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A Study on the Prediction of Demand for Sustainable Growth of "National Physical Fitness 100" Policy in Korea

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Abstract

The purpose of this study is to secure basic data for forecasting demand for new sports public services and to provide basic data on policy strategies for introducing new sports public services. This is achieved by predicting demand for the project using the Bass model, exponential smoothing method, and qualitative Delphi method. First, analysis of the demand for "National Physical Fitness 100" from the Bass model showed that the innovation coefficient was relatively low (0.029) compared to other physical fitness centers and that the initial service spread rate was slow. However, it was found that the imitation coefficient (0.332) was relatively high, the q/p value (11.45) was large, and that demand gradually increased. Secondly, the demand forecast based on the exponential smoothing method appeared more rapidly than in the Bass model. This is because the exponential smoothing method determines an exponential smoothing coefficient, which is an inclination value of the regression line, by the rate of change of existing data. Therefore, stable demand based on the exponential smoothing coefficient can be predicted and used as a basis for the initial demand forecast. Finally, the result predicted by the National Physical Fitness 100 expert Delphi method increased significantly in 2020 but has since become a gentle straight line. This can be interpreted as an expectation for an infrastructure expansion plan such as human resources and facilities, as the national physical fitness budget for 100 operations was to increase in 2020. The Bass model, the exponential smoothing method, and the Delphi method used in the research can thus confirm how the forecast results of the demand for National Physical Fitness 100 are spread by period. This can contribute to the policy decision-making process for efficient government budget management and effectively meeting social needs, as demand by period can be predicted over time from the point of introduction of the service.

Key words: National Physical Fitness 100, sustainable growth, new sports public services, forecasting demand, Delphi method

Introduction

The purpose of social welfare is to solve basic human needs. Therefore, social welfare has been discussed in various ways for a long time. So, the government, which

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is the subject of social welfare, has prepared various policies and institutionalized them to meet the needs of social help to provide services (Huh & Min, 2014).

These social welfare services can be public goods such as medical care, education, housing, national defense, and safety from a macro perspective. In addition, in recent years, 'social care' for population aging and health, which has emerged as a social problem, is expressed in the microscopic meaning of social welfare services (Huh & Min, 2014). For such social welfare services, the government conducts various demand surveys to establish a supply plan for the people.

The results of the demand survey are directly linked to the estimation of supply. Therefore, predictive demand estimation reduces budget waste from the government's point of view, such as service development and administrative costs. In addition, social job creation plans can also prevent disruptions that may occur in establishing macro national policies in advance. Therefore, in the process of policymaking for the introduction of new social welfare services, it is important to develop an analysis method that predicts the exact demand for them (Lee et al., 2012).

In previous studies related to demand prediction, most of the sports fields focused on ARIMA models based on time series data, such as golf (Kim & Jun, 2013; Sul et al., 2011), professional baseball (Song, 2013), and demand prediction for female members of the sports center (Sul & Park, 2011). However, the ARIMA model has limitations in predicting demand for new products and services that lack time series data. Therefore, this study aims to predict the demand for social services by mixing the Bass model, the exponential smoothing method, and the Delphi method, which are mainly used to estimate the demand for new products or services.

This study focused on sports welfare services among social welfare services. Specifically, we would like to estimate the demand for the "National Physical Fitness 100" project organized by the Korea Sports Promotion Foundation. The importance of sports activities has been emphasized as individual health and well-being are recognized as major measures of life due to the recent increase in economic income. As the people's desire for sports activities becomes more diverse through this, the government continues to implement infrastructure creation and sports environment improvement projects to increase the participation rate of people in sports activities through various sports welfare policies.

Among them, "National Physical Fitness 100" operated by the Korea Sports Promotion Foundation is a representative sports welfare service. It scientifically measures the level of physical strength of the people and provides customized exercise prescription programs to induce physical strength management and participation in daily sports activities. In addition, various efforts such as business diversification and system advancement are being made to induce people to voluntarily participate in sports for all and to support physical fitness (Article 16-2 of the National Sports Promotion Act).

