Study on configuration sequence of indemnificatory community public service facility based on MIV-BP Neural Network

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Abstract

China is seeing large-scale construction of indemnificatory community being. Yet due to lack of dynamic planning and arrangement in advance and little consideration of public service facility configuration sequence, the configuration of public service facility in indemnificatory community is lagging behind and inefficient, failing to attract the residents to move in the community. This paper structures the MIV-BP Neural Network Model, and gives an empirical analysis on the influence sequence of the indemnificatory community public service facilities to the population occupancy rate. The results suggest that the configuration of public service facility in indemnificatory community should be sequentially configured in period and in grade according to the community's specific present situation and developmental conditions as well as the continuous increase of population occupancy rate.

Keywords: indemnificatory community, public service facility, configuration sequence, MIV-BP neural network

1 Introduction

Recent years has seen large-scale construction of indemnificatory communities, such as low-rent housing, affordable housing, and relocation-oriented housing. The traditional indemnificatory community public service facility configuration and planning theory only focuses on the configuration at the end of the planning, without giving consideration to, or before-hand planning and arrangement of, the configuration process of public service facility from the beginning to the end, with little consideration of the sequence of public service facility, blindly follows the plan of public service facility without considering the population change and demands change in indemnificatory community. Consequently, some facilities were constructed prematurely, causing waste due to limited population; some facilities failed to meet the daily fundamental needs of existing residential population and to attract intake population. Therefore, it is high time to study the configuration sequence of indemnificatory community public service facility.

Current researches by domestic and foreign scholars mainly focus on the accessibility and fairness of public service facility configuration. Macintyre S.L [1] holds that the spatial accessibility of public service facility, which is an important indicator of the city residents' life quality, concerns the social fairness and justice of the city public resources allocation. Luo W [2] finds that the accessibility of public service facility is usually positively related to the type of profession and the level of income; individuals with a relatively low social and economic standing usually have a relatively low accessibility to public service facility. Coombes and Jones [3] use questionnaires and field interview to study the accessibility to public service facility by individuals. The accessibility study from the time geography perspective examines the chance of obtaining service based on the behaviour space model and analyses the impact of space distribution of chance on the choice of individual behaviour [4].

A representative scholar of the spatial fairness study of public service facility is Nicholls, who uses the park system of Bryan, Texas, as example and the geography information system technology as platform, analyzes the social and economic attributes of the corresponding regional populations through Mann-Whitney U test, and conducts a comprehensive evaluation of the spatial fairness of the park facilities in Bryan City [5]. Kinman [6] proposes the spatial equality of health care and medical care service facility. Hay [7] believes that urban citizens have equal opportunities of utilizing public service facility. Bach [8] examines the relationship between spatial fairness and benefit of service implementation of public service facility.

Only few scholars have studied the configuration sequence of public service facility. This study uses the MIV-BP Neural Network model to examine the effect of indemnificatory community public service facility on occupancy rate, studies the configuration sequence of indemnificatory community public service facility based on the analysis of the model conclusion and the demand characteristics of public service facility, and is therefore of high practical value.

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2 Demand analysis of indemnificatory community public service facility and construction of MIV-BP neural network model

2.1 DEMAND ANALYSIS OF INDEMNIFICATORY COMMUNITY PUBLIC SERVICE FACILITY

The indemnificatory community public service facility in this study mainly refers to the 11 types of public service facilities defined based on the different functions of the facility according to the Configuration Standards of Public Service Facility in Urban Residential Areas and Urban Residential Communities (DGJ08-55-2006 J100-2006) of Shanghai, including commercial facility, education, culture, fitness, finance, medical care, public administration, municipal public utilities, and greenbelt [9].

Based on the levelled demand theory of Abraham H. Maslow and the questionnaire results, we can divide the demands of indemnificatory community residents for public service facility into several levels, from the low-level fundamental demand to the mid-level comfort demand and the high-level developmental demand. The low-level fundamental demand is the basic subsistence demand for the basic necessities of life, such as food, clothes, housing and transportation, involving the most fundamental demand for daily material and cultural life and the minimum standard of living, such as real property maintenance, cleaning, security, transportation, and water and electricity. The dissatisfaction of these low-level demands, though not affecting the residents' survival, will severely undermine their basic life and therefore require the government and the community to provide corresponding public service facility. The mid-level comfort demand refers to the demand for services for the convenience of residents' life, such as housekeeping, restaurant, shopping, medical care, and children's education. The satisfaction of the mid-level demands improves the convenience level of residents' life and the quality of their material life, which can be realized by the development of public service facility. The high-level developmental demand mainly refers to residents' need for spiritual and cultural life and the demand for community self-governance, including culture, entertainment, and democratic management, which is equal to the high-level demands such as self-respect and self-actualization in Maslow's demand theory. These different levels of demands are summarized in Table 1.

