

Identification of Influencing Factors of Urban Residential Quality based on Pajek Social Networks Analysis Model

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Abstract

It is the premise of improving the overall service level and environmental quality of residential areas to grasp and identify the key factors of residential quality. Firstly, it establishes the main body of the residential quality, finds out the various influencing factors, and constructs the social network analysis structure model; then, based on Pajek social networks analysis tool, it constructs the matrix of the influencing factors, analyzes the centrality, the betweenness centrality and the closeness centrality, so as to identify the five key factors affecting the residential quality. The factors include surrounding greening, building density, road and building quality, property quality and public activity places. Finally, according to the analysis results, the paper puts forward some countermeasures and suggestions, such as keeping the network connection among various factors in the planning, following the wishes and requirements of the residents in the reconstruction and upgrading of the community, and strengthening the comprehensive management of all aspects of the community by the property company.

Keywords

Residential quality; Influencing factors; Element identification; Social networks analysis.

1. Introduction

The construction of residential environment is an important part of urban management and overall planning, which permeates and affects the living environment of the whole city to a great extent. With the increasing diversification and complexity of the comprehensive conditions of the contemporary urban residents, the good residential quality in the built environment of the residential area can meet the basic material requirements and deep psychological needs of the residents. Such as dense residential space organization, residents can feel comfortable in space vision and physical perception; effective management of urban natural disasters and epidemic prevention and control, can ensure the internal safety of residential areas and promote rational communication between residents and property; rich open leisure and entertainment facilities, residents can get more opportunities for recreation and interactive communication in public space; beautiful environment around reasonable traffic arrangements, will give residents physical and mental enjoyment and safety protection. In the fine community living environment and social network relationship atmosphere, residents will naturally have a strong sense of belonging, pride.

However, the builders and managers of residential areas often sacrifice the legitimate rights and interests of residents for the maximization of economic benefits, resulting in a large discount on the living quality of residential areas, and many problems such as high building density, low green rate, traffic jam, lack of infrastructure facilities and public land use. It is also difficult to provide comprehensive and high-quality services to residents with single-function residential facilities, which can not meet the requirements of residents for comfort, safety and diversified living environment. Therefore, it is necessary for the planning builders of the

residential district and the property managers in the later period to cooperate together to provide the residents with humanized and professional practical function and high quality service.

Based on this, this paper constructs the main body of residential quality by analyzing the characteristics of residential environment, finds out all kinds of influencing factors, and uses Pajek social network analysis tools to scientifically identify the key influencing factors. In order to improve the comprehensive living quality environment, realize the rational allocation of public resources, promote the management optimization, and actively provide a good living service experience.

2. Structure of Influencing Factors on Residential Quality of Second Residential Area and Construction of Social Network Relationship Model

2.1. The Main Body and Influencing Factors of Residential Quality

In the modern urban life, the high quality residential environment meets the needs of residents' diversified communication and communication to a certain extent, and at the same time, it can promote and promote the living activities. It is necessary to take the creation of a "people-centered" living environment as the goal of community construction, proceed from people's "sense of experience", pay attention to the spatial scale and spatial level of daily life, and pursue a high quality life of communication, identity, harmony and harmony, co-governance and sharing, safety and stability[1].Chen Fu [2] and Chen Zhengfa [3] analyzed the residents' satisfaction with the residential environment quality by establishing the environmental quality evaluation index system and evaluation model; Zhang Feng [4] selected four system indicators, including the level of community environment construction, residential construction level, infrastructure construction level and social security level, in accordance with the principles of pertinence, scientificity, dynamism and stability And 20 single indicators to evaluate the environmental quality of residential areas; Du Hongwu [5] through the study of the factors affecting the residents' satisfaction with the residential environment quality, to find out which core factors affect the subjective feeling of the residential environment quality, so as to obtain a further understanding of the residential demand and living environment.

Based on the above research results, it provides a useful idea for this paper to establish the main body and influencing factors of residential quality. Based on the condition of household type, age distribution, basic facilities and geographical location, this paper randomly selects 10 commercial residential areas in Lin'an District of Hangzhou as the field research object, and establishes the main factors of residential quality composition according to the subjective judgment of residents' demand survey and the objective situation of residential building environment. It is divided into four aspects: natural environment quality, traffic building quality, life service quality and public facilities quality. On this basis ,19 sub-factors of residential quality are subdivided into alphabetical a-s, as shown in table 1 .

