression analysis, it was adopted simple regression analysis due to having a high coefficient of determination.

Simple Regression Analysis : Adoption				Multiple Regression Analysis : Not adopted			
Factor	R	R Square	ANOVA : p-value	Factor	R	R Square	ANOVA : p-value
A*	0.208	0.043	0.140	E*+A*	0.812	0.660	0.000

※ A*: Area, E*: Employees, P*: Amount of products

Table 27. Analysis result of C33

The results of the statistical significance review and regression analysis among each factor for 23 of manufacture codes are summarized in Table-28.

Code	R Square	Factor*	ANOVA (p-value)	Formula	Collinearity	
					Tolerance	VIF
C10	0.299	A*	0.000	y = 2835.856+2.437*A y = 0.547*A	1.000	1.000
C11	0.866	A* E*	0.000	y = -5110+6.076 *A-704.493*E y = 1.139*A – 0.498*E	1.000	1.000
C13	0.240	A*	0.000	y = -3734.712+13.144*A y = 0.490*A	1.000	1.000
C14	0.210	A*	0.001	y = 746.669+0.160*A y = 0.459*A	1.000	1.000
C15	0.056	A*	0.217	y = 2554.340+1.101*A y = 0.237*A	1.000	1.000
C16	0.752	P*	0.000	y = 226.290+0.104*P y = 0.867*P	1.000	1.000
C17	0.938	A* P*	0.000	y = -53259.987+8.908*A+4.392*P y = 0.630*A+0.405*P	0.499	2.003
C18	0.756	E*	0.000	y = -920.313+127.993*E y = 0.870*E	1.000	1.000
C19	0.991 0.970	P* E*	0.000 0.000	y = 242199.056+1.334*P y = 0.996*P y = 137881.886+13004.033*E y = 0.985*E	1.000 1.000	1.000 1.000
C20	0.638	A*	0.000	y = -28088.626+7.990*A y = 0.799*A	1.000	1.000
C21	0.964	P* A*	0.000	y = 8351.856+0.167*P-0.757*A y = 1.136*P-0.247*A	0.523	1.923
C22	0.931	P* A*	0.000	y = 8351.856+0.167*P-0.757*A y = 1.136*P-0.247*A	0.875	1.143
C23	0.850	A*	0.000	y = -16363.262+2.608*A y = 0.922*A	1.000	1.000
C24	0.861	A* P*	0.000	y = -11725.670+1.971*A+0.492*P y = 0.605*A+0.356*P	0.263	3.805
C25	0.472	A*	0.000	y = 1041.503+0.693*A y = 0.687*A	1.000	1.000
C26	0.792	A*	0.000	y = -3022.812+2.853*A y = 0.890*A	1.000	1.000
C27	0.614	A*P*E*	0.000	y=-5696.20+5.687A-0.882*P+242.37*E y = 0.683*A-0.349*P+0.258*E	0.690	1.448
C28	0.525	A*	0.000	y = -387.607+1.908*A y = 0.725*A	1.000	1.000
C29	0.899	A* E*	0.000	y = -800.749+0.283*A+71.510*E y = 0.607*A+0.395*E	0.386	2.590
C30	0.828	A* E*	0.000	y = -1475.109+0.601*A+0.120*E y = 0.560*A+0.381*E	0.246	4.057
C31	0.632	A*	0.000	y = -1328.548+1.024*A y = 0.795*A	1.000	1.000

	0.698	E*	0.000	y = -2232.852+354.310*E y = 0.836*A	1.000	1.000
C32	0.728	A*	0.000	y =-124.880+0.384*A y = 0.853*A	1.000	1.000
C33	0.660	E*P*	0.000	y =-505.329+195.006*E-0.603*P y = 1.265*E-0.707*P	0.352	2.842

Table 28. Analysis of C10-C33

Water consumption in all manufacturing industries (twenty-three manufacture codes) is not dependent solely on the land area variables, but it can be affected by various factors. Table-29 showed these influence factors obtained through the regression analysis. Furthermore, six manufacture codes (C10, C11, C13, C14, C15, C25, C28) were analyzed again after sub-classification for obtaining a higher coefficient of determination and statistically significant value.

