

Need Identification and Spatial Allocation Models for Urban Community Eldercare Facilities: A Case Study of the Central Urban Area of Tianjin

LIU Yishan¹, LIU Conghong², YANG Hongwei³, CHENG Tan⁴

Author Affiliations 1 PhD Candidate; 2 Professor; 3 Associate Professor, Corresponding Author, Email: hongwei_yang@tju.edu.cn; 4 PhD Candidate; 1&2&3&4 School of Architecture, Tianjin University

ABSTRACT: Amid ongoing improvements in urban public service provision, the standardized provision of community eldercare facilities often fails to adequately align supply with user needs. From a supply-and-demand perspective, this study examined differences in needs across population groups. Andersen's behavioral model and the Kano model were used to assess respondents' need categories and degrees of need. Correlation analysis was conducted to identify factors associated with these needs, followed by cluster analysis based on the Kano categories to characterize population groups, identify typical user groups, and examine their functional-space needs. The results show that needs differed significantly according to population characteristics and functional-space type. Based on these findings, spatial allocation models were developed for the overall population and typical user groups, and a spatial allocation framework organized around functionally independent modules was proposed. This approach supports more precise identification of user needs and more evidence-based allocation of functional spaces, thereby informing the planning and design of community eldercare facilities.

KEY WORDS: community eldercare facilities; spatial allocation model; kano model; need categories; degree of need

Introduction

Since the 19th CPC National Congress, China has advanced supply-side structural reform in health services for older adults to promote healthy aging [1]. The promulgation of the *Standard for Urban Residential Area Planning and Design* (GB 50180-2018) has made community eldercare facilities a standard component of residential areas [2]. Excerpts from Xi Jinping's *Discourse on Urban Development* sets out requirements for the coordinated development of urban space, scale, and industry [3]. Against this background, integrating the eldercare sector into urban communities and providing functional spaces tailored to

older adults' needs have become major priorities for supporting aging in place.

Extensive research has been conducted in China and internationally on the functional allocation of community eldercare facilities and the service needs of older adults. Studies on functional allocation have primarily focused on issues such as insufficient flexibility and incomplete planning standards, with particular attention given to the positioning and evaluation of functional spaces [4], mixed-use design [5], adaptive design [6], and facility typologies [7, 8]. These studies have identified a tendency in eldercare facility development to prioritize bed capacity over

[The format of citation in this article]

Liu YS, Liu CH, Yang HW, Cheng T. Need identification and spatial allocation models for urban community eldercare facilities: a case study of the central urban area of Tianjin. *South Architecture*. 2026;(3):76-93.

• **Fund Projects:** National Natural Science Foundation of China (No. 52378029); Tianjin Natural Science Foundation (No. 21JCQNJC00450)

Document Identification Code A

DOI 10.33142/jsa.v3i3.20299

Article number 1000-0232(2026)03-005-18

Received: 2026-7-27

Accepted: 2026-8-07

Copyright © 2026 by author(s). This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License

(<https://creativecommons.org/licenses/by-nc-nd/4.0/>).

<http://www.viserdata.com/journal/jsa>

older adults' actual needs, and the widespread mismatches between supply and demand [9]. Research on service needs has increasingly focused on identifying the needs of different user groups. In particular, previous studies have examined functional-space need categories for the overall population using Maslow's hierarchy of needs [10], ERG theory [11], and the theory of attractive quality [12]. However, only a limited number of studies have examined how eldercare service needs vary across population groups with different characteristics [13]. Although differences in need categories associated with functional status, age, and living arrangements have been identified, how these differences should inform spatial allocation remains largely unexplored. Therefore, there is a need to investigate how functional-space allocation should vary across population groups with different characteristics, thereby supporting more evidence-based urban infrastructure planning and creating age-friendly community environments.

