Factor Weight Analysis of Community Needs for Elderly Care Based on Crowd Attributes and Behavior Characteristics

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Abstract. Based on Gibson's concept of affordance and its methodological application in the design and the subject and object elements of "demand affordance, " ANP was used to solve the horizontal ties among the aspects of affordance, judge the research elements, SPSS correlation analysis was used to construct the judgment matrix, and a consistency test was conducted, establish a study on community function and behavior space design of elderly population under the dual coupling elements of functional needs and behavioral needs.

Keywords: community endowment; functional demand; behavior demand; interaction.

1. Proposal and design application of affordance

The theory of affordance comes from the concept of psychology and extends to the field of design to study the relationship between human behavior and the environment.

" Affordance" is a theory put forward by James J. Gibson, an American ecological psychologist, the original meaning of "affordance" refers to the resource supply or allocation of the natural environment for the species in which it is located, and the possibility of environmental provision determines the potential of action [1][2]. The concept of affordance was put forward in the context of ecological psychology, emphasizing the reciprocal relationship between individual behavior and environment.

The meaning of affordance is divided into many types in academic promotion and research. Donald Arthur Norman, a cognitive scientist, introduced the concept into the field of design, emphasizing more attention to the "perceived affordance" of the use[3][4]. Gaffer put forward the "technical affordance, " the connection between the subject actor and its' technological environment, and believed that affordance is the possibility of actual behavior[5][6]. Within the same species, people of different sexes and ages coordinate differently with the environment. The needs of people of varying age groups for the environment are the basis for developing their behavioral abilities.

This study proposes affordance based on the needs of the elderly. The elderly, as a particular group of society, in the community living environment, their physical and physiological abilities gradually decline with age. In this study, the elements of demand media required by the elderly from the coupling of functional and behavioral needs will construct the community elderly care service functions.

2. Composition of demand elements

2.1 Main elements: characteristics of the elderly

According to the physical needs and self-care ability of the elderly, as well as the general laws of the human life cycle, HTA divides the elderly and their residential demand into seven levels (Figure 1). In this study, 207 valid questionnaires were sent to people over 40 years of age in society. Among them, the feedback results of "Community care and home care" accounted for 98.07% of the question about choosing the future way of providing for the aged; The results showed that the selection of the institutions for senior care, medical institutions, and "migratory bird" care decreased with the increase of age; The "Community care and home-care" elderly care mode will be the main track of the elderly care mode for people over 40 years old.

Category			Principal object	Residential demand
Full self-care	I Independent period	Category a	Self-care-capable,retired or Pre-retired seniors	Non-senior-specific, mainly home care, followed by community services.
		Category b	Healthy seniors who are energetic and largely self-sufficient, requiring only some supervision and a little help	Healthy senior housing with some degree of supervision and a little help.
		Category c	Healthy and energetic seniors	Specialized senior housing with facilities to help seniors live with basic independence, providing round-the-clock supervision and a minimum of services and utilities.
Semi-self-care	II Device-helping period	Category d	Weakness of the body and soundness of the mind	Specialized senior housing where residents do not require hospital care but may require occasional personal living assistance and care, providing supervision and meal supplies.
		Category e	The elder who is physically healthy but mentally declining	Occupants may require some personal living supervision and care, and common facilities require personal living assistance and care, providing supervision and meal supplies.
Total-care	III Under nursing period	Category f	Elder people who are physically and mentally declining and need personal supervision	Many of the residents are unable to take care of themselves, so it is unlikely that the residents will be independent, and services such as meals, bathing, cleaning, and dressing will be provided.
	IV Professional care period	Category g	Same as f outside, and sick, injured, temporary or permanent patients	The medical and nursing care provided in this type of building should be in a registered healthcare facility, and the housing should be almost exclusively single-bed rooms with a focus on end-of-life care.

Figure.1 International Charities related to geriatric classification

2.2 Object element: functional demand

In response to the diversification of modern community construction, under the characteristics of demand affordance and the demand level of the elderly, according to the principle of meeting the living needs within a reasonable walking distance according to the layout of functional service facilities in the urban life circle, the service facilities for community elderly care are divided into two categories: basic needs and advanced needs. The basic requirements include basic supporting facilities and quality improvement facilities, and the advanced needs are to meet the needs reflected by the value of the elderly.

It is divided by level and type to provide the functional needs of different life circles of the elderly, including life services, medical care, health activities, entertainment business, and spiritual comfort.

2.3 Object element: behavioral demand

The demand for behavior space is the second element of the first-level indicator. From the micro level, the interaction between the elderly and the environment and their behavioral characteristics are restored through spatial behavior analysis [7]. The space needs clear design elements to allow user behavior and become an active functional space.