(unit : the number of sectors of manufacturer)

Only A*	Only E*	Only P*	A* and E*	A* and P*	E* and P*	A*, E* and P*
4	3	1	3	4	1	1

※ A*: Area, E*: Employees, P*: Amount of products

Table 29. Classification of influence factors

4. Review of six manufacture codes

For the six industries (C10, C13, C14, C15, C25, and C28) that do not show statistically significant values or have a very low coefficient of determination among 23 manufacture codes in the industrial complexes, the review method is changed sub-classification or small groups with sub-classification rather than the current classification (middle manufacture code). The sub-classification system of the six manufacturers is as follows, and the coefficient of determination and the statistical significance were reviewed once again.

C10	Manufacture of food products	C101	Slaughtering of livestock, processing and preserving of meat and meat
		C102	Processing and preserving of fish, crustaceans, mollusks and seaweeds
		C103	Processing and preserving of fruit and vegetables
		C104	Manufacture of vegetable and animal oils and fats
		C105	Manufacture of dairy products and edible ice cakes
		C106	Manufacture of grain mill products, starches and starch products
		C107	Manufacture of other food products
		C108	Manufacture of prepared animal feeds and feed additives
C13	Manufacture of textiles, except apparel	C131	Spinning of textiles and processing of threads and yarns
		C132	Weaving of textiles and manufacture of textile products
		C133	Manufacture of knitted and crocheted fabrics
		C134	Dyeing and finishing of textiles and wearing apparel
		C139	Manufacture of other made-up textile articles, except apparel
C14	Manufacture of wearing apparel, clothing accessories and fur articles	C141	Manufacture of sewn wearing apparel, except fur apparel
		C142	Manufacture of articles of fur
		C143	Manufacture of knitted and crocheted apparel
		C144	Manufacture of apparel accessories
C15	Manufacture of leather, luggage and footwear	C151	Manufacture of leather, luggage and similar products
		C152	Manufacture of footwear and parts of footwear
C25	Manufacture of fabricated metal products, except machinery and furniture	C251	Manufacture of structural metal products, tanks, reservoirs and steam generators
		C252	Manufacture of weapons and ammunition
		C259	Manufacture of other fabricated metal products; metalworking service activities
C28	Manufacture of electrical equipment	C281	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
		C282	Manufacture of batteries and accumulators
		C283	Manufacture of insulated wires and cables
		C284	Manufacture of electric tubes and bulbs and lighting equipment
		C285	Manufacture of domestic appliances
		C289	Manufacture of other electrical equipment

Table 30. Sub-classification of 6 middle manufacture codes

The analysis results of C10 (Manufacture of food products) are as follows. The water consumption of C101 was influenced by the number of employees, and Group 1 (C103 ~ 106, 108) was affected by the amount of product. C102 and C107 were not statistically significant or were analyzed to have very low coefficients of determination.

Adoption		Not adopted	
C101	C103-106, 108 (Group 1)	C102	C107
R Square : 0.758 Statistically significant y = -14568.275+798.351*E y = 0.871*E	R Square : 0.705 Statistically significant y = -10137+428.18*E+0.325*P y = 0.535*E+0.427*P	R Square : Very low Not statistically significant	R Square : Very low

※ A*: Area, E*: Employees, P*: Amount of products

Table 31. Re-analysis result of C10

The analysis results of C13 (Manufacture of textiles, except apparel) are as follows. The water consumption of C133 and C134 was affected by the number of employees, but C131, C132, and C139 did not show statistically significant values.