Previous studies have also demonstrated that user needs can be classified into different categories and that the relationship between service attributes and user satisfaction is inherently nonlinear [14]. Consequently, evaluating only the degree of need is insufficient for accurately identifying users' actual needs [15]. This study applies the Theory of Attractive Quality and the Kano model to functional-space allocation. Guided by the principles of shared urban development and intergenerational use of community eldercare facilities, the study conducted a survey in the central urban area of Tianjin, quantitatively prioritized functional-space needs, and developed differentiated spatial allocation models. It further proposes a spatial allocation approach based on functionally independent modules, as an alternative to conventional single-unit layouts and large, complex building forms.

1 Theoretical basis and research framework

1.1 Theory of attractive quality and the Kano model

This study is grounded in the Theory of Attractive Quality proposed by Noriaki Kano. Originally developed in the field of quality management, the theory has subsequently been widely applied in architecture [16], sociology [17], and behavioral science [18] to evaluate the relationships between service attributes and user satisfaction.

According to the Theory of Attractive Quality, service attributes and user satisfaction exhibit a nonlinear relationship, which makes the theory suitable for identifying different categories of user needs.

Based on this theory, the Kano model uses the combination of functional and dysfunctional questions ("paired questions" hereinafter) to classify user needs into distinct categories. By distinguishing between what users "want" and what they "need", the model classifies user needs into five categories [19, pp. 5]. Must-be (M) attributes represent basic needs. They exhibit a nonlinear relationship between quality attributes and user satisfaction: their provision does not increase satisfaction, whereas their absence leads to dissatisfaction, reflecting their essential nature. One-dimensional (O) attributes exhibit a linear relationship with user satisfaction: their provision increases satisfaction, whereas their absence decreases satisfaction, indicating that user satisfaction depends directly on their provision. Attractive (A) attributes are desirable features. They exhibit a nonlinear relationship with user satisfaction: their absence does not reduce satisfaction, whereas their provision increases it, reflecting users' expectations for added value. Indifferent (I) attributes have little or no effect on user satisfaction, regardless of whether they are provided. Reverse (R) attributes produce effects opposite to those intended and therefore represent attributes that users generally do not want. Questionable (Q) responses represent invalid or inconsistent response combinations and should be excluded from subsequent analysis. Accordingly, the need categories are ranked in the following order of priority: Must-be > One-dimensional > Attractive > Indifferent. The classification criteria based on the paired questions are presented in Table 1.

After the need categories have been determined, the satisfaction index (SI) and dissatisfaction index (DI) can be used to distinguish among individual attributes within the same category [19, pp. 18]. They are calculated as follows:

$$SI = (A + O) / (A + O + M + I) \quad (1)$$

$$DI = -(O + M) / (A + O + M + I) \quad (2)$$

A higher SI value indicates a greater increase in user satisfaction when the corresponding attribute is provided,

whereas a more negative DI value indicates greater user dissatisfaction when the attribute is not provided. Subsequently, the average satisfaction coefficient (ASC) was proposed as an integrated alternative to SI and DI for assessing the overall degree of need associated with each at-

Table 1 Kano evaluation for need categories

If the attribute is not provided	If the attribute is provided				
	I like it	I expect it	I am neutral	I can tolerate it	I dislike it
I like it	Q	R	R	R	R
I expect it	A	I	I	I	R
I am neutral	A	I	I	I	R
I can tolerate it	A	I	I	I	R
I dislike it	O	M	M	M	Q

1.2 Andersen's behavioral model

User needs are influenced by multiple factors to varying degrees. Previous studies in architecture [21], sociology [22], and medicine [23] have investigated factors associated with community eldercare service needs using methods such as linear regression [24] and correlation analysis [25]. These studies have consistently identified age, functional status, living arrangements, support from adult children, income, health status, frequency of medical visits, health insurance coverage, and educational attainment as common factors associated with service needs. Andersen's behavioral model is widely used in healthcare research to examine factors influencing healthcare utilization [24]. The model classifies determinants into three dimensions: predisposing characteristics, enabling resources, and need factors. Predisposing characteristics include demographic characteristics, social structure, and health beliefs; enabling resources include individual, family, and community resources; and need factors comprise both perceived and evaluated needs [26].