As the importance of health is emphasized in terms of social costs as well as universal welfare services that support customized exercise prescriptions through individual physical strength measurement, "National Physical Fitness 100" needs to be continuously expanded and distributed. In this process, it is necessary to promote policies for new sports welfare services through data-based demand forecasting. As a result, it is possible to predict clear demand for implementing health service policies to improve the universal welfare of the people and contribute to smooth operation through efficient distribution of resources based on this.

Therefore, the bass model, exponential smoothing method, and delphi method are used to estimate the potential demand for the "National Physical Fitness 100" project, and demand patterns are identified through the derived results to secure evidence for future demand forecasts and provide basic data for policy strategies for the introduction of new sports welfare services.

Methods

Estimated Direction of Demand Forecast

Demand estimation for National Physical Fitness 100 was conducted in parallel with qualitative analysis methods to supplement the estimation, based on future demand growth factors based on the quantitative estimates of previous data. Therefore, it was performed quantitatively using the Bass model and exponential smoothing method and qualitatively using the Delphi method.

Quantitative estimation has the advantage of being highly reliable in forecasting short-term demand outcomes. It uses quantified objective data and substitutes demand estimation models using time-series statistics at regular intervals over time (Farley & Lehmann, 2001). In addition, a qualitative estimation can generate demand by analysing the actual situation of consumers and gathering expert opinions as a method to compensate for data limitations when estimating demand. This study aimed to investigate the effectiveness of policies based on the demand forecast for National Physical Fitness 100.

Analytical Data and Method

The demand forecast analysis data were used as data for annual users from 2012 to 2019 of the National Physical Fitness 100 division of the Korea Sports Promotion Foundation. Number of participants in National Physical Fitness 100 by year is shown in Table 1.

Table 1. *Number of participants in National Physical Fitness 100 by year*

Operating period	Data	Operating period	Data
2012	12,216	2016	161,122
2013	56,104	2017	211,807
2014	86,887	2018	267,401
2015	122,739	2019	303,772

Source: Korea Sports Promotion Foundation (2020). Plan for 2020 operation of National Physical Fitness 100 project.

The analysis was performed using the Bass and the exponential smoothing method models using the quantitative method and the Delphi method using the qualitative method. First, the Bass model is a research model that combines Rogers' Diffusion Theory into marketing and business administration; it is a predictive model that estimates demand from the adoption rate of new products and services. Unlike other demand prediction methods such as time series analysis, the Bass model has the advantage of being able to predict demand for new products without past demand data (Bertotti & Modanese, 2019).

Therefore, the Bass model is not a model for predicting the demand for a specific product but predicts demand for government public goods and services for the whole nation (Dunn et al., 2012). The Bass diffusion model can change the way consumers consume products and services through innovation and imitation factors since the time that new products and services first appear in the market, so it is necessary to calculate the coefficient and check the model's suitability. In particular, in the early stages of spread, products are purchased and consumed due to external factors. As time goes by, consumption affected by internal factors increases, that influenced by external factors decreases, and the factors affecting consumption thus change. Diffusion models can indirectly estimate the saturation point and current stage of product demand. Diffusion prediction using the Bass model is a demand prediction through the estimation of external influence coefficient (p), internal influence coefficient (q), and potential market size (m) as three parameters are derived. The basic Bass model formula used in this study is as follows (Boswijk & Franses, 2005).

$$S(T) = pm + (q-p)\,Y(T) - \frac{q}{m}[\,Y(T)]^2 \qquad (1)$$

p : Innovation Coefficient

q : Imitation Coefficient

m : Ultimately the size of the potential market to join

$S(T)$: Number of subscribers for the year at point T
$Y(T)$: Cumulative number of subscribers before point T

In the process of estimating the Bass model, it is difficult to obtain p, q, m immediately. Thus, a, b, c must be obtained first by substituting the below formula.

$$N(t) = a + bN(t) + cN(t)^2 \quad (2)$$

$$a = pm,\ b = q - p,\ c = -\frac{p}{m}$$

When a, b, and c are obtained, the value of each coefficient is derived from the relationship between p, q, and m through the root formula. The parameters p, q and m to be obtained were derived by Ordinary Least Square (OLS) using the regression analysis module of SPSS (version 20.0), a statistical program package. Then, the coefficient values of p, q, and m were estimated. Estimated p, q, and m values are substituted for the mathematical expression (1) to calculate the Bass model's predicted value for a future section. In addition, to enhance study validity and confirm the data accountability of the Bass model, it was decided whether to adopt the model, because it would explain the data well when the R2 value was higher than 0.6 (Hsiao et al., 2009).