Adoption		Not adopted		
C133	C134	C131	C132	C139
R Square : 0.762 Statistically significant y = -91.083+72928*E y = 0.873*E	R Square : 0.628 Statistically significant y = -7374.163+658.951*E y = 0.793*E	R Square : Very low Not statistically significant		

※ A*: Area, E*: Employees, P*: Amount of products

Table 32. Re-analysis result of C13

C14 (Manufacture of wearing apparel, clothing accessories and fur articles) was reviewed in three groups, each with different impact factors

Adoption			Not adopted
C141	C142~143	C144	-
R Square : 0.632 Statistically significant y = 41.861+14.377*E y = 0.795*E	R Square : 0.831 Statistically significant y = 201.862+0.292*A y = 0.912*A	R Square : 0.545 Statistically significant y =935.277+0.441*P y = 0.525*A	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 33. Re-analysis result of C14

The results of sub-classification analysis of C15 (Manufacture of Leather, Luggage, and Footwear) were shown a very low coefficient of determination and statistically insignificant.

Adoption	Not adopted	
-	C151	C152
-	R Square : Very low Not statistically significant	R Square : Very low Not statistically significant

※ A*: Area, E*: Employees, P*: Amount of products

Table 34. Re-analysis result of C15

The analysis results of C25 (Manufacture of fabricated metal products, except machinery and furniture) were shown that the water consumption of C251 is affected by the number of employees, C252 is affected by amount of product, and C259 is affected by land area.

Adoption			Not adopted
C251	C252	C259	-
R Square : 0.546 Statistically significant y = -2491.530+278.560*E y = 0.739*E	R Square : 0.932 Statistically significant y = 4481.177+0.009*P y = 0.965*P	R Square : 0.624 Statistically significant y =1179.058+0.671*A y = 0.790*A	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 35. Re-analysis result of C25

C28 (Manufacture of electrical equipment) was classified into two groups. The water consumption of C281 is very influenced by the number of employees, and group 1 (C282 ~ C289) was found to have an effect on the land area.

Adoption		Not adopted
C281	C282~289 (Group1)	-
R Square : 0.969 Statistically significant y = -323.921+62.379*E y = 0.984*E	R Square : 0.527 Statistically significant y = 1822.303+2.007*A y = 0.726*A	-

※ A*: Area, E*: Employees, P*: Amount of products

Table 36. Re-analysis result of C28

5. Conclusion / Policy recommendation / limitations

The results of the analysis in Table 37 present the factors affecting water consumption in the 23 manufacturing codes. The six manufacturing codes (C10, C13, C14, C15, C25, and C28) in Table 30-36 whose coefficient of determination were below 0.6 or do not represent statistically significant values were re-analyzed by a sub-classifying or small groups with sub-classification rather than the current classification.

Category (manufacturing code)	Unstandardized Coefficients of Independent Variables Combinations			R^2
	Land Area	Employees	Amount of product	
C10	2.437	-	-	0.299
(C101)	-	798.351	-	0.759
(C103~106, 108)	-	428.18	0.325	0.758
C11	6.076	-	704.493	0.866
C13	13.144	-	-	0.240
(C133)	-	72928	-	0.762
(C134)	-	658.951	-	0.628
C14	0.160	-	-	0.210
(C141)	-	14.377	-	0.632
(C142~143)	0.292	-	-	0.831
(C144)	-	-	0.441	0.545
C15	1.101	-	-	0.056
C16	-	-	0.104	0.752
C17	8.908	-	4.392	0.938
C18	-	127.993	-	0.756
C19	-	-	1.334	0.991
C20	7.990	-	-	0.638
C21	-	0.757	0.167	0.964
C22	2.441	-	5.367	0.931
C23	2.608	-	-	0.850
C24	1.971	-	0.492	0.861
C25	0.693	-	-	0.472
(C251)	-	278.560	-	0.546
(C252)	-	-	0.009	0.932
(C259)	0.671	-	-	0.634
C26	2.853	-	-	0.792
C27	5.687	242.37	0.882	0.614
C28	1.908	-	-	0.525
(C281)	-	62.379	-	0.969
(C282~289)	2.007	-	-	0.527
C29	0.283	71.510	-	0.899
C30	0.601	0.120	-	0.828
C31	1.024	-	-	0.632
C32	0.384	-	-	0.728
C33	-	195.006	0.603	0.660

Note. 1) Table 37 is shown that Unstandardized coefficients(Beta) from regression using SPSS program
2) y-intercept (constant) no mark. ; There are all coefficients with formula in the appendix.
3) C102, C107, C131, C132, C139, C151, C152 are shown statistically insignificant or very low coefficient of determinant.