The shopping behavior, exercise behavior, medical care behavior, leisure behavior, and socializing of the second-level indicators, from the perspective of demand level and based on the behavioral characteristics of the elderly, focus on the travel distance, purpose, time and travel frequency, and realize the health, safety, accessibility, diversity and participation of the elderly's community behavior space according to the demand level [8].

2.4 Build hierarchy elements of demand affordance

In this study, ten secondary indicators were obtained from the two elements of functional demand and behavioral demand through a relevant literature review and network survey. A questionnaire analysis was carried out. Forty-six sub-element indicators were generated, and 207 valid questionnaire survey data were used. The correlation analysis of the subject background,

attributes, characteristics, and behavior to find out the related factors of the subject and object and the quantitative importance analysis of indirect or weak elements was carried out (Figure 2).

3. The interaction model of demand availability

3.1 Correlation analysis of main elements of affordance

Pearson product-moment correlation coefficient is used to select the correlation analysis between the main elements of affordance, the elderly population, and the characteristic elements, which is used to screen the correlation between the main attributes of the elderly population, including age, physical condition, the degree of need for care, the functional demand elements and their behavioral characteristics. By analyzing the subject and subject attributes of the elderly, the degree of care needs is related to age and closely related to physical condition. In contrast, age, sex, physical condition, living condition, etc., are not directly related (TableⅠ).

First-level indicator	Secondary demand indicators	Demand sub-elements
B1 Funtional Demand	C11 Community public service facilities	D11-1. Medical and health care (such as community health education, prevention, free clinic, rehabilitation, psychological consultation, etc.); D11-2. Outpatient department (medical service for common basic diseases); D11-3. Elderly Activity Center; D11-4. Nursing home (providing living, catering services, medical care, and other services, mainly for the elderly who are fully self-care and semi-self-care); D11-5. Nursing homes for the elderly (providing life care, catering services, psychological counseling, hospice care, and other services, mainly for the elderly who are semi-self-care and without self-care ability); D11-6. Community schools (provide cultural learning, exchange, performance, etc., based on the urban education structure
	C12 Community business facilities	D12-1. Comprehensive community mall; D12-2, Vegetable market or fresh supermarket; D12-3. Community post station (agent purchase, distribution station, consultation, housekeeping service, community canteen)
	C13 Community elderly care service facilities	D13-1. Elderly activity station; D13-2. Comprehensive fitness venues (large fitness facilities, square dance, and other venues); D13-3. Daycare center for the elderly (providing day care services); D13-4. Community commercial outlets; D13-5. Indoor fitness venue
	C14 Community elderly care convenient service facilities	D14-1. Walking and rest activities for the elderly; D14-2. Outdoor fitness and activity equipment venues for the elderly; D14-3.Convenience Store
B2 Behavioral Demand	C21 Behavior type(Travel purpose)	D21-1. Exercise behavior; D21-2. Shopping behavior; D21-3. Leisure behavior; D21-4. Socialize behavior; D21-5 Medical behavior
	C22 Travel distances	D22-1. ≥ 1000m; D22-2. 500-1000m; D22-3. 300-500m; D22-4. ≤300m
	C23 Travel frequency	D23-1. ≥ 1time/day; D23-2. 1time/day; D23-3. 2-3times/week; D23-4. 1time/week; D23-5. 1-2times/month
	C24 Travel time	D24-1. 1-3hours; D24-2. 0.5-1hours; D24-3. 3-5hours; D24-4. ≤0.5hours
	C25 Travel period	D25-1. 8:00-12:00; D25-2. 14:00-16:00; D25-3. 6:00-8:00 ; D25-4. 16:00-18:00; D25-5. 12:00-14:00; D25-6. 18:00-20:00; D25-7. After 20:00
	C26 Function space attribute	D26-1. Safety; D26-2. Accessibility; D26-3. Diversity; D26-4. Comfortability; D26-5. Participatory;

Figure.2 Community endowment demand index elements

TABLE I.　　Correlation analysis of population background and characteristic elements

Item	Average	Standard deviation	2. How old are you?	4. How is your health now?	5. What level of care do you need now?
2. How old are you?	1.69	0.75	1		
4. How is your health now?	1.26	0.64	0.09	1	
5. What level of care do you need now?	1.43	0.8	0.29**	0.41**	1
*p＜0.05**p＜0.01					

3.2 Correlation analysis of subject and object elements

Using the correlation analysis of SPSS, we can judge the relationship between the background attributes of the elderly and the characteristic behavior relationship elements, such as travel-appropriate distance, travel frequency, and travel time. The results show that the age of the elderly is correlated with travel frequency and negatively correlated with travel distance and time (Table Ⅱ). Combined with the cross-analysis method, the suitable activity distance will be shortened from 1000m to 300m with age for the elderly over 60. Still, there is no significant change in the travel frequency and time (Figure 3).