In this study, Andersen's behavioral model is applied to functional-space allocation in community eldercare facilities. The survey examines population characteristics across the model's three dimensions: predisposing characteristics such as age, sex, and educational attainment; enabling resources such as living arrangements, income, occupation, and proximity to adult children; and need factors such as functional status.

tribute [20]. It is calculated as follows:

$$ASC = (|SI| + |DI|)/2 \quad (3)$$

In the context of spatial allocation, both the need category identified by the Kano model and the ASC should be considered to comprehensively evaluate users' needs.

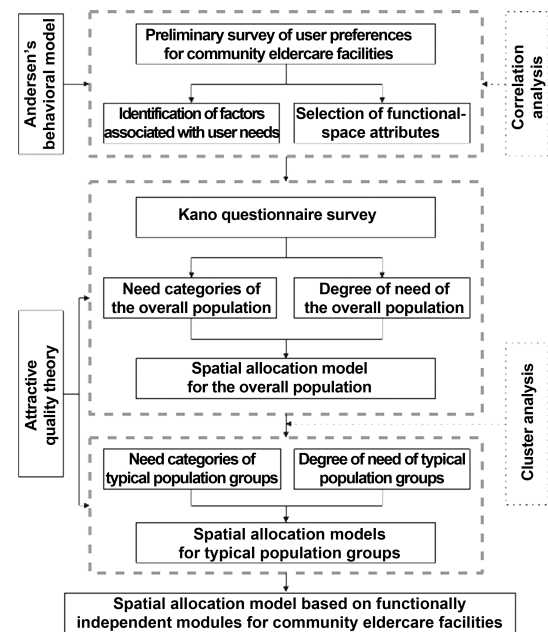


Figure 1 Research framework

1.3 Research framework

From a needs-based perspective, this study first conducted a preliminary survey to identify users' functional-space needs for community eldercare facilities and the factors associated with these needs, thereby informing the subsequent questionnaire survey and interviews. The Kano model was then used to determine allocation priorities for each functional-space attribute based on its need category and degree of need. Cluster analysis was subsequently used to identify typical user groups, for which tailored spatial allocation models were developed. Finally, a spatial allocation model based on functionally independent modules was proposed for community eldercare facilities (Figure 1).

2 Survey of community eldercare facilities based on the Kano model

2.1 Preliminary survey on user preferences for community eldercare Facilities

To accurately identify users' functional-space needs and the factors associated with them, the research team conducted two rounds of surveys and interviews in Tianjin's six central urban districts from 2020 to 2022. Owing to COVID-19 restrictions, 594 online questionnaires and 50 face-to-face questionnaires were administered as part of the preliminary survey, yielding 465 valid responses. Given that the needs of both older adults and those approaching old age are equally important, no age restriction was

imposed on survey participants. The coding and frequency distributions of the relevant factors are presented in Table 2. A five-point Likert scale was used to assess respondents' preferences across six functional categories. The scores, in descending order, were community dining facilities (4.24), medical care (4.21), residential care (3.90), healthcare and nursing (3.71), cultural and recreational activities (3.69), and consultation services (3.34). The preliminary survey also included questions on participants' willingness to use community eldercare facilities and the existing provision of such facilities. These findings provided the basis for selecting the functional-space attributes and factors associated with user needs for the subsequent Kano questionnaire.