Table 37. Results of Analysis

It is expected that this research will be used to predict the infra-capacity of the future industrial complex using formula. This process will enable the use of the formula with statistically significant results, but some small codes (C101, 107, C131, C132, C139, 151, and C152) would be difficult to apply because of the lack of statistical significance.

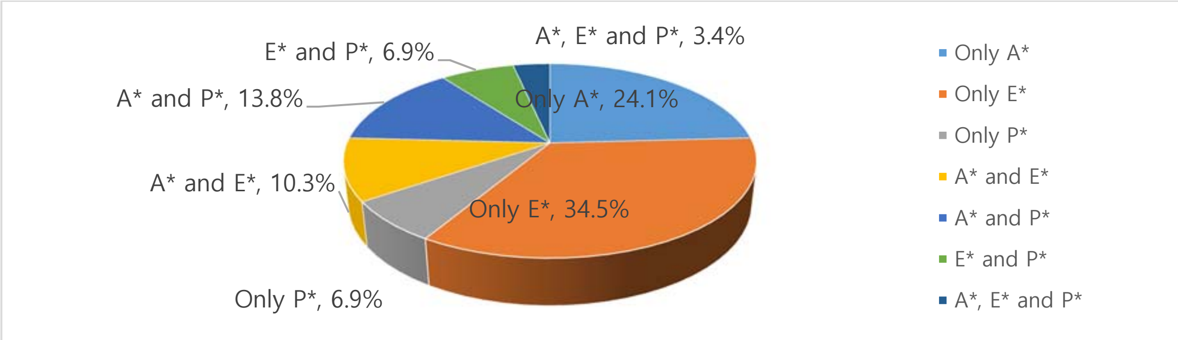

Figure 2. Rate of influence factors with water consumption

In the past, planners in the field of water usually used water consumption units per land-area because of their ease of application. The reason is that land area and manufacture codes in a new industrial complex on the initial planning stage are provided. Using this information, the planners are forecast water demand and determined proper infrastructure scale. However, this study is confirmed that water consumption each manufacturer were not absolutely dependent on the land area due to the different nature of water consumption in each industry. For each code of manufacturing, a single variable (land area, number of employees, amount of product) or many variables affects water consumption. Therefore, the sole application of land area unit when forecasting future industrial water use may not only lead to errors in the reliability of the forecasts but also affect the sizing of water supply facilities or sewage treatment facilities. This leads to unfeasible or inefficient investment in infrastructure.

This study analyzed 4,524 of the more than 3,995 samples needed to meet 95% confidence levels and 1.5% total margin of error at 62,123 companies in the industrial complexes of Korea. The figure (3,995 samples) of the 95% confidence levels and 1.5% total margin of error was quoted by the report of the Ministry of Land, Transport and Maritime Affairs (2016). However, the margins of error in each manufacture code are range from 10% to 20% since the number of data in the survey has deviations, it requires a lot of the number of data in order to reduce margins of error. Therefore, from the beginning of the survey, it is necessary to clarify the number of samples required for each manufacturing code to obtain survey data. In addition, government and public institutes that manage or plan industrial complexes should continue to expand their forecasting research on the basic units of number of employees, land-area, and amount of product. Since water is a public good that is limited by region and season, it must be distributed efficiently, taking into account the optimal use of the national budget for the installation of infrastructure for industrial water supply. Forecasting methods of reliable water demand for industrial complexes will be the basis for resource allocation and infrastructure installation scale.

