B2B Electronics Demand Forecast Model: PC Market Case

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Abstract: Businesses want a trustworthy approach to estimate market demand due to the rising level of demand uncertainty in the B2B electronics sector. For a corporation to avoid producing too few or too many of its products, which could have an effect on the performance of the business, an accurate estimation of the market demand is essential. However, given the wide variety of businesses in terms of size, industry, and mode of operation, it can be challenging to estimate demand in a B2B market, particularly for the private sector. For B2B PC products, this study suggests using both qualitative and quantitative demand forecasting methods. Personal work, common work, promotion, and welfare are the four separate criteria for projecting PC products in the B2B market while accounting for the variety of PC uses. These calculations are backed up by survey data gathered from specialists in 139 companies, which may be applied when a specific company evaluates the demand for PC products in a B2B market. The multiple regression model, which has variables for area, industry, and company size, is the suggested quantitative approach. When it is necessary to estimate the whole demand for the domestic PC market, the regression model may be used.

1 INTRODUCTION

With the start of colour TV broadcasting in 1980, the rapid spread of the PC market in the mid-1980s, the expansion of the Internet user base in the mid-to-late 1990s, and the emergence of smartphones in the late 2000s, the domestic electronic market continued to grow (Doane and Seward, 2014). However, due to the improvement of product durability, after-sales services and intensifying competition among manufacturers, the overall market growth has been slowing or declining in recent years (Doane and Seward, 2014). In the economic situation, uncertainty about the future economy is gradually increasing due to a decrease in household income growth rate and an increase in household debt burden (Doane and Seward, 2014). Looking at the size of the domestic electronic market, in 2014, it is estimated to be 39 trillion won, down 5% from the previous year, and in 2015, it is expected to reach 35.1 trillion won, down about 10% compared to 2014, as shown in

It also means a decline in the market for four consecutive years (Gartner Incorporated, 2014). In
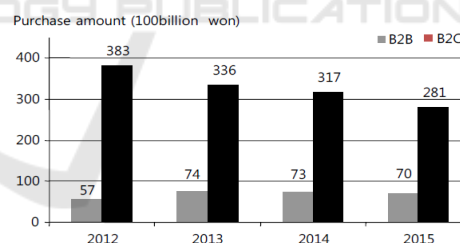
Figure 1: Domestic Electronics Market.

2015, it is analyzed that tablet PCs and hybrid PCs that will replace the existing PC market along with high-performance smartphones will lead the market demand (Gartner Incorporated, 2014).

The domestic electronic market can be broadly divided into B2C and B2B (Gartner Incorporated, 2014). B2C means a market for individuals, mass retailers, department stores, exclusive stores of suppliers, home shopping, and individual sales at online shopping malls (Gartner Incorporated, 2014). On the other hand, B2B refers to the market for corporations and public institutions, and the B2B
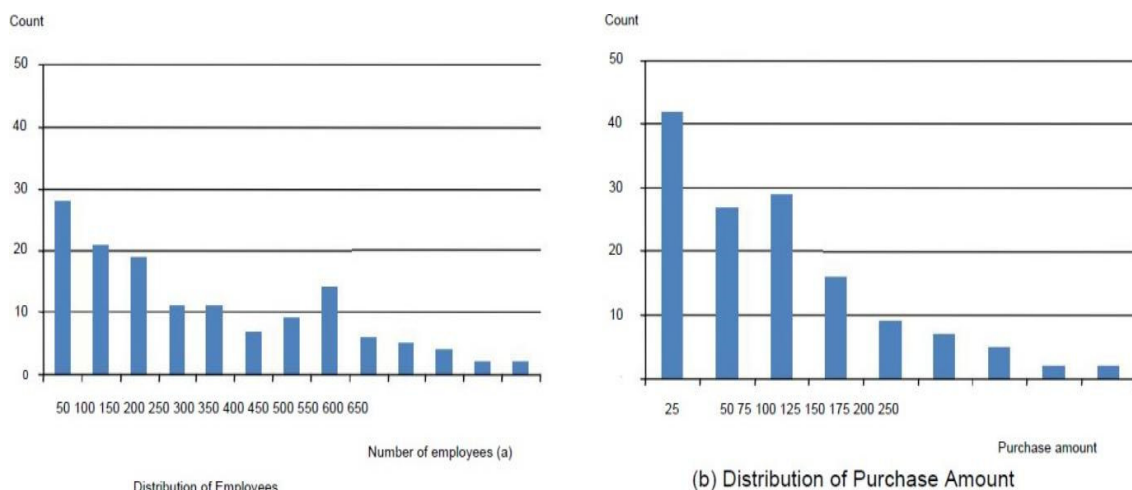
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Figure 2: Statistics of Survey.