TABLE II.   Correlation analysis of background attribute and characteristic behavior

Item	Average	Standard deviation	2. How old are you?	4. How is your health	12. How far is the appropriate distance for your daily	13. How often do you travel	14. What time do you go out
2. How old are you?	1.69	0.75	1				
4. How is your health now?	1.26	0.64	0.09	1			
12. How far is the appropriate distance for your daily activity?	3.2	0.91	-0.24**	-0.03	1		
13. How often do you travel for your activity?	1.72	1.02	0.15*	0.25**	-0.21**	1	
14. What time do you go out each day?	2.79	1.01	-0.16*	0.1	0.25**	-0.05	1
*p＜0.05**p＜0.01							

X/Y	≤300m	300-500m	500-1000M	≥1000m	Inconvenient to go out and about	Total
40-60years old	5(5.15%)	11(11.34%)	25(25.77%)	55(56.70%)	1(1.03%)	97
60-74years old	4(5%)	11(13.75%)	34(42.5%)	31(38.75%)	0(0.00%)	80
75-89years old	2(7.41%)	7(25.93%)	10(37.04%)	8(29.63%)	0(0.00%)	27
≥90year old	2(66.67%)	0(0.00%)	1(33.33%)	0(0.00%)	0(0.00%)	3

Figure. 3 Cross-analysis of the elderly population with different degrees and home range

3.3 Object demand hierarchy element analysis model

The relationship between the elements of the functional space system of community elderly care is not a single vertical hierarchical relationship. There is also a horizontal relationship between the elements. A comprehensive evaluation model is established using the ANP and consistency check to solve the coupling relationship of various aspects under the dual criteria: the interdependence and feedback of influence elements under the control level of functional and behavioral requirements.

3.3.1Build a judgment matrix

Adopt experts in the industry to make pairwise comparisons of the importance of functional demand elements and analyze the significance of the original data of the expert questionnaire.

Santy's 1-9 scale method obtains the relative importance weight. The larger the number is, the more vital the relative importance is (Table Ⅲ).

TABLE III.   Judgment matrix table

Xmn	Meaning (Importance)
1	Indicates that two factors are equally important compared to each other
3	Indicates that one factor is slightly more important than the other compared to two factors
5	Indicates that one factor is significantly more important than the other compared to two factors
7	Indicates that one factor is strongly more important than the other compared to two factors
9	Indicates that one factor is extremely important compared to the other
2,4,6,8	Indicates the median value of the above two adjacent reviews
reciprocal	The comparison of factors m and n is judged to be Xmn, and the comparison of characteristics n and m is judged to be 1/Xmn

3.3.2Consistency check of judgment matrix

The sum-product method of SPSS calculates the scoring weight and checks the consistency. The consistency index $CI=\frac{\lambda max-n}{n-1}$ (When CI=0, X is consistent; the more significant the CI, the more serious the X inconsistency is). The consistency ratio is calculated as $CR=\frac{CI}{RI}$. Generally, the smaller the CR value is, the better the judgment matrix's consistency. Generally, the CR value is less than 0.1, and the judgment matrix meets the consistency test; If the CR value is more significant than 0.1, it indicates no consistency. The judgment matrix should be adjusted appropriately and then analyzed again.

3.3.3Select the Index layer and establish matrix elements

Based on the questionnaire of the elderly, select the primary indicator elements B1(function demand) and the second indicator elements C21 (behavior type) and C26 (function space attribute) of the demand element to build a comparison matrix. This study adopts the primary data of 53 experts for important pairwise comparison and functional space attribute elements.

3.3.4Comparative analysis of the importance of functional demand element matrix

The study of the community functional demand of the elderly population obtained the eigenvector value and the weight value of five items (Table IV). The judgment matrix of this study meets the consistency test, and the calculated weight is consistent. And get the importance ranking of 5 elements: 1. life service, 2. medical care, 3. health activities, 4. spiritual comfort, 5. Entertainment-business.