2.2. Social Networks Analysis and Pajek Application

Social network analysis is a set of theories and methods to analyze the structure of social relations and its related attributes. It is also called structural analysis. It is a kind of network analysis method to analyze the correlation degree between various factors and the influence degree of each factor on the whole system by constructing the social network diagram of the relationship between various factors[6].Social network analysis is not only limited to individual interaction at the micro level, but also can be used in various social phenomena at the macro level, such as community relations, organizational structure and even international relations.

Pajek means "spider" in slovenian. It is a kind of software specially used to process large data sets. It not only provides a visual interface for users, but also provides a set of fast and effective algorithms to analyze complex networks. Users can understand the connection degree and structural characteristics of complex networks more intuitively through visual angle. Pajek social network analysis tools are used to identify the influencing factors of residential quality.

Table 1. Influencing factors of residential quality

Serial number	Influencing factors	Influencing factors
a	Natural environment quality	Illumination
b		Air quality
c		Noise status
d		Surrounding greening
e	Traffic Construction Quality	Building density
f		Road mix
g		Road parking
h		Road and building quality
i	Quality of life services	Property Quality
j		Shop
k		Public health
l		Educational institutions
m		Lighting Quality of Street Lamp
n		Security facilities and management
o		Electricity and water supply and drainage
p	Quality of public facilities	Public activity place
q		Number of recreational facilities
r		Quality of Leisure Facilities
s		Number of seats

2.3. Construction of Social Networks Analysis Structure Model

The social network is a network-like structure connected by different nodes, and the interaction between the roles forms the connection between the nodes[7]. A social network is all the connections that exist in a particular thing, and the sum of the characteristics of a connection can be used to explain the influence of something on other things in a network relationship. Similarly, the residential quality of residential areas is also composed of many factors, each link will inevitably affect other aspects, such as high residential density will lead to poor lighting conditions, traffic obstruction will reduce the safety factor, The lack of lighting and health facilities will lead to a decline in the enthusiasm of residents. If it is difficult to realize the connection of each link and make scientific and reasonable residential area management, it may lead to domino effect and eventually destroy the whole residential quality system. Based on this, this paper carries on the social network analysis to the residential quality of the community and carries on the model construction to its structure.

The social network diagram of residential quality is mainly composed of points, edges and weights, Among them ,19 sub-factors of residence quality are nodes of network graph, Directed connections between nodes form the edges of the whole network, The weight size between each edge represents the strength of the interaction between the two nodes. In this paper, the influence of each factor is divided into four levels, The evaluation criteria are as follows :3- having great influence (strong relation),2- having great influence (strong relation),1- having

little influence (weak relation), 0- having no influence (no relation). This paper studies and designs a questionnaire on the relationship between the influencing factors of residential quality, A total of 826 questionnaires were sent to 10 residents, 802 valid questionnaires were collected, The interaction weight of 19 factors is obtained by integration analysis. And then use the Pajek social network analysis tool to draw the network map of the influencing factors of residential quality (Figure 1), In the network diagram, red, yellow, blue and green colors are used to distinguish the main factors of residential quality of different types of residential areas (shading the directed connection with the relationship between factors is 0).