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Appendix. Analysis Results of Manufacture codes (C10~C33)

Category (manufacture code)	R^2	Factor*	ANOVA (p-value)	**Formula** (Unstandardized coefficients) (Standardized coefficients)	**Not Adoptation**
C10	0.299	A*	0.000	y = 2835.856+2.437*A y = 0.547*A	C102, C107
(C101)	0.758	E*	0.000	y = -14568.275+798.351*E y = 0.871*E	
(C103~106, 108)	0.705	E* P*	0.000	y = -10137+428.18*E+0.325*P y = 0.535*E+0.427*P	
C11	0.866	A* E*	0.000	y = -5110+6.076 *A-704.493*E y = 1.139*A – 0.498*E	
C13	0.240	A*	0.000	y = -3734.712+13.144*A y = 0.490*A	C131, C132, C139
(C133)	0.762	E*	0.000	y = -91.083+72928*E y = 0.873*E	
(C134)	0.628	E*	0.000	y = -7374.163+658.951*E y = 0.793*E	
C14	0.210	A*	0.001	y = 746.669+0.160*A y = 0.459*A	
(C141)	0.632	E*	0.000	y = 41.861+14.377*E y = 0.795*E	
(C142~143)	0.831	A*	0.000	y = 201.862+0.292*A y = 0.912*A	
(C144)	0.545	A*	0.000	y =935.277+0.441*P y = 0.525*A	
C15	0.056	A*	0.217	y = 2554.340+1.101*A y = 0.237*A	C151, C152
C16	0.752	P*	0.000	y = 226.290+0.104*P y = 0.867*P	
C17	0.938	A* P*	0.000	y = -53259.987+8.908*A+4.392*P y = 0.630*A+0.405*P	
C18	0.756	E*	0.000	y = -920.313+127.993*E y = 0.870*E	
C19	0.991 0.970	P* E*	0.000 0.000	y = 242199.056+1.334*P y = 0.996*P y = 137881.886+13004.033*E y = 0.985*E	
C20	0.638	A*	0.000	y = -28088.626+7.990*A y = 0.799*A	
C21	0.964	P* A*	0.000	y = 8351.856+0.167*P-0.757*A y = 1.136*P-0.247*A	
C22	0.931	P* A*	0.000	y = -23451.654+5.367*P-0.2.441*A y = 1.005*P-0.138*A	
C23	0.850	A*	0.000	y = -16363.262+2.608*A y = 0.922*A	
C24	0.861	A* P*	0.000	y = -11725.670+1.971*A+0.492*P y = 0.605*A+0.356*P	
C25	0.472	A*	0.000	y = 1041.503+0.693*A y = 0.687*A	
(C251)	0.546	E*	0.000	y = -2491.530+278.560*E y = 0.739*E	
(C252)	0.932	P*	0.000	y = 4481.177+0.009*P y = 0.965*P	
(C259)	0.634	A*	0.000	y =1179.058+0.671*A y = 0.790*A	

C26	0.792	A*	0.000	y = -3022.812+2.853*A y = 0.890*A	
C27	0.614	A*P*E*	0.000	y=-5696.20+5.687A-0.882*P+242.37*E y = 0.683*A-0.349*P+0.258*E	
C28	0.525	A*	0.000	y = -387.607+1.908*A y = 0.725*A	
(C281)	0.969	E*	0.000	y = -323.921+62.379*E y = 0.984*E	
(C282~289)	0.527	A*	0.000	y = 1822.303+2.007*A y = 0.726*A	
C29	0.899	A* E*	0.000	y = -800.749+0.283*A+71.510*E y = 0.607*A+0.395*E	
C30	0.828	A* E*	0.000	y = -1475.109+0.601*A+0.120*E y = 0.560*A+0.381*E	
C31	0.632 0.698	A* E*	0.000 0.000	y = -1328.548+1.024*A y = 0.795*A y = -2232.852+354.310*E y = 0.836*E	
C32	0.728	A*	0.000	y =-124.880+0.384*A y = 0.853*A	
C33	0.660	E*P*	0.000	y =-505.329+195.006*E-0.603*P y = 1.265*E-0.707*P	