TABLE IV.   Weight value and consistency test of B1 functional requirement element judgment matrix

The data of AHP					
	Life services	Medical care	Healthy activities	Entertainment-business	Spiritual comfort
Life services	1	3	5	5	5
Medical care	0.333	1	3	5	3
Healthy activities	0.2	0.333	1	5	3
Entertainment-business	0.2	0.2	0.2	1	1
Spiritual comfort	0.2	0.333	0.333	1	1
The results of the AHP analysis					
Item	Eigenvector	Weighting Value	Maximum Eigenvalue		CI
Life services	2.337	46.74%			
Medical care	1.217	24.35%			
Healthy activities	0.802	16.03%	5.368		0.092
Entertainment-business	0.301	6.03%			
Spiritual comfort	0.343	6.85%			
RI value of consistency index					
n	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R	0.5	0.8	1.1	1.2	1.3	1.4	1.46	1.4	1.5	1.5	1.5	1.5	1.5	1.5
n	17	18	19	20	21	22	23	24	25	26	27	28	29	30
R	1.6	1.6	1.6	1.6	1.6	1.6	1.64	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Summary of Consistency Test Results					
Maximum Characteristic Root	CI	RI	CR	Consistency Test Results	
5.368	0.092	1.12	0.082	Pass	

3.3.5 Comparative analysis of the importance of the behavior type element matrix

The characteristic vector value and the weight value of five items (Table V) were obtained from the analysis of the behavior type of the elderly population. The judgment matrix of this study met the consistency test, and the computed weight was consistent. The importance order of 5 elements including 1. medical behavior, 2. exercise behavior, 3. social behavior, 4. leisure behavior, 5. shopping behavior was obtained.

TABLE V.   Weight value and consistency test of C21 behavior type element judgment matrix

The data of AHP					
	Shopping behavior	Exercise behavior	Medical behavior	Leisure behavior	Social behavior
Shopping behavior	1	0.333	0.333	0.333	0.333
Exercise behavior	3	1	1	3	1
Medical behavior	3	1	1	5	3
Leisure behavior	3	0.333	0.2	1	1
Social behavior	3	1	0.333	1	1
The results of the AHP analysis					
Item	Eigenvector	Weighting Value	Maximum Eigenvalue		CI
Shopping behavior	0.369	7.38%			
Exercise behavior	1.301	26.01%			
Medical behavior	1.81	36.20%	5.327		0.082
Leisure behavior	0.646	12.92%			
Social behavior	0.874	17.49%			
RI value of consistency index					
n	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R	0.5	0.8	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
n	17	18	19	20	21	22	23	24	25	26	27	28	29	30
R	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Summary of Consistency Test Results					
Maximum Characteristic Root	CI	RI	CR	Consistency Test Results	
5.327	0	1.12	0.073	Pass	

3.3.6 Comparative analysis of the importance of spatial attribute element matrix

The weight value is obtained from the functional spatial attribute analysis of the elderly population (Table VI). The judgment matrix of this study meets the consistency test, and the calculated weight is consistent. The importance ranking of five elements, namely, 1. safety, 2. comfort, 3. accessibility, 4. participatory, 5. diversity is obtained.

TABLE VI.   Weight value and consistency test of C26 functional space attribute element judgment matrix

The data of AHP					
	Safety	Accessibility	Diversity	Participatory	Comfort
Safety	1	3	5	5	1
Accessibility	0.333	1	3	3	1
Diversity	0.2	0.333	1	1	0.333
Participatory	0.2	0.333	1	1	1
Comfort	1	1	3	1	1

The results of the AHP analysis				
Item	Eigenvector	Weighting Value	Maximum Eigenvalue	CI
Safety	1.965	39.30%	5.305	0.076
Accessibility	1.033	20.65%		
Diversity	0.377	7.54%		
Participatory	0.531	10.61%		
Comfort	1.095	21.90%		

RI value of consistency index														
n	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R	0.5	0.8	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
n	17	18	19	20	21	22	23	24	25	26	27	28	29	30
R	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6

Summary of Consistency Test Results				
Maximum Characteristic Root	CI	RI	CR	Consistency Test Results
5.305	0	1.12	0.068	Pass

3.4 Conclusion of influence factor analysis

The interactive analysis of correlation and cross-analysis methods can get the behavioral characteristics of older people over 60 years old. The range of behavioral activities of the elderly population is mainly within 1000 meters, and the activity time is 1 to 3 hours. With the growth of age and the change in physical health, the range of activities gradually reduces to within 300 meters, and the activity time is reduced to 0.5 to 1 hour. The average frequency of behavioral activities is once a day, and the period is between 6 a.m. and 6 p.m., mainly from 8 a.m. to 12 a.m.

According to the analysis, the order of importance of community life function demand factors of the elderly is life service, medical care, health activities, spiritual comfort, and entertainment-business.