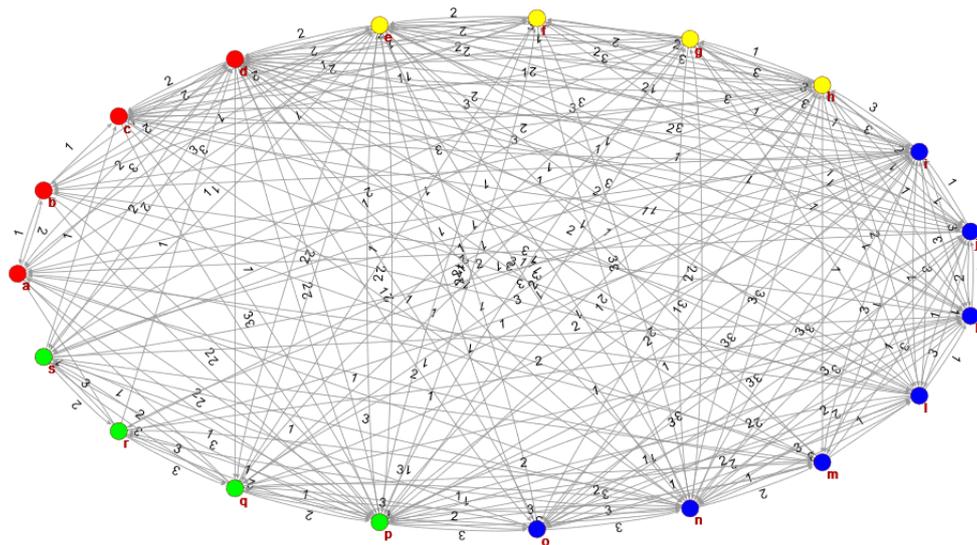


Figure 1. Network Diagram of Factors Affecting Residential Quality

3. Analysis of Residential Quality Based on Pajek Social Network Analysis Model

Power, as a measure of influence, is defined quantitatively from the perspective of "relationship" in social network analysis, and a variety of formal definitions of power are given, that is, various centrality and centrality index[8].The centrality refers to the position of the individual in the network, and the central potential represents the characteristics of the whole network, both of which are concrete manifestations of the "centrality" of the social network and can reflect the size of a point or individual's power in the network. Therefore, the central analysis Pajek social network analysis tools can be used to describe the relationship between the various influencing factors, which can reflect the core position of the key influencing factors in the residential quality social network.

3.1. Construction of Influencing Factors Matrix and Analysis of Centrality

According to the interaction weight and social network diagram between the influencing factors of residential quality, the adjacency matrix of influencing factors is constructed (Table 2). The rows and columns in the matrix represent the influencing factors, and the data in the matrix represent the close relationship Y the influencing factors X and the influencing factors. It can be used to measure the interaction intensity between the influencing factors and to find out the influencing factors at the core and edge. If an influencing factor has a higher output weight, it means that the influencing factor is easy to interact with other influencing factors. When the weight value is large, it means that the influencing factor is more vulnerable to the correlation of other influencing factors, while the weight value is small, which means that the influencing factor has strong objectivity. Other influencing factors are difficult to have a direct relationship with the influencing factor [9].

Table 1 shows that, Among the factors affecting residential quality, The quality of roads and buildings (36 and 20), the number of recreational facilities (21 and 16), and the quality of recreational facilities (17 and 12) all have relatively high point out weight and low point in weight, indicating that these influencing factors have a strong correlation with other influencing factors, For example, the maximum difference between point entry and point out weight of road and building quality factors is 16, Therefore, the probability that the influencing factor is directly controlled by other influencing factors is low. while air quality (7 and 15), road mix (13 and 20), safety facilities and management (30 and 38), Both have relatively low point-out weights and higher point-in weights, indicating that such factors are vulnerable to other factors, However, it is not possible to analyze whether these factors affect the above factors by weight, The potential attributes of various influencing factors need to be further analyzed.

Table 2. Adjoining matrix of factors affecting residential quality

Influencing factors	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	Output weights	
Natural environment Quality	a	0	1	0	2	3	0	0	0	0	0	0	2	1	0	2	0	0	0	11	
	b	2	0	1	1	0	0	0	0	0	0	0	1	0	0	2	0	0	0	7	
	c	0	0	0	2	2	1	1	3	3	1	0	3	0	1	3	0	0	0	20	
	d	3	2	2	0	2	2	2	1	3	1	2	2	1	1	2	1	0	2	30	
Traffic buildings Quality	e	3	1	2	2	0	2	3	2	2	2	1	1	1	1	2	2	0	1	29	
	f	0	1	2	1	2	0	0	2	0	1	0	0	0	3	1	0	0	0	13	
	g	0	0	1	2	1	2	0	1	3	1	1	1	0	2	3	2	0	2	22	
	h	1	3	2	2	3	3	3	0	3	2	1	2	1	3	3	2	1	0	1	36
Life services Quality	i	1	1	2	3	1	3	3	3	0	1	3	3	1	3	2	1	3	1	38	
	j	1	0	1	1	3	0	0	1	1	0	3	1	3	3	3	0	0	0	21	
	k	0	3	0	3	0	1	1	0	3	2	0	1	0	2	2	3	0	0	21	
	l	1	1	3	1	1	0	0	1	1	1	3	0	0	3	2	1	0	0	19	
	m	1	0	0	1	0	0	0	0	3	1	0	1	0	2	0	3	0	0	12	
	n	0	0	0	1	1	3	2	3	3	3	2	3	1	0	3	3	1	1	30	
	o	0	0	0	2	2	0	0	1	3	3	2	2	1	3	0	3	1	0	23	
Public facilities Quality	p	2	2	3	2	2	2	2	1	2	1	3	1	2	3	2	0	2	2	37	
	q	1	0	0	0	2	1	1	0	2	0	1	0	2	1	3	1	0	3	21	
	r	1	0	0	1	0	0	0	1	3	0	2	0	0	3	0	1	3	0	17	
	s	0	0	1	2	1	0	1	0	2	0	1	0	1	3	1	1	2	3	0	19
Weight of Entry		17	15	20	29	26	20	19	20	37	20	25	21	17	38	24	35	16	12	15	