market, centered on corporate electronic devices, is expected to grow at a very high rate and demand in the future (Han and Lee, 2010). This is because each product can form a larger market through new technology and convergence, and can create predictable and sustainable profits through cooperation between companies (Han and Lee, 2010). Therefore, recently, electronic companies are rushing to attack the B2B electronic market as a way to replace the B2C electronic market that has reached its limit (Han and Lee, 2010).

B2B market is again divided into public market and private market. In the public market, where purchasing power is etermined according to the government budget, demand is clear, whereas in the private market, it is very difficult to measure the size of the market because the products used are different depending on the industry and purpose of the business. The private market refers to a market where general companies purchase goods (Jang, 2008. Above all, incorrect demand forecasting for the private market causes not only financial losses such as overinvestment and loss of opportunity for electronic product manufacturers, but also weakening of market dominance and the rise of new competitors. Accurate demand forecasting is very important because it can cause more serious problems. In order to accurately predict the demand for electronic products in the private market, the economic and social conditions and the competitive structure between manufacturers as well as the company's own attributes such as the company's financial status, industry or size, purchase policy and use of electronic products, and the region to which the company belongs (Jeon et al., 1990). Various external factors such as such should be considered together, but there

are many difficulties due to the uncertainty of data collection and environment. Based on the opinions of experts in charge of marketing and sales of electronic products, this paper proposes a quantitative demand forecasting model using multiple regression analysis and a qualitative-based B2B demand forecasting model for each use of electronic products (Jeon et al., 1990). Products for demand forecasting were limited to personal computers (PCs) including desktop PCs and notebook PCs. For the demand forecasting model by use, the use is defined by dividing it into four categories: personal work, common work, promotion, and welfare (Jeon et al., 1990).

In the multiple regression model, region, industry, and company size were classified according to the following criteria and used as variables:

Region: Divided into 17 cities, including Bangalore and Kulana, and subdivided into 252 districts and localities

Type of business: 24 middle classification systems corresponding to the manufacturing sector among the industry classifications of the National Statistical

Office Scale: Companies with 1 to 4, 5 to 9, 10 to 19, 20 to 49, 50 to 99, according to the number of employees; Classified as 100-299 people and 300 or more people

The structure of the thesis is as follows. In Chapter 2, various studies related to demand forecasting were investigated, and in Chapter 3, demand forecasting methods for each use were presented and the pros and cons were analyzed. In Chapter 4, a demand forecasting model was built using multiple regression analysis and the significance of the model was verified. The conclusion and limitations of the study were discussed in the last chapter.
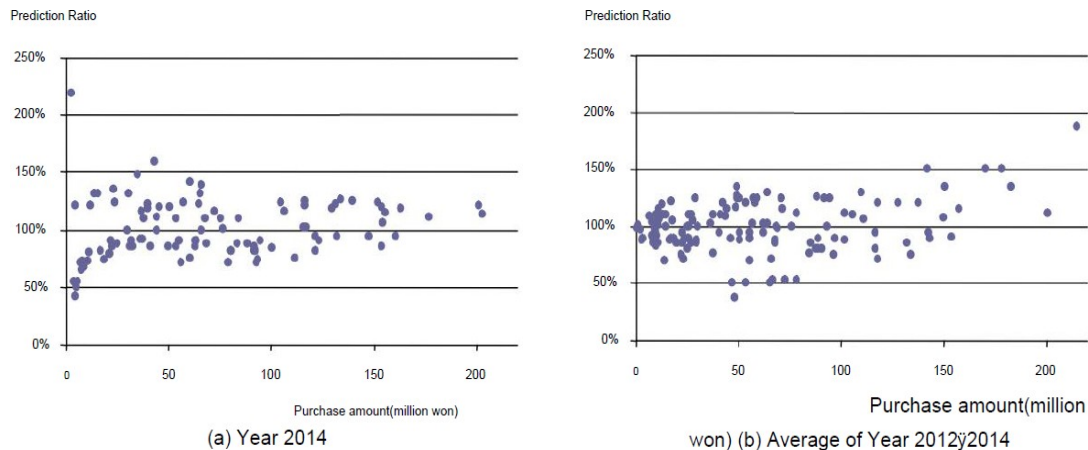
Figure 3: Prediction Ratio.