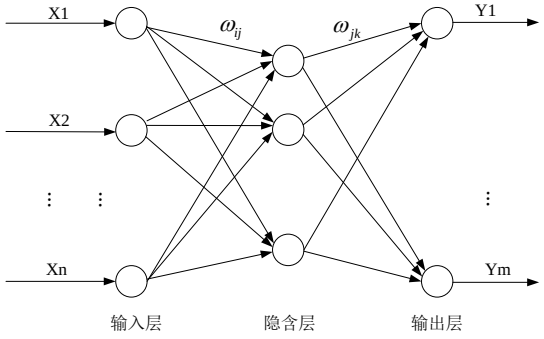
TABLE 1 Demands for indemnificatory community public service facility

Demand Level			Shown As	Corresponding Public Service Facility	
Low-level	Living demands Security demands	Fundamental demands	Food and clothes Utilities	Business service municipal public utilities	Fundamental facility
Mid-level	Social intercourse demands Respect demands	Comfort demands	Healthcare, rest Welfare	Medical treatment and public health Community service	Amelioration facility
High-level	Self-actualization demands	Developmental demands	Cultural entertainment Pursuit for knowledge	Culture and fitness Education	Advancement facility

The above table suggests that residents' demands for public service facility evolve gradually from low-level to high-level; when a lower level of demands are satisfied, people would have a next level of demands. In other words, when people's physical demands are met, they will inevitably pursue spiritual demands. The nature of demands gradually evolving has determined that there is a sequence in residents' demands for public service facility.

2.2 CONSTRUCTION AND THEORY OF MIV-BP NEURAL NETWORK MODEL

BP network is a multilayer feed forward network in single-direction dissemination. As shown in Figure 1, it is a neural network of three or more layers, including the input layer, the middle layer (hidden layer), and the output layer, with complete connection between two neighbouring layers and no connection between the neurons of each layer. Luan Qinghua et al. [10] pointed out that the BP neural network features strong mapping ability, flexible self-adapting data processing ability, rapid self-learning ability, and a highly parallel internal link structure. The BP neural network can be regarded as a nonlinear function, in which the network inputs and predictions are the independent variable and dependent variable respectively of the function. When the input node number is N and output node number is M, the BP neural network expresses the functional mapping relationship from N independent variables to M dependent variables. Before it is put into use, the BP neural network must be trained to have associative memory and prediction ability.



Input layer Hidden layer Output layer

FIGURE 1 BP neural network topological structure diagram

In many practical application cases, due to lack of clear theoretical basis, the independent variables, or the network input characteristics, of the neural network can hardly be predetermined. The introduction of some non-important independent variables into the neural network reduces the

precision of the model. Therefore, choosing meaningful independent variables characteristics as the network input data is more often than not a crucial step in analysing prediction problems of using the neural network. To improve the network performance and reduce the errors between prediction output data and expected data, scholars have tried to optimize the network and its input and output data from different perspectives. Yuan Changfeng, Wang Wanlei et al. [11] point out that algorithms such as rough sets algorithm, genetic algorithm, and fuzzy theory can be used to improve the BP neural network training ability. Li Jun et al. [12] introduce the method for accurately predicting film popularity using two indicators by training the neural network through normalization of data in their study of interactive network system. Ding Shifei et al. [13] also hold that the BP neural network based on the genetic algorithm has more powerful local data search capability. Dombi et al introduce the method of using the Mean Impact Value (MIV) - considered as one of the best indicators for evaluating variable correlation in the neural network - to reflect the variation of weight matrix in the neural network, thereby creating a brand-new thought for solving similar problems [14].

3 Empirical analyses

3.1 DATA COLLECTION

This study uses data from Shanghai Statistical Yearbook, Shanghai Baoshan District Statistical Yearbook, and Questionnaire for an Indemnificatory Community in Baoshan District, Shanghai from 2006 to 2010, as shown in Table 2 and Table 3.