Besides, based on the weight value of each factor and the analysis of the important nodes of the social network in the Pajek software, we can determine the two important node types of the hub and authority, and get the important node and authority weight table of the influencing factors of the residential quality of the community. When a node is considered a good hub, it will point to many good authoritative nodes, and if it is connected by many good hub nodes, it is a good authoritative node. In Table 3, when the obtained classification value is "1", the node is an authoritative node, and when the obtained classification value is "2", the node is both an authoritative node and a set node. When the obtained classification value is "3", the node is a set node. It can be seen from the table that the classification values of the four influencing factors of surrounding greening, property quality, safety facilities and management, and public activity places are all 2, which can be preliminarily judged as the key nodes, that is, the important influencing factors of residential quality in residential areas, and the specific key influencing factors also need further analysis.

Table 3. Important node and authority weight of residential quality influencing factors

Classification values	Influencing factors	Authority weights
0	a	0.1586262
0	b	0.1575916
0	c	0.1977038
2	d	0.2681753
3	e	0.2381838
0	f	0.2290499
0	g	0.2173366
3	h	0.1981349
2	i	0.3472937
0	j	0.2040988
1	k	0.2546205
0	l	0.2256961
0	m	0.1543380
2	n	0.3462590
1	o	0.2523508
2	p	0.3059995
0	q	0.1603318
0	r	0.1230905
0	s	0.1529067

3.2. Key Impact Factor Analysis

3.2.1. Betweenness Centrality Analysis

Betweenness centrality is also known as intermediary centrality. In social networks, if a point is on many communication network paths, it can be considered as an important point because it has the ability to control the communication between other two points[10]. We usually use the concept of "intermediate ratio" to describe this kind of "capability", which is defined as the ratio of the total number of geodesics between point i and point j and point k. It measures how much I lies between J and K[11]. Specifically, suppose that the number of shortcuts between point J and point K is represented by g_{jk} , the third point I can control the communication ability between these two points is represented by $b_{jk}(i)$, that is, the probability that I is on the shortcut between points J and K; the number of shortcuts between points J and K passing through point I is represented by $g_{jk}(i)$. Then, we can get $b_{jk}(i) = g_{jk}(i) / g_{jk}$. In order to calculate the betweenness centrality of point I (denoted as C_{ABi}), it is necessary to add the corresponding intermediate degree of all point pairs in the graph [12], that is:

$$C_{ABi} = \sum_j^n \sum_k^n b_{jk}(i), j \neq k \neq i \text{ and } j < k$$

By analyzing the influencing factors of residential quality by Pajek software, the betweenness centrality of each factor can be obtained (Table 4). By comparison, it is found that the betweenness center degree of the six influencing factors, such as surrounding greening, building density, road and building quality, property quality, safety facilities and management and public activity place, is high, and play an important role of transmission and media in the residential quality of residential areas, so it belongs to the key influencing factors. When these key factors are missing, they may lead to changes or faults in other factors.

Specifically, the surrounding greening is the main manifestation of the landscape situation of the whole district and the direct way for residents to get close to nature. The greening

arrangement is not only reasonable arrangement in the early stage of the district planning, but also carefully designed around buildings, roads and equipment after completion. Reflect the overall aesthetic attributes and natural environment of the district. Building density affects lighting, road width, activity site and other factors. Loose building spacing can reduce the pressure of residents, improve living comfort and road accessibility. The quality of roads and buildings belongs to the basic elements of community construction, and most of the planning and management will be carried out around it, which is an "important bridge ". There is no doubt about the importance of property quality, related to all aspects of the daily management of the community, but also the main way for residents to complain and protect their rights. Safety facilities and management are the basic requirements of each influencing factor. If the overall safety factor of the district is not high, it will inevitably lead to the sinking of the word of mouth and occupancy rate of the district, and will not be affirmed by the residents on the overall quality of the district. It can be seen that the betweenness centrality of the public activity place is the highest, which reflects the high attention and urgent demand of the residents of the garden, and is an effective space for residents of all ages to communicate and contact. Also related to other factors of organizational arrangements and setup planning.