Second, the exponential smoothing method is a kind of weighted average method, in which the more recent the data, the smaller the exponentially. The basic exponential smoothing method formula is as follows:

$$St = St-1 + \alpha(Xt-1 - St-1) \quad (3)$$

S : Demand forecast value
X : Actual demand value
α : Exponential smoothing coefficient

In recent years, the exponential smoothing method has been the most used short-term forecasting method. Companies use it to calculate short-term production and forecast demand for inventory management. The exponential smoothing method is also highly understandable, easy to model, accurate for short-term forecasts, sensitive to the latest changes, easily adjusts weight distribution, and has low data storage requirements (Park, 2014).

Finally, the expert Delphi method is a qualitative demand estimation method. The expert Delphi method is used to collect opinions from multiple experts and repeatedly converges the results of rounds of questionnaires. The Delphi method is generally used when there is a shortage of data for estimating demand. Companies use it to predict demand for new markets such as new business development and new product launches. The Delphi Act also has the advantage of reducing waste of time and money, clarifying the issue through researcher involvement, and facilitating smooth convergence and feedback from many experts (Park, 2011).

The Delphi method for estimating demand consisted of the involvement of eight experts related to the topic of National Physical Fitness 100. The research was conducted after providing the experts with information, including estimating demand and the results of estimating quantitative demand. Each individual in-depth interview conducted by this method was divided into the first and second stages. The first in-depth interview was conducted based on an open questionnaire to freely express the expert's opinions on national physical fitness demand. Afterward, and based on the unstructured questionnaire results, the second in-depth interview was conducted by gathering and collecting further opinions to obtain the final result.

Results

BASS Result

To estimate the Bass model's coefficients, we first derive parameters a, b, and c. The Innovation Coefficient, the Immigration Coefficient, and the Potential Number

of Ultimate Adopters were derived by applying the derived parameters as shown in Table 2.

Table 2. *Results of Bass model estimates*

Parameters	Estimate	Coefficient	Estimate
a	14011.517	p	0.029
b	0.303	q	0.332
c	-6.844E-07	m	484940.5
R2	.604	q/p	11.45

Finally, the derived innovation coefficients (p), imitation coefficients (q), and the potential number of customers (m) are applied to the formulas of the Bass model to derive the results of semi-annual demand forecasts. The estimated parameters can be used to predict demand, and the comparison between the predicted and actual values is shown in Table 3.

Table 3. *Bass model demand forecast results*

Year	Data	Bass	Year	Bass
2012	4583	16305.28	2020	322169.9
2013	12216	37868.09	2021	359762.2
2014	56104	65548.84	2022	390912.7
2015	86887	99758.85	2023	415647.8
2016	122739	140107.6	2024	434631.7
2017	161122	185154.3	2025	448825
2018	211807	232465.2	2026	459229.9
2019	267401	279070	2027	466748.2

Exponential Smoothing Method Results

The exponential smoothing method estimated demand for 2027 using the exponential smoothing method based on the 2012–2019 year certification center and participant data, and the demand estimation result is as shown in Table 4.

Table 4. *Exponential smoothing method demand forecast results*

Year	Data	Year	Predicted value
2012	12,216	2020	340,820
2013	56,104	2021	382,611
2014	86,887	2022	426,155
2015	122,739	2023	471,594
2016	161,122	2024	515,798
2017	211,807	2025	558,543
2018	267,401	2026	599,260
2019	303,772	2027	640,441

Delphi Results

The first and second Delphi surveys from eight experts related to National Physical Fitness 100 estimated acceptance of the number by 2027. The demand estimate results are shown in Table 5.

Table 5. *Delphi-based demand forecasting results*

Year	Data	Year	Predicted value
2012	12,216	2020	443720
2013	56,104	2021	473302
2014	86,887	2022	502883
2015	122,739	2023	532464
2016	161,122	2024	562046
2017	211,807	2025	591627
2018	267,401	2026	621208
2019	303,772	2027	650790

Demand Forecast Results

As described above, each result was derived using three methods of forecasting demand: quantitative and conscientious. Using a conservative approach to demand forecasting and an average approach as an application to each result, the results of demand forecasting from 2012 to 2027 are shown in Table 6 and Figure 1.