2 LITERATURE REVIEW

Demand forecasting refers to predicting the size of sales or services sold by a company for a certain period of time. It is a very important issue in decision making (KDB Research Institute, 2015). In particular, the introduction of new products, selection of target markets, and the timing of maturity and withdrawal of existing products are very important issues in marketing decision-making. Demand forecasting techniques are largely classified into qualitative and quantitative techniques (KDB Research Institute, 2015).

Qualitative demand forecasting technique is a technique for predicting demand based on the experiences and opinions of people with expertise in the relevant field, such as management or experts. This method is mainly used when there are insufficient past data or reference data, such as a new product or service (Kim, 2005).

There are Delphi Method, Market Research, and Index Method (Lee and Ryu, 2012). On the other hand, quantitative demand forecasting is a method of predicting future demand based on previous market demand data. Representatively, there are time series models and regression analysis models. Time series models are mainly used for short-term forecasting such as monthly sales fluctuations. It is a method of formulating relationships with various variables (Doane and Seward, 2014) (Park et al., 2002).

Qualitative and quantitative demand forecasting techniques have been widely used across various industrial fields, but research on demand forecasting for B2B electronic products market is considered to be very insufficient. However, some research on market demand for specific products in the B2B electronic market has been conducted, and the research and analysis of mobile B2B demand is a related study. Kim (2005) conducted a demand survey through a survey of users, suppliers, universities, and research institutes, along with trends in mobile B2B, and analysed business, market, content/application, technology development, and legal system. Five areas were investigated. However, we did not measure B2B demand directly, only investigating priorities based on a five-point scale (Kim, 2005).

Lee et al. (2006) analysed the purchase demand according to the price and performance of mobile communication terminals with a focus on subsidies and replacement cycles. However, considering only two representative characteristics, it is judged that there are some limitations in the prediction of real demand (Lee et al., 2006). Han and Lee (2010) conducted a survey of working-level purchasing companies under the assumption that in the qualitative factors of the B2B market, the friendship between the buyer and the supplier greatly affects the demand. Reliability, economic transaction performance and scale are the main factors of demand (Han and Lee, 2010). As a B2B study, there is little direct relevance to demand forecasting. However, Park et al. (2002) found customer value in B2B transactions. was measured with the CSI (Customer Sentiment Index) score. As a qualitative method, the present value of customers was measured with the relative value of the importance of customers before purchase and satisfaction after purchase (Park et al., 2002).

The future value was predicted by performing factor analysis with the CSI score. However, there are some limitations in calculating the value of customer

behavior using only the customer trend index score and using it as an objective demand forecasting index. Meanwhile, research on demand forecasting for the overall electronic product market including B2C and B2B was also conducted.