TABLE 2 BP Neural Network Input Data

Year	Public Administration	Fitness	Commerce	Community service	Municipal public utilities	Culture	Education	Medical care	Finance	Greenbelt	Total number of apartments
2006.6	2460	960	1500	60	2300	60	11507	340	804	69839	6563
2006.12	2460	960	1500	80	2680	60	34980	360	804	82804	6563
2007.6	3721	1280	5351	120	2680	200	34980	360	804	88056	12458
2007.12	4432	1280	8927	120	2704	200	34980	4560	804	92414	12458
2008.6	5738	2520	8927	120	3511	1290	34980	4560	804	106601	12458
2008.12	6608	2840	15161	120	3511	2010	34980	4560	804	106601	12458
2009.6	6608	2840	15161	320	3511	2882	34980	4560	804	112850	12458
2009.12	6608	2840	15161	320	3511	3642	34980	4560	804	112850	12458
2010.6	6720	2960	16500	320	3511	3642	34980	4560	804	112850	12458
2010.12	6720	2960	16500	320	3511	3642	34980	4560	804	112850	12458

TABLE 3 BP neural network output data

Year	Number of households
2006.6	236
2006.12	652
2007.6	2018
2007.12	2449
2008.6	3015
2008.12	3314
2009.6	3613
2009.12	3771
2010.6	3841
2010.12	3962

3.2 THE IMPLEMENTATION STEPS OF MIV-BP NEURAL NETWORK

Step 1. Training data selection. From the data shown in Table 2 and Table 3, use the data of the first nine of the ten available time spots as training samples for the neural network and the number of households at the last time spot 2010.12 as the prediction output value of the neural network to test the reliability of the model.

Step 2. BP neural network hidden layer neuron number set. The number setting of neurons in the hidden layer of the BP neural network follows the following principles: First, there need not to be too many hidden layers in the BP neural network; usually one hidden layer suffices to meet the precision requirements. Second, the number of neurons in the hidden layer varies according to different cases; too many neurons are not necessarily good. Based on tests, at last this study sets one hidden layer, with 10 neurons, in the BP neural network.

Step 3. BP neural network transfer function set. Set the transmission function tansig for the hidden layer neurons, with output as purelin, and use the Levenberg-Marquardt method (trainlm) for the training of the BP neural network.

Step 4. Set the BP neural network training parameters.

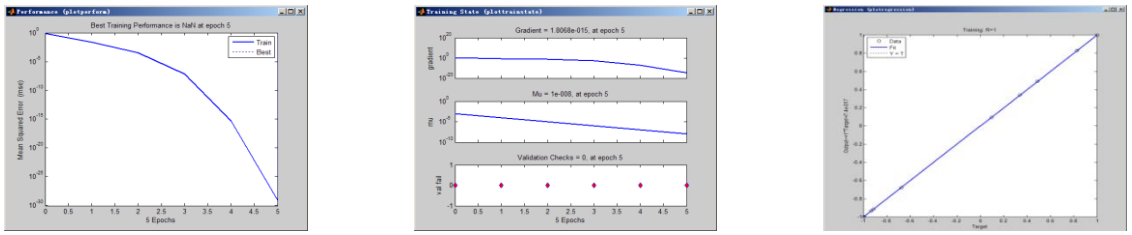
To prevent overfitting, set the number of network trainings as 2000 times and choose trainlm training function. Use default values for other parameters.

Step 5. Use the 10th set of data as input and use the trained neural network for prediction to verify the BP neural network effect. Compare the result with the actual value so as to determine the effect of network category prediction.

Step 6. Evaluate using the MIV algorithm.

3.3 THE BP NEURAL NETWORK TRAINING AND EXPLANATION

Neural Network Training, Figure 2a) suggests that the neural network achieves the training effect after five trainings. It is far less than the maximum number we have set and it is the result of normalization processing of selected data that made the training data is more suitable for the neural network training. Figure 2b) and Figure 2c) suggest that the fitting degree R2 = 1 of the neural network training data and the prediction effect of the neural network for the training data is better after training.



a) b) c)

FIGURE 2 a) Neural Network Training Effect, b) Neural Network Training Parameters, c) Neural Network Training Regression.

3.4 MIV RESULT ANALYSIS

Based on the MIV-BP neural network program calculation results, the impact of the public service facility of indemnificatory community on the occupancy rate is shown in Table 4.

TABLE 4 Importance ranking of the impact of public service facilities in an indemnificatory community on occupancy rate.

Variable	MIV	Importance Ranking
Public administration	108.4404	6
fitness	3.093	10
Commerce	373.8412	2
Community service	-35.1358	8
Municipal public utilities	546.009	1
Culture	31.8653	9
Education	85.0184	7
Medical care	-159.2199	4
Finance	-151.5123	5
Greenbelt	273.9467	3

Calculation results suggest that the importance ranking of the impact of indemnificatory community public service facilities on occupancy rate is: municipal public utilities, commercial, and greenbelt facilities of the first group; medical, financial, and public administration facilities of the second group; and education, community service, cultural, and fitness facilities of the third group. In summary:

1) There is a large gap between the cultural and fitness facilities of the community and residents' expectation, lacking cultural exchange centre, indoor fitness gym, and outdoor fitness area; the community service facilities, such as youth activity centre and senior citizen activity centre are also deficient; in terms of education facility, despite the sufficient scale of the fundamental education facility, the teacher resources still lag behind, with a vacuum area in adults education and continuing education. As a result, these facilities become impediments to, instead of the main driving force for, the intake population.