Table 2 Coding and relative frequency distribution of variables in the preliminary survey of preferences for community eldercare facilities

Factors associated with user needs	Coding and relative frequencies
Age	1< = 30 years (0.07); 2= 31-40 years (0.18); 3= 41-50 years (0.17); 4= 51-60 years (0.27); 5= 61-70 years (0.24); 6= > 70 years (0.07)
Gender	1= Male (0.33); 2= Female (0.67)
Functional Status ¹	1= Intact physical function (0.58); 2= Mild functional impairment (0.38); 3= Moderate functional impairment (0.03); 4= Severe functional impairment (0.01)
Living arrangement	1= Living alone (0.09); 2= Living with a spouse (0.59); 3= Living with adult children (0.18); 4= Living in a multigenerational household (0.11); 5= Other (0.03)
Total monthly income ²	1= No income (0.01); 2= < RMB 3,000 (0.34); 3= RMB 3,000-5,000 (0.19); 4= RMB 5,001-8,000 (0.15); 5= > RMB 8,000 (0.31)
Educational attainment	1= Below primary school (0.01); 2= Primary school (0.01); 3= Junior high school (0.15); 4= Senior high school or technical secondary school (0.15); 5= Junior college diploma, bachelor's degree, or higher qualification (0.68)
Occupational category ³	1= Heads of government agencies or organizations (0.17); 2= Technical professionals (0.30); 3= General staff (0.18); 4= Service workers (0.05); 5= Workers in agriculture, forestry, animal husbandry, fisheries, and water conservancy (0.09); 6= Military personnel and students (0.04); 7= Other (0.17)
Proximity to adult children	1= Nearby (same city or province) (0.56); 2= Moderate distance (neighboring province) (0.03); 3= Distant (non-neighboring province or abroad) (0.27); 4= Mixed distances (multiple children) (0.09); 5= Prefer not to disclose (0.05)
Total number of valid questionnaires	465
1 In this survey, functional status was self-assessed on a four-point scale across four domains: self-care ability, perception, memory, and attention, where 1 indicated normal functioning and 4 indicated severe difficulty. Functional status was then classified according to the total score: 4= intact physical function, 5-8= mild functional impairment, 9-12= moderate functional impairment, and 13-16= severe functional impairment. The classification criteria were based on the <i>Standard for Design of Care Facilities for the Aged</i> (JGJ 450-2018). 2 Income categories were defined with reference to Tianjin's minimum wage standard (RMB 2,180 per month during the survey period) and the average wages of employees in non-private and private-sector organizations reported in the 2022 <i>Tianjin Yearbook</i> (approximately RMB 5,000-9,000 per month). 3 Occupational categories were defined with reference to the <i>Classification and Codes of Occupations</i> (GB/T 6565—2015).	

2.2 Classification of factors associated with user needs

Based on the correlation analysis of the preliminary survey data (Table 3), factors with relatively high Pearson correlation coefficients indicating linear relationships or Spearman rank correlation coefficients indicating rank-order relationships were selected for inclusion in the Kano

questionnaire. These factors included age and educational attainment (predisposing characteristics), living arrangements and income (enabling resources), and functional status (need factors). Given the relatively high correlations between age and functional status ($r = 0.568$) and between educational attainment and total monthly income ($r =$

0.631), the factors associated with user needs were re-grouped within Andersen's Behavioral Model into three

analytical dimensions: individual characteristics, family characteristics, and socioeconomic characteristics.

Table 3 Correlation analysis of factors associated with user needs in the preliminary survey