A mathematical model for measuring the demand forecasting accuracy and inventory level in the overall electronics industry. It is expressed in terms of demand forecasting accuracy compared to actual sales volume (Noh et al, 2010). As a result, it was emphasized that demand forecasting accuracy should be improved to reduce inventory fluctuations when the predicted sales value is larger than the actual sales value. Although it is somewhat different from the electronics field, an urban energy demand prediction algorithm was developed using environmental and energy planning data, and energy consumption was predicted by systematizing it (Yeo and Yoon, 2012). What is unique is that it enables energy demand prediction by standardizing urban facilities such as the use and area of buildings as well as the local environment and climate. Considering the similarity, it is judged that this method can be used for demand forecasting. Demand forecasting based on time series analysis analyzed domestic companies' refrigerator sales for three years by removing seasonal factors (Seo and Rhee, 2003). However, this study was conducted within the scope of a single company's sales forecast rather than a demand forecast for the entire refrigerator market. predicted demand by analyzing the correlation between the TV penetration rate and the number of households. In particular, it is estimated that this model can be extended to predict the demand for durable household items such as refrigerators and automobiles according to the number of households (Jeon et al., 1990).

However, it is somewhat difficult to apply to B2B demand forecasting, which has different characteristics depending on the type and size of the purchasing company conducted a demand forecasting study based on point of sale (Jang, 2008.

Table 1 Classification of purpose of use.

Purpose	Definition
Personal Work	PC used for personal work. (white collar workers)
Common Work	PC used for common work at office, factory, research center etc.
Promotion	PC provided for various promotions
Welfare	PC provided to all employees for welfare

Table 2: Demand Estimation Formula.

Purpose	Definition
Personal Work	(No. of White collar workers)÷ (PC Exchanging period) × (Unit Selling Price)
Common Work	(No. of Employees/100)÷ (PC Exchanging period) × (Unit Selling Price)
Promotion	(Sales Amount) × (Promotion Weight) ×0.5%
Welfare	(No. of Employees) × (Credit rating threshold)

For personal business: Number of office workers (200 people) ÷ replacement period (5 years) × unit selling price (800,000 won)	= 32 million won
For common duties: Total number of employees (1,000 people) ÷ 100 people ÷ replacement period (5 years) × PC sales unit price (800,000 won)	= 1.6 million won
For promotion: Sales (20 billion won) × Proportion of promotion expenses by industry (5%) × 0.5%	= 5 million won
Welfare: Number of employees (1,000 people) × C grade (0 won) 0 won	= 0 million won
Sum	**= 38.6 million won**

(POS) data to understand the demand management characteristics of electronic companies and analyzed the effect of forecasting accuracy on inventory and sales performance.

Some studies on demand forecasting in the G2B market were also conducted. In the B2B market, it is difficult to collect the data necessary to predict the overall demand for electronic products, whereas in the G2B market, it is relatively easy to conduct research in terms of data collection because the information in the Public Procurement Service general shopping mall (Nara Market) can be utilized. There is an advantage that implemented a market demand forecasting program based on the ARIMA model by systematically using public data and measured the demand for each product using the information on the Nara Market (Park and Ahn, 2014).

Table 3: Prediction Ratio.

Purchase Amount	Number of Companies		Average Prediction Ratio	
	2014	2012-2014	2014	2012-2014
Under 50,000,000 Won	42	69	98% (34%)	97% (16%)
Over 50,000,000 Won	61	70	101% (19%)	102% (26%)

Table 4: Variables and Corresponding codes.

Type	Code	Remarks
Area Name	do_nm(State Code) Ct_nm(City Code)	17 State Codes 252 City Codes
Business Type	C10yC34	24 Manufacturing Business codes
Business Scale	1/7	
Purchase Amount	amt	Number of Product Sales Price

3 DEMAND FORECAST BY USE

B2B demand forecasting is a function that is absolutely required to maintain an appropriate level of production and inventory from the point of view of a supplier who sells products. In the meantime, suppliers have mainly predicted demand based on past patterns (Lee et al., 2006). However, from the point of view of the company purchasing the product rather than the supplier's own standards, "what user group of the purchasing company (Who), when, when, where, for what purpose (What), why (Why) is used? Here, depending on who uses 'who', it can be divided into executives and employees and customers of the purchasing company (McClave and Benson, 1985). The 'when' can be set as a period of one year, but it can also be the time of recruiting employees or relocating the workplace. 'Where' refers to offices, factories, and research institutes as examples, and 'what' refers to what electronic products are suitable for each purpose. "Why" is the purpose of using the product for business purposes? Are you using it for promotional purposes? It is the standard for judging whether it is used for employee welfare. Therefore,

demand forecasting by usage can help to make more accurate demand forecasting by considering the demand from the point of view of the purchasing company (McClave and Benson, 1985).