2) The current administrative facilities in the community only meet the ordinary office management requirements of the neighbourhood committee and the property management. Therefore, the financial facility cannot meet the demand and the medical care facility is only limited to the community health centre, unable to meet residents' demand in cases of serious diseases and emergency treatment. Accordingly, these facilities have no significant attraction for the intake population.

3) Municipal public utilities, as fundamental living facility, is the prerequisite for the intake population in the community and ranks the first in the importance ranking, which suggests its crucial effect on the occupancy rate. Although the community business facility includes food market, small supermarket, all types of clothes and beauty salons, food and beverage, and service, due to the limited scale and insufficient number, it has a limited contribution to the occupancy rate of the community despite its high ranking and results in low occupancy rate of communities.

4 Conclusions

The indemnificatory community intake population is mainly mid-income and low-income classes, whose education background, occupational skills, consumption ability, and living standard are relatively low and, compared with the mid-and high-level income classes, are at a relatively low demand level, with the fundamental fund for daily life. In the meanwhile, due to the dynamic and stage nature of the occupancy process, the demand level for public service facility varies at different stages, with different configuration focuses. The dynamic strategy of sequential configuration objective construction for public service facility includes the dynamics of the time dimension and the dynamics of the spatial sequence.

In the time dimension, establish the near-term targets and long-term targets of indemnificatory community public service facility. The near-term targets should have implement stability and operability, giving priority to the configuration of fundamental public service facility to address the existing fundamental living demand for the community residents. The long-term targets should have foresight, giving priority to amelioration and advancement facilities to satisfy residents' increasing comfort and developmental demands. In the meanwhile, during the configuration process, under the influence of the community construction development and residents' demand variation, new facilities should be provided.

In the spatial dimension, establish the target system composed of diversified facilities dominated by public welfare facility. Public welfare facility aims to meet residents' major demand and has strong population aggregation effect, while other types of facilities focus on addressing a specific demand level of the residents.

Therefore, the configuration of indemnificatory community public service facility should adopt by-stage planning, abide by the principles of promoting community

development, accelerating the scale construction of public service facility, and reasonably and sequentially improving public service facility configuration in the middle and long term to determine the public service facility planning objectives, and at the same time improve the public service facility configuration gradually and by stage with full consideration of the operation requirements, economic benefits, and resource sharing. Due to resource limitation, the configuration of indemnificatory community public service facility should first address the problem of "absence", followed by the problem of "deficiency". The public service facility configuration should satisfy residents' different levels of demand in the sequence from the low level to the high level:

1) The near-term planning should focus on fundamental living facility.

The near-term planning objective of indemnificatory community public service facility should focus on the fundamental living service facility for which residents have strong demand for in their daily life and some of the amelioration public service facility for which residents have a pressing demand and control the scale, reserve the land for future demands, leave the room and space for further development, and set the solid schedule. In the meanwhile, it should give consideration to the government-subsidized public welfare facility, such as education and medical care, which have a major impact on population aggregation.

2) The mid-and long-term planning should focus on amelioration and developmental facilities.

The mid-and long-term plan for indemnificatory community public service facility should follow the layout model of balanced configuration and, by evaluating and optimizing the layout models constructed at different stages, obtain the layout model that is more suitable for the indemnificatory community characteristics. In terms of facility configuration, it should make flexible adjustment and supplementation based on the variation of population demands at different stages, so that the balance of layout is reflected both in time and in space, thereby realizing the coordinated development between the public service facility and the intake population scale and demands and satisfy residents' increasing requirements for living standards and self-development. Specially, besides the configuration of fundamental public service facility, a series of amelioration and developmental public service facility should be planned and configured to meet residents' higher level of demand for material and spiritual cultural life. This type of facilities make residents' living conditions more convenient and improve their life value, such as the community service facility of senior citizen recreation service centre, cultural entertainment facility, comprehensive gym, comprehensive stadium, and different types of restaurant and business facilities.

3) A complete public service facility system should be established.

The reasonable planning for the public service facility configuration should be made, identifying the facilities and projects to be configured in the near term, the middle term, and the long term, so as to facilitate the residents that have early moved in, bring into full play the service function and improve the operation efficiency of the facilities. In terms of the spatial configuration, a public service facility network service system should be established with hierarchical functions and spatial layout, more pertinent service, richer contents for each demand level, and greater flexibility.

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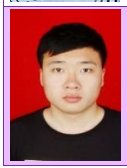

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