Spearman correlation	Pearson correlation													
	Age	Gender	Functional status	Living arrangement	Total monthly income	Educational attainment	Occupational category	Proximity to adult children	Meal services	Care services	Health maintenance and rehabilitation	Medical and nursing care	Cultural and recreational facilities	Assistance services
Age	1	−0.073	0.568***	−0.313***	−0.465***	−0.530***	0.451***	0.353***	−0.011	−0.237***	−0.280***	0.060	−0.070	−0.371***
Gender	−0.061	1	−0.059	0.116**	−0.063	−0.100	−0.232***	0.034	0.088	−0.004	0.037	0.033	0.024	0.080
Functional status	0.593***	−0.033	1	−0.260***	−0.442***	−0.446***	0.364***	0.358***	−0.016	−0.218***	−0.191***	0.024	−0.116**	−0.313***
Living arrangement	−0.333***	0.126**	−0.296***	1	0.163***	0.239***	−0.015	−0.203***	−0.054	0.060	0.143**	−0.073	0.035	0.084
Total monthly income	−0.461***	−0.023	−0.463***	0.208***	1	0.631***	−0.497***	−0.485***	−0.069	0.253***	0.211***	−0.127**	−0.021	0.318***
Educational attainment	−0.528***	−0.093	−0.484***	0.255***	0.613***	1	−0.305***	−0.075	−0.060	0.205***	0.130**	−0.151***	−0.002	0.196***
Occupational category	0.438***	−0.198***	0.382***	−0.075	−0.557***	−0.400***	1	0.349***	−0.068	−0.165***	−0.194***	0.038	0.030	−0.298***
Proximity to adult children	0.344***	0.055	0.406***	−0.284***	−0.455***	−0.288***	0.353***	1	0.033	−0.211***	−0.279***	0.045	0.099	−0.278***
Meal services	−0.011	0.117**	0.008	−0.037	−0.033	−0.057	−0.096	0.042	1	0.581***	0.572***	0.695***	0.448***	0.371***
Care services	−0.303***	−0.010	−0.283***	0.088	0.327***	0.305***	−0.233***	−0.258***	0.349***	1	0.711***	0.573***	0.209***	0.616***
Health maintenance and rehabilitation	−0.340***	0.021	−0.266***	0.202***	0.257***	0.186***	−0.223***	−0.325***	0.318***	0.543***	1	0.584***	0.265***	0.567***
Medical and nursing care	0.084	0.058	0.151***	−0.118**	−0.119**	−0.165***	0.089	0.086	0.351***	0.283***	0.330***	1	0.338***	0.366***
Cultural and recreational facilities	0.012	−0.027	−0.015	0.028	−0.031	−0.005	0.097	0.099	0.275***	−0.004	0.081	0.095	1	0.368***
Assistance services	−0.362***	0.085	−0.309***	0.091	0.332***	0.225***	−0.302***	−0.280***	0.231***	0.496***	0.457***	0.218***	0.198***	1

* : $P < 0.1$; ** : $P < 0.05$; *** : $P < 0.01$

Table 4 Coding of functional-space attributes in the Kano questionnaire

Level-2 code	Level-2 functional category	Level-1 code	Level-1 functional-space attribute
A	Cultural and recreational facilities	A1	Arts activity room
		A2	Leisure room
		A3	Sports activity room
		A4	Multifunctional room
		A5	Outdoor activity area
B	Medical and healthcare services	B1	Healthcare and nursing room
		B2	Medical consultation room
		B3	TCM consultation room
		B4	Pharmacy
C	Residential care	C1	Nap room
		C2	Single-occupancy room
		C3	Twin room
		C4	Multi-bed room
		C5	Two-person suite
		C6	Shared living room
		C7	Staff dormitory

(Continued)

Level-2 code	Level-2 functional category	Level-1 code	Level-1 functional-space attribute
D	Community dining facilities	D1	Community dining hall
		D2	Institutional dining hall
		D3	Staff dining hall
		D4	Takeaway window

2.3 Identification of functional-space attributes for the Kano questionnaire

Based on the findings of the preliminary preference survey, the functional-space attributes included in the Kano questionnaire were organized into four functional categories: cultural and recreational facilities, medical and healthcare services, residential care, and community dining facilities. Each category was subdivided into specific space types, yielding a total of 20 first-level functional-space attributes. The coding scheme is presented in Table 4.

2.4 Questionnaire design based on the Kano model

The Kano questionnaire consisted of paired function-

al and dysfunctional questions, and the resulting data were analyzed according to the Kano model. Drawing on previous studies of question design and response formats for

the Kano model [19, pp.5-10], this study adopted a five-point response scale. The question design and wording of the response options are shown in Figure 2.