Demand forecasting by use from the buyer side is a qualitative demand forecasting technique. To predict the B2B demand of individual companies, the use of electronic products is specifically investigated, and standard demand calculation formulas are defined for each use (Neter et al., 1985). Based on this, the total B2B demand It can be considered as a method of calculating In this study, the usage and demand calculation formulas for each usage were derived through interviews and surveys with 131 executives and employees in charge of sales and marketing of domestic electronic companies. Therefore, it was defined as in <Table1>.

In addition, the formula for calculating demand for each use is defined as (number of office workers) ÷ (replacement period) × (unit selling price)' for personal business use, and '(1 unit per 100 employees) × (unit selling price)' for public business use. did. Specific calculation formulas and standards are summarized in <Table 2>.

For example, suppose that, in 2014, the total number of employees in Company A is 1,000 and the number of office workers is 200, the sales are 20 billion won, the proportion of promotional expenses is 5%, and the credit rating is C grade. If the demand for each use is calculated according to the criteria in <Table 2>, the total PC demand for this company in 2014 can be predicted to be 38.6 million won as shown in the formula below.

In order to verify the validity of the demand forecasting technique for each usage, a PC purchase status survey was conducted for 500 domestic companies. Of these, 198 companies responded, and the demand forecasting technique was applied to 139 companies that were judged to have relatively high reliability of answers.

Table 5: List of Manufacturing Business Codes.

Code	Classification Name	Code	Classification Name
10	Food Products	22	Rubber and Plastic Products
11	Beverages	23	Other Non-metallic Mineral Products
12	Tobacco Products	24	Basic Metal Products
13	Textiles except Apparel	25	Fabricated Metal Products except Machinery and Furniture
14	Apparel, Clothing Accessories and Fur Articles	26	Electronic Components, Computer, Radio, TV and Communication Equipment
15	Tanning and Dressing of Leather, Luggage and Footwear	27	Medical, Precision and Optical Instruments, Watches and Clocks
16	Wood Products of Wood and Cork except Furniture	28	Electrical Equipment
17	Pulp, Paper and Paper Products	29	Other Machinery and Equipment
18	Printing and Reproduction of Recorded Media	30	Motor Vehicles, Trailers and Semitrailers
19	Coke, Hard-coal and Lignite Fuel Briquettes and Refined Petroleum Products	31	Other Transport Equipment
20	Chemicals and Chemical Products	32	Furniture
21	Pharmaceuticals, Medicinal Chemicals and Botanical Products	33	Other Manufacturing

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	69	8.338771E18	1.208518E17	13.99	<.0001
Error	88	7.599914E17	8.636266E15		
Corrected Total	157	9.098763E18			

Root MSE	92931512	R-Square	0.9165
Dependent Mean	107257558	Adj R-Sq	0.8510
Coeff Var	86.64332		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Variance Inflation
Intercept	1	56504681	18714726	3.02	0.0033	0	0
C10_2	1	-4713958	1799682	-2.62	0.0104	-0.59283	53.96782
C10_3	1	3937886	3737664	1.05	0.2950	0.31579	94.65114
C10_4	1	4762756	3742348	1.27	0.2065	0.23315	35.35740
C11_4	1	-41441660	13155312	-3.15	0.0022	-0.19691	4.11637
C11_6	1	176277857	36842069	4.78	<.0001	0.36811	6.23596
C11_7	1	-232177480	75461958	-3.08	0.0028	-0.16937	3.19253
C12_1	1	206986942	161571166	1.28	0.2035	0.28366	51.65453
C12_4	1	464744175	180588872	2.57	0.0117	0.60397	58.02933

Figure 4: Outputs of Multiple Regressions.

<Figure 2> is the result of basic statistical analysis of 139 companies. The average number of office workers is 207. It can be seen that the largest number of 28 companies are distributed in the range of 1-50 people. In addition, the average purchase amount was 58.79 million won, and the largest number of purchases were companies with less than 25 million won.