The order of the importance of the demand elements of the behavior types of the elderly is medical behavior, exercise behavior, social behavior, leisure behavior, and shopping behavior.

The order of the importance of the demand elements of the behavior types of the elderly is safety, comfort, accessibility, participatory, and diversity.

4. Suggestions on the interactive design of the elderly care function and behavior space in the community

4.1 Enthusiasm for function and space interaction

Take the community life circle as the research scope, study the life function demand, behavior type demand, and space attribute, propose the suggested strategy of the interaction between function and space, perception and behavior, and the intelligent interaction of human-computer feedback, solve the contradiction between demand and supply, experience and feeling, and use intention and design assumption.

4.1.1 Behavior space that can be reached by walking.

The behavioral space of essential functions is used frequently and for a long time. Safety, comfort, and accessibility are the basic standards, and participatory and diversity are the promotion standards. This study concludes that the 500 meters range of the elderly's life circle is the main activity concentration area, and the participatory behavior of the 500 to 1000 meters activity circle is gradually weakened. According to the guiding standard of the life circle theory, the main facilities and functions of a 10-min pedestrian-scale neighborhood with a walking distance of 500 meters include a primary school, multi-purpose courts, shopping mall, vegetable market or fresh supermarket, catering facilities, banking, telecommunications, postal and other business outlets, bus stations, rail transit stations, and other daily functions. The elderly can reach the functional space with high frequency in everyday use. Currently, they mainly use the living road network of streets

to strengthen the slow and safe walking space and pay attention to constructing a continuous space system while building walking accessibility.

4.1.2Community space with continuous space

Community space, satisfying, comfortable distance and accessibility, building walking continuity. Continuous walking space can improve the activity frequency, time, and activity of the elderly and increase participation. With the primary service function of the life circle as the link point, use the block roads and pedestrian space to establish a grid public space system, form the layout and implementation of facilities and space to achieve continuous activity space, and improve the use and participation of the elderly.

4.1.3Functional space for Multiple sharing.

From the perspective of spatial behavior, according to the stratification of life circle facilities, classification of functional facilities, and classification of population types. Through the primary and promotion standards of behavior accessibility, grid space is established to realize the concatenation of functions and space sharing. The public space to meet the physical and psychological needs of the elderly is an essential functional requirement for building community elderly care. The needs of social participation and self-realization are the needs of the elderly to improve the quality of community life. Create diversified and shared functional space to enhance the quality of life for the elderly and realize the diversity of elderly life and space participation, improve physical and mental health and satisfaction, and realize the active involvement of functional space.

4.2 The available enthusiasm for perception and behavior interaction

The interaction between perception and behavior can be understood as a positive response as the enthusiasm for affordance. For example, the physical function of the elderly is declining. Under the perception of fatigue, when the seat or step can provide people perform the sitting behavior, the most basic rest needs are met; At this time, children may jump and lie down to meet the needs of play; The passers-by may require sorting things. So this is to explain the hierarchical interaction between people, needs, and behaviors with the affordance of requirements, which is the affordance of multiple needs.

The perception of the elderly's community spatial behavior is the leading indicator of the evaluation of the screening participatory activities and the positive attribute feedback of the availability.

4.3 Trends of wisdom available

Community elderly care will gradually become intelligent, and the positive effect of affordance can solve the contradiction of the subjective assumptions between designers and users. Perception is also the most basic feedback information of the Internet of Things (IoT). Positive effects can be achieved through the feedback perception of the knowledge of the IoT. Human-computer interaction method is to build the model of anthropometric parameters and computer and IoT. Two main factors affect human-computer interaction: internal and external factors. The external aspects of human-computer interaction involve environmental monitoring technology, monitoring and optimizing the living environment and residence information of the elderly, and improving the optimal regulation and management of the live environment of the elderly community.

5. Conclusion

According to the ecological theory of affordance and community life circle. Through the correlation comparison and analysis of the population characteristic attributes and the demand measurement of the ingredients, respectively, obtain the appropriate activity distance, frequency, time, and other attribute values of the elderly. The community life function, behavior type, and

spatial attribute demand elements are essential. The research suggests that the hierarchical interaction model of the life circle interacts separately with the function and space, perception and behavior, and human-computer so that it can form a function and spatial system of three-level cascade interaction, realize the transformation of the research object from function design to behavior and space design thinking, from physical logic to behavior and perception logic thinking, and realize the thinking logic construction of the goal what the function and behavior needs, and use feeling are in the community elderly care life for the elderly. To establish a research basis for the design of public space for the high-quality life of the elderly community.

6. Fund project

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