Table 6. Final results based on demand forecasting

Year	Data	Year	Predicted value
2012	12,216	2020	368903.3
2013	56,104	2021	405225.1
2014	86,887	2022	439983.6
2015	122,739	2023	473235.3
2016	161,122	2024	504158.6
2017	211,807	2025	532998.3
2018	267,401	2026	559899.3
2019	303,772	2027	585993.1

Conclusion

This study compared the demand for National Physical Fitness 100 using quantitative methods such as the Bass model and the exponential smoothing method and qualitative methods such as the Delphi method. This makes sense for the application of various research methods to predict the demand for public sports services.

We analysed the demand for National Physical Fitness 100 using the Bass model. An innovation coefficient (p) derived as a research result means the diffusion rate of the service implementation period. An imitation coefficient (q) means the diffusion rate of the period through word of mouth and the networking effect. A maximum demand value (m) indicates the magnitude of potential service demand. Therefore, in implementing the National Physical Fitness 100, it is useful to examine the policy effectiveness of the service and the sustainability of the policy implementation by predicting the speed of diffusion of the service and potential demand for it. For example, if when public sports services are implemented, the diffusion rate coefficient is high, and policy effects will appear early in the short term.

On the other hand, when the diffusion rate coefficient is low, policy effects only gradually emerge. Consequently, the policy objectives and the priority of implementation can be planned to consider the rate of expansion of public sports services. Furthermore, the magnitude of potential demand in public sports services means how long the policy effect will last. If the potential demand is high, sustained policy effects can be expected in the execution of public sports services.

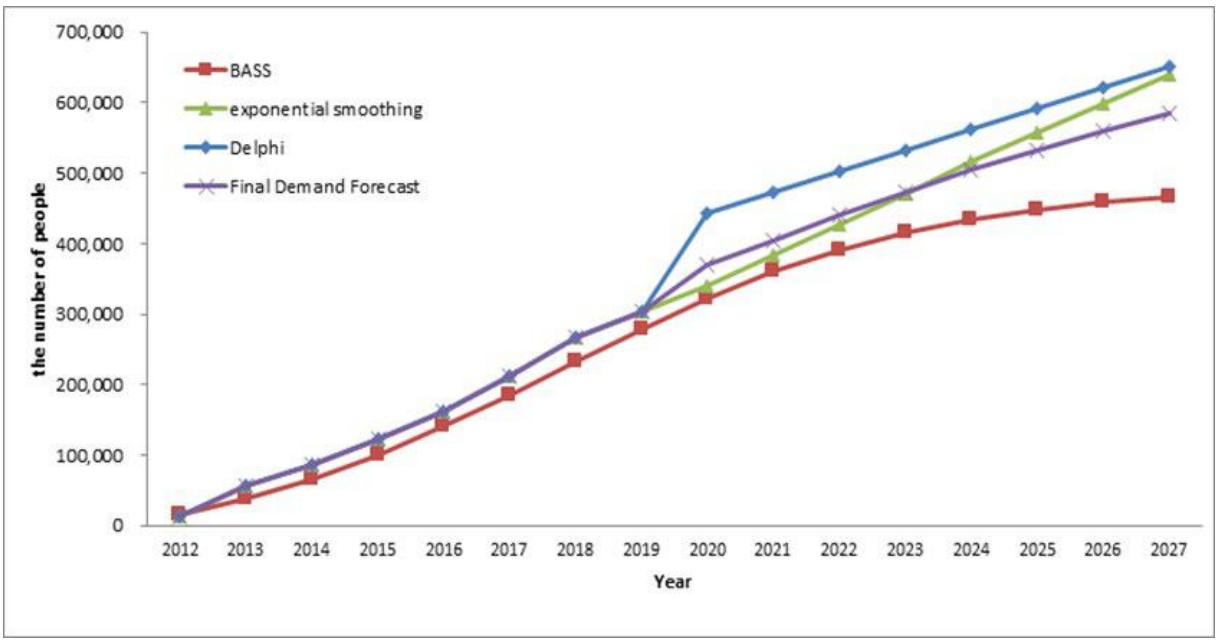

Figure 1. Results of the National Physical Fitness 100 demand forecast

Therefore, it can be said that it has high sustainability. On the other hand, when the potential demand is low, it can be postulated that it would be difficult to maintain the policy's effect.