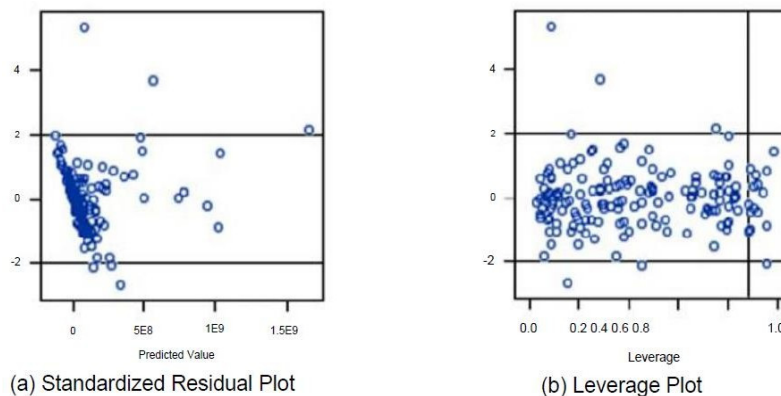(a) Standardized Residual Plot   (b) Leverage Plot

Figure 5: Residual Analysis.

Figure 3 is a scatter plot showing the results of calculating the estimated demand for average PC purchases in 2014 and 2012-2014 by applying the formula in <Table 2> to 139 companies, respectively. Both <Figure 3>(a) and <Figure 3>(b) are distributed around the 100% prediction rate, but when the purchase amount is more than 50 million won, the average is 100 in 2014, and when the purchase amount is less than 50 million won, the average is 100 %. This fact is also confirmed in the statistical table in <Table 3>. When the purchase amount is less than 50 million won, the average value of the forecast rate for 2014 and 3 years (2012-2014) is as the difference was offset, it was very high at 98% and 97%, respectively, but the standard deviation was 34% in 2014, which is about 18% higher than the 3-year average.

On the other hand, when the purchase amount was 50 million won or more, the average value and standard deviation of the forecast for 2014 were 101% and 19%, respectively, which was 1% lower and the standard deviation 7% lower than the three-year average of 102% and 26%. Based on the above results, it is judged that it is desirable to use information from the last year for large companies with annual PC purchases of KRW 50 million or more, and to calculate demand using information from the last three years for small businesses with less than KRW 50 million. The rationale for such a judgment can be explained from a practical point of view. Despite the fact that other demands such as promotions may occur in the long term, large corporations that generate a large amount of replacement demand every year have a constant purchase of business PCs, while This is because, in the case of small and medium-sized enterprises (SMEs) that make little or no purchases for promotion or welfare purposes, the amount of PC purchases is not constant every year.

As of 2014, there are about 360,000 manufacturing companies in Korea, which is 9.8% of the total. In order to predict the total domestic demand for B2B PCs in electronic manufacturers using the demand forecasting technique for each use, specific and accurate data such as the number of office workers, total number of employees, sales, promotion cost ratio, and credit rating are required for these manufacturing companies. Realistically, there is a limit to collecting such data, and this is the biggest drawback of the demand forecasting technique for each use. However, it is considered that this method can be used appropriately when it is necessary to calculate the demand of individual companies.

4 MULTIPLE REGRESSION METHODS

In this chapter, multiple regression analysis, one of the most representative quantitative demand forecasting techniques, was used to compensate for the shortcomings of the aforementioned demand forecasting techniques by usage and to predict the size of the entire domestic PC market (Park and Ahn, 2014). In particular, considering that B2B demand forecasting is the purpose The analysis was conducted based on the assumption that the number and size of companies by industry in the region would have the greatest impact on demand. The data used for the actual analysis were collected from Credit Rating Company B as source data by region, industry, company, and In addition, the purchase amount is the sum of the purchase items expressed in PC in each city/gun/gu region for each city/gun/gu region. Based on this interpretation of the first row of <Table 6>, 'Wanju-gun, Jeollabuk-do' has 75 and 25 grocery manufacturers with 1-4 and 5-9 employees,