A1.
 - If an arts activity room, such as a reading room, calligraphy and painting room, or handicraft room, were provided, how would you feel?
 1 = I like it; 2 = I expect it; 3 = I am neutral; 4 = I can tolerate it; 5 = I dislike it
 - If such a room were not provided, how would you feel?
 1 = I like it; 2 = I expect it; 3 = I am neutral; 4 = I can tolerate it; 5 = I dislike it

Figure 2 Design of the Kano questionnaire items

3 Analysis of functional-space needs for community eldercare facilities

The coding of factors associated with user needs in the Kano questionnaire was consistent with that used in the preliminary survey. No eligibility restrictions were imposed on the basis of age, functional status, living arrange-

ments, or other characteristics. To better capture users' actual perceptions, the Kano questionnaire was administered through both online and face-to-face surveys. A total of 170 online questionnaires and 53 face-to-face questionnaires were collected, yielding 210 valid responses (Table 5).

Table 5 Coding and relative frequencies of factors associated with user needs in the Kano questionnaires

Factor associated with user needs		Coding and relative frequencies
Individual characteristics	Age	1= < 50 years (0.26); 2= 50-59 years (0.17); 3= 60-69 years (0.25); 4= > 70 years (0.32)
	Functional status	1= No functional impairment (0.59); 2= Mild functional impairment (0.33); 3= Moderate functional impairment (0.07); 4= Severe functional impairment (0.01)
Family characteristics	Living arrangement	1= Living alone (0.12); 2= Living with a spouse (0.53); 3= Living with adult children (0.17); 4= Living in a multigenerational household (0.07); 5= Residing in an eldercare institution (0.11)
Socioeconomic characteristics	Total monthly income	1= No income (0.06); 2= < RMB 3,000 (0.13); 3= RMB 3,000-5,000 (0.37); 4= RMB 5,001-8,000 (0.27); 5= > RMB 8,000 (0.17)
	Educational attainment	1= Below primary school (0.02); 2= Primary school (0.03); 3= Junior high school (0.19); 4= Senior high school or technical secondary school (0.30); 5= Junior college diploma, bachelor's degree, or higher qualification (0.46)
Total number of valid questionnaires		210

aIn this survey, functional status was self-assessed on a four-point scale across four domains: self-care ability, perception, memory, and attention, where 1 indicated normal functioning and 4 indicated severe difficulty. Functional status was then classified according to the total score: 4= no functional impairment, 5-8= mild functional impairment, 9-12= moderate functional impairment, and 13-16= severe functional impairment.

The responses were classified according to the Kano evaluation matrix (Table 1). For each functional-space attribute, the need category receiving the highest number of responses (Must-be, One-dimensional, Attractive, or Indifferent) was assigned as its final Kano category. The classification results are presented in Figure 3. Among the cultural and recreational attributes (A1-A5), all were classified as Indifferent attributes, although the number of One-dimensional responses for the outdoor activity area was second only to the number of Indifferent responses. The medical and healthcare attributes (B1-B4) were predominantly classified as One-dimensional attributes. All residential care attributes (C1-C7) were classified as Indiffer-

ent attributes. Within the community dining category (D1-D4), the community dining hall was classified as a One-dimensional attribute, whereas the remaining attributes were classified as Indifferent. Overall, the surveyed population did not exhibit clear needs for either residential care or cultural and recreational facilities. This finding highlights the necessity of further analyses based on population characteristics.

The ASC values are presented in Figure 4. Among the four functional categories, medical and healthcare services (B1-B4) exhibited the highest overall degree of need, followed by community dining facilities (D1-D4) and cultural and recreational facilities (A1-A5), whereas

residential care (C1-C7) showed the lowest degree of need. For the individual functional-space attributes, an $ASC \geq 0.50$ was regarded as indicating a high degree of need. Ranked in descending order, these attributes were pharmacy, medical consultation room, TCM consultation room,

and community dining hall. Attributes with $0.40 \leq ASC < 0.50$ were considered to indicate some degree of need, including, in descending order, the outdoor activity area, healthcare and nursing room, takeaway service window, and institutional dining hall.