According to Bulte & Stremerch (2004), trends in various factors affecting the demand pattern can be grasped through q/p values rather than individual values of p and q. According to their research results, ① A higher the q/p value, the stronger the collectivist tendency and the weaker the individualist tendency. ② The higher the q/p value, the stronger the tendency to avoid uncertainty. ③ The higher the q/p value, the greater the income inequality of the buyer population. Therefore, looking at the demand pattern of National Physical Fitness 100 users, it was found that the q/p value was 11.45, indicating that the imitation demand is greater than the innovation demand.

Research by Lee et al. (2012) shows trends in policy effectiveness based on the relationship between innovation coefficient and potential demand. In other words, if the value of both innovation demand and maximum demand is large, the spread of services is fast, potential demand is high, short-term policy effects can be expected, and policy sustainability value is great. When the value of innovation demand is large, the speed of service spread is fast if the value of maximum demand is small. Short-term effects can be expected due to low potential demand, but continuous policy implementation is difficult. Conversely, if the value of the innovation coefficient is small and the maximum demand value is large, the rate of diffusion of services is slow, but potential demand is high. Therefore, long-term effects can be expected through continuous policy implementation. When both the innovation factor and the maximum demand value are low, so are the rate of service diffusion and the potential demand. Therefore, it is challenging to expect clear long-term and short-term policy effects.

By applying this relationship to this study, the overall user demand forecast for National Physical Fitness 100 predicted that the innovation coefficient would be relatively low (0.029) compared to other fitness centers and that the initial services spread would be slow. However, it was found that the imitation coefficient (0.332) was relatively high, the q/p value (11.45) was large, and that demand gradually increased. Therefore, although the service diffusion rate is slow, potential demand is high, and long-term effects can be expected through continuous policy implementation.

Secondly, the demand forecast based on the exponential smoothing method appeared more rapidly than the Bass model. This is because the exponential smoothing method determines an exponential smoothing coefficient, which is an inclination value of the regression line, by the rate of change in existing data. As a result, it is difficult to apply the exponential smoothing method to changes in internal and external factors relating to forecasting demand. However, stable demand based on the exponential smoothing coefficient can be predicted and used as a basis for the initial demand forecast.

Finally, the result predicted by the National Physical Fitness 100 expert Delphi method increased significantly in 2020 but has since become a gentle straight line. This can be interpreted as an expectation for an infrastructure expansion plan including human resources and facilities, as the national physical fitness budget for 100 operations was to increase in 2020. The results show results similar to those predicted by the exponential smoothing method to occur in 2027. Based on experts' judgments, this reflects an increased prospective rate of demand for sports participation, self-directed physical health management services, and related exercise prescriptions due to an increased home training population that has resulted from factors such as COVID-19.

In addition, as part of an expanded physical fitness measurement target age due to the operating budget increase, another demand estimate was taken into consideration to develop physical fitness measurement evaluation items for children 5-6 years of age.

The Bass model, the exponential smoothing method,

and the Delphi method used in the research confirm in detail how the forecast results of the demand for National Physical Fitness 100 are spread by period. To summarize the results, the Bass model has shown a gentle curve since, although the demand curve has grown steeply until 2021. On the other hand, Delphi and exponential smoothing methods predict demand while maintaining a constant curve. As a result, if you look at it on average based on three types of demand forecasts, it has grown steeply until 2020, showing gentle demand since then. As a result, the direction in which the policy effectiveness can be maximized can be presented based on the demand pattern analysis of sports-related public services. Thus, it is possible to anticipate demand over time from the time-of-service introduction, thereby contributing to the policy decision-making process for efficient government budget management and effectively meeting social needs. Therefore, it is expected that these results will provide objective evidence of how to effectively promote sports public service policies in response to changes in the medium- to long-term budget.

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