respectively, and the total PC purchase amount is 300,152,151. In <Figure 4>, variables were selected using a stepwise method as the result of multiple regression analysis, and the significance level was set to 0.3 when selecting and removing variables. Finally, 69 independent variables were selected, and the F-value of the entire regression model and the t-value for each regression coefficient were also significant within a given level. At 0.91 and 0.85, the explanatory power of the variables selected in the regression model was relatively high. The formula of the finally constructed model is shown in is the residual analysis result for the multiple regression model. The standardized residual chart in <Figure4>(a) shows the difference between the actual value and the predicted value, and although some are out of the range, the difference between the actual value and the predicted value is mostly included within ±2 range. Therefore, it can be seen that the predicted values are relatively accurate. Even in the leverage chart of <Figure 6>(b), which can determine the degree of extreme bias of explanatory variables, only some occupy a high influence of 0.9 or higher, but most are evenly distributed (McClave and Benson, 1985; Neter et al. , 1985). Calculating the manufacturing PC demand with the formula for demand forecasting by multiple regression analysis yields 21.5 billion won. According to the domestic market demand report of Gartner, a market research firm released in 2014, the manufacturing PC demand in 2015 was 21 billion won. Comparing with the regression analysis results, it is relatively similar at 98% (Gartner, 2014). The contribution of this thesis to research from a practical point of view and an academic point of view can be divided into two major categories. First, in practice, new standards and directions to consider when forecasting demand were presented to B2B marketing and sales managers. The technique by use considers four factors that should be looked at from the point of view of a buyer rather than a seller when forecasting demand for individual companies, and the multiple regression analysis method considers the region and the industry and size of the company when macroscopically analyzing the B2B commercial area. Therefore, it was used as an independent variable in the predictive model. The result of demand forecasting can be used as an indicator to allocate and use marketing and sales resources more efficiently for suppliers, and above all, it can be an objective standard for regional performance analysis of an organization (Park et al., 2010). Second, academically, it is meaningful that the qualitative and quantitative B2C demand forecasting techniques presented in various literatures were reflected in the

B2B demand forecasting to derive meaningful results. As suggested by the Delphi method, the qualitative method sought expert advice, verified its validity through sample surveys, and attempted to analyze demand forecasting in the B2B commercial area using quantitative methods such as multiple regression analysis (Ryu, 2013). However, although there are many manufacturers in Korea, there are some limitations to the generalization of the proposed model because only 139 companies were targeted for the validity of the demand forecasting technique by use, and multiple regression analysis was performed using only 2014 data. have it Therefore, we would like to leave as future tasks the task of improving the objectivity of the model by securing more data and the task of constructing a model for various industries other than manufacturing and other electronic products other than PC.

5 CONCLUSIONS

In this paper, among the B2B electronic products market, PC demand forecasting methods were studied for the private market, where demand forecasting is relatively difficult compared to the public market. For this purpose, a qualitative- based demand forecasting technique for each usage and a quantitative multiple regression analysis were presented. In the demand forecasting technique for each use, the demand calculation formula was derived by dividing the use into four categories: personal work, common work, promotion, and welfare, reflecting the opinions of field experts, and verified for 139 companies. In addition, multiple regression analysis was performed by collecting PC purchase amount data by region, industry, company, and company size, and the significance of the model was tested through F-value and t- value tests and residual analysis. Each had different characteristics, and when it was necessary to calculate the demand of individual companies, the demand forecasting technique for each usage was suggested, and the use of multiple regression analysis was suggested to predict the size of the entire domestic PC market. As a result of the demand forecasting, the standard deviation of the demand forecasting technique according to the usage was rather large, but the forecasting rate was found to be high between 97% and 102%. However, there is a difference in the forecasting rate for each demand section, which suggests that it should be applied to large and small businesses. The result of the demand forecasting technique by multiple regression analysis also predicted the PC demand to be 21.5 billion won

in 2015, which is relatively similar to the 21 billion won forecast in the Gartner Group's domestic market demand report published in 2014.

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