Table 4. Betweenness centrality degree of influencing factors of residential quality

1.	0.005860 - a
2.	0.003575 - b
3.	0.012096 - c
4.	0.059039 - d
5.	0.033011 - e
6.	0.004915 - f
7.	0.008020 - g
8.	0.023588 - h
9.	0.043459 - i
10.	0.012556 - j
11.	0.011089 - k
12.	0.011066 - l
13.	0.008217 - m
14.	0.042122 - n
15.	0.005842 - o
16.	0.072846 - p
17.	0.009891 - q
18.	0.002246 - r
19.	0.006379 - s

3.2.2. Closeness Centrality Analysis

Sometimes we may pay more attention to the degree of proximity of one point to all other points in the network, which leads to the closeness centrality of point X: a measure that is not controlled by other points. There is usually a shortcut between two points, and the length of the shortcut is the distance between two points[13]In measuring closeness centrality, we focus on shortcuts, not direct relationships. When a point is connected to many other points through a shorter path, the point is said to have a high degree of closeness centrality [14].It is defined as: The closeness centrality of a point is the sum of the shortcut distances between that point and all the other points in the graph, and the expression is as follows:

$$C_{AP_i}^{-1} = \sum_{j=1}^n d_{ij}$$

Where d_{ij} is the shortcut distance between point I and point J (i.e., the number of lines contained in the shortcut).

The internal and external center potential of a point is an important index of the proximity center degree of the point. In order to accurately identify the key influencing factors of residential quality, this paper analyzes the internal and external proximity center potential of each influencing factor. In order to determine the center of each influencing factor. If a certain influencing factor has a higher outer close center potential and a lower inner close center potential, the closer the influencing factor is, the less likely it is to be affected by other influencing factors, so the factor is identified as the key influencing factor [15].

By using the Pajek social network analysis tool, the internal and external proximity potentials of the influencing factors of residential quality are obtained. Table 5 shows that of the 19 sub-factors, according to the discriminant methods and rules of the central potential of the influencing factors, 11 kinds of influencing factors are the key factors affecting the residential quality of the residential area, and the external close center potential is higher than the internal close center potential (the internal and external central potential of the surrounding greening, educational institutions, water supply and drainage are found to be the same in the table, because the other factors and the degree of influence are relatively consistent, so the comprehensive effect is relatively strong, but also determined as the key influencing factors). Taking the influencing factors of property quality as an example, the output closeness centrality is as high as 1.00. It can be seen that the quality of property affects the overall living environment quality of the residential area, which not only plays an important "media" role, but also closely related to the daily life of the residents.

Table 5. The input and output closeness centrality of the influencing factors in the plot

Influencing factors	Influencing factors	Output closeness centrality	Input closeness centrality	Is it critical
Natural environment quality	Illumination	0.600000- a	0.720000- a	No
	Air quality	0.580645- b	0.666667- b	No
	Noise status	0.692308- c	0.720000- c	No
	Surrounding greening	0.947368- d	0.947368- d	Yes
Traffic Construction Quality	Building density	0.947368- e	0.818182- e	Yes
	Road mix	0.642857- f	0.692308- f	No
	Road parking	0.782609- g	0.692308- g	Yes
	Road and building quality	0.947368- h	0.750000- h	Yes
Quality of life services	Property Quality	1.000000- i	0.857143- i	Yes
	Shop	0.720000- j	0.782609- j	No
	Public health	0.692308- k	0.782609- k	No
	Educational institutions	0.750000- l	0.750000- l	Yes
	Lighting Quality of Street Lamp	0.620690- m	0.750000- m	No
	Security facilities and management	0.8182- n	0.947368- n	No
	Electricity and water supply and drainage	0.720000- o	0.720000- o	Yes
Quality of public facilities	Public activity place	1.000000- p	0.947368- p	Yes
	Number of recreational facilities	0.750000- q	0.692308- q	Yes
	Quality of Leisure Facilities	0.666667- r	0.580645- r	Yes
	Number of seats	0.750000- s	0.642857- s	Yes

In general, most of the factors affecting the quality of the natural environment are not the key factors. On the one hand, residents are more interested in the choice of residential areas, such as close to the school district, business district, transportation hub and other convenient areas as the first choice; on the other hand, the builders and maintainers do not create a comfortable and pleasant living environment. Most of the influencing factors of traffic building quality are key factors. It can be seen that residents pay more attention to daily traffic travel and vehicle placement, building quality and building density, and also remind district managers to pay attention to daily road dredging and building maintenance. It is worth noting that safety facilities and management are not key factors, mainly because they are close to the center, that is, they are affected to a large extent. Safety factor is a necessary condition for other factors. The sub-factors of the quality of public facilities are all key factors, especially the output closeness centrality of public activities is 1.00, which is closely related to the residents' urgent need for daily rest and entertainment. The community is not only reflected in the comfort of living, but also to ensure the comfort of living.