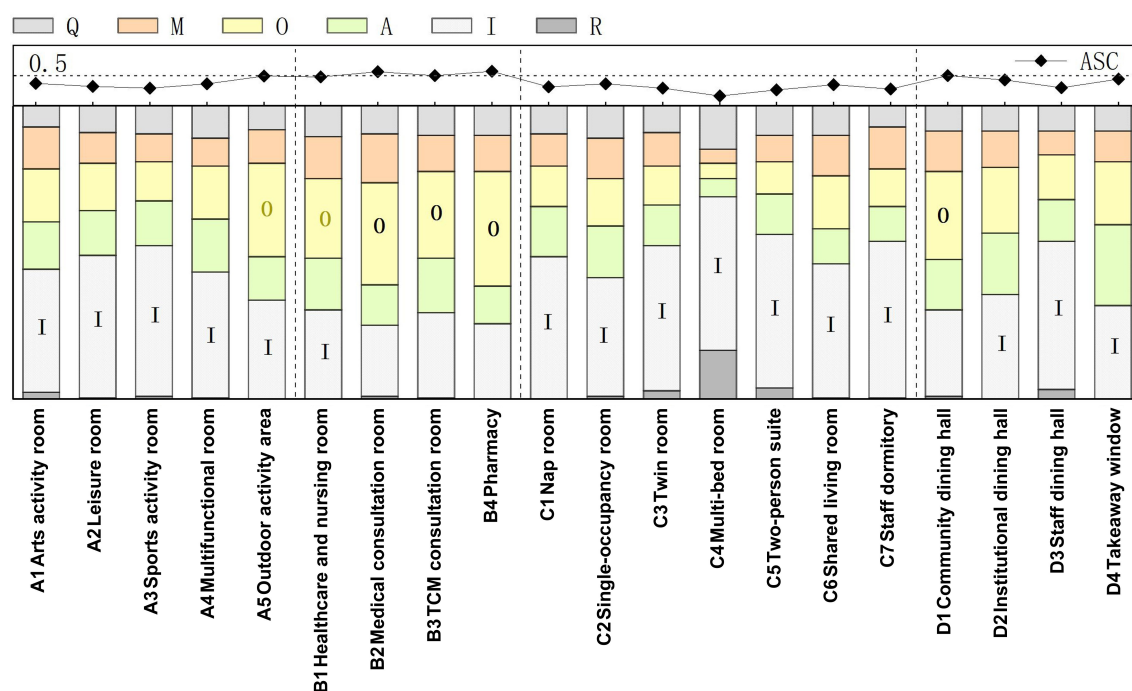


Figure 3 Kano need categories and average satisfaction coefficient values for functional-space attributes in community eldercare facilities

4 Analysis of functional-space needs based on population characteristics

4.1 Cluster Analysis of User Needs Across Population Groups

The overall analysis showed that, with the exception of medical and healthcare services, the surveyed population exhibited relatively low degrees of need for the remaining functional categories ($ASC < 0.50$), and most of the associated attributes were classified as Indifferent. To further explore differences in user needs among population groups, a cluster analysis based on the Kano need categories was conducted (Figure 4). Population characteristics were analyzed according to the Kano classifications (Must-be, One-dimensional, and Attractive). The results indicate that respondents who exhibited a need for cultural and recreational facilities were generally characterized by older age, good functional status, co-residence with adult children, a total monthly income of RMB 3,000-5,000, and a senior high school education. Respondents with greater need for residential care facilities were typically character-

ized by older age, poorer functional status, multigenerational living arrangements, a total monthly income of RMB 3,000-8,000, and a junior or senior high school education. Those expressing stronger need for community dining facilities were generally older adults in poorer physical condition who lived with their adult children, had a total monthly income of RMB 3,000-5,000, and had completed senior high school education. Medical and healthcare services were generally classified as Attractive attributes by the surveyed population.