4. Conclusion Analysis and Countermeasures to Improve Residential Quality

4.1. Conclusion

Through the construction of social network analysis structure model, pajek software is used to analyze the influencing factors of residential quality, especially the betweenness centrality analysis and the closeness centrality analysis. 6 and 11 key factors affecting the residential quality of the residential quarter are identified respectively, and the key influencing factors of the two are: surrounding greening, building density, road and building quality, property quality, public activity place. From this we can judge that these five factors are the key influencing factors of the residential quality of the community, which are in the core and most important position in the network, and are also the key points related to the overall living environment quality of the community and the need to focus on improving. Therefore, the management and control of these key elements and the reasonable implementation of relevant policies and suggestions can not only ensure the stability of the overall living quality of the community through the key points, but also promote the close connection of other related influencing factors and improve the residential satisfaction of the whole small area.

4.2. Responses and Recommendations

4.2.1. Planning to Maximize Networking among Factors

In the process of community construction planning and maintenance, we should start from the perspective of social space network, because the factors that affect the living quality of the community are also linked, which contain social principles and the sociality of space. And the interaction between the two affects the development of residential areas, so residential areas should change from a single physical space to multiple complex places[16]. High connectivity is the basic characteristic and connotation of the influencing factors of residential quality. Taking key elements as the core standard and communication link, the units can be well combined, such as increasing vegetation coverage to improve air condition and noise pollution, widening roads and activity sites to improve residents' living convenience and rest comfort. The first condition to realize these requirements is that the residential area has certain network connection, that is, resource sharing, open equilibrium, communication fusion and function mixing[17] Give full play to the positive effect of network connection and improve the overall living environment quality index.

4.2.2. The Upgrading and Upgrading of the Community Should Follow the Wishes and Requirements of the Residents

The reform and upgrading of the residential environment will not meet the demands of every resident. Therefore, the construction of the residential area must be carried out in detail, and the most direct interests of the residential system should not be ignored and excluded. It is necessary to follow the principle that the residents should have the right to know and make decisions, and adhere to the principle that the advantages and disadvantages should be balanced, the two advantages should be taken, and the two disadvantages should be compared with the two disadvantages[18]According to the analysis of the impact factors on the residential quality of the Chujing Garden District, the key elements are actually the places where the residents appeal more loudly. Therefore, we should understand in detail the natural environment, traffic buildings, living services and other aspects of the community, be familiar with the social network status, cultural differences and value orientation of the residents, as well as local customs, environmental monitoring requirements, urban and rural planning and laws and regulations.

4.2.3. Enhanced Integrated Management of all Aspects of the Community by Property Companies

With the change of urban residents' housing demand from simple "survival demand" to "comfortable demand", the quality and quality of property service will become the core element of the development of property management industry[19]According to the results of the analysis, we can see that the middle degree and proximity degree of the influencing factors of residential property quality are relatively high, which is related to the overall living environment quality of the residential area and is in the core leading position. This requires that the property should pay more attention to "service to people" on the basis of "managing things", and win the recognition and satisfaction of the owners to the maximum extent with the quality of service. The construction and management of the district inevitably involve the actual interests of the residents, which requires the property companies to strengthen comprehensive control and balance control in all aspects of the district, especially in the stage of urban natural disasters or epidemic prevention and control. And actively participate in the planning and construction of residential quality environment as a whole more comfortable and competitive.

5. Shortcomings and Prospects

This article mainly has two aspects insufficiency, one is the article mainly has carried on the research to the key influence factor, not the key factor is also worth exploring, may combine the two to look for the breakthrough which enhances the residential quality; the other is the judgment to the community comprehensive residential quality influence factor, but the different community condition is generally different, the next research may link the different type or the individual residential area, in the geography, the culture, the building, the environment and so on many aspects has the pertinence to carry on the residence quality influence factor inquiry. Social network analysis has crossed the traditional meaning of discipline boundaries, its application is not limited to sociology, anthropology and other few fields, but widely extended to almost all fields of humanities, social sciences and technical sciences. As one of the most powerful tools of social network analysis, Pajek software not only has the characteristics of humanization and effectiveness, but also provides a simulation platform for the comprehensive analysis of complex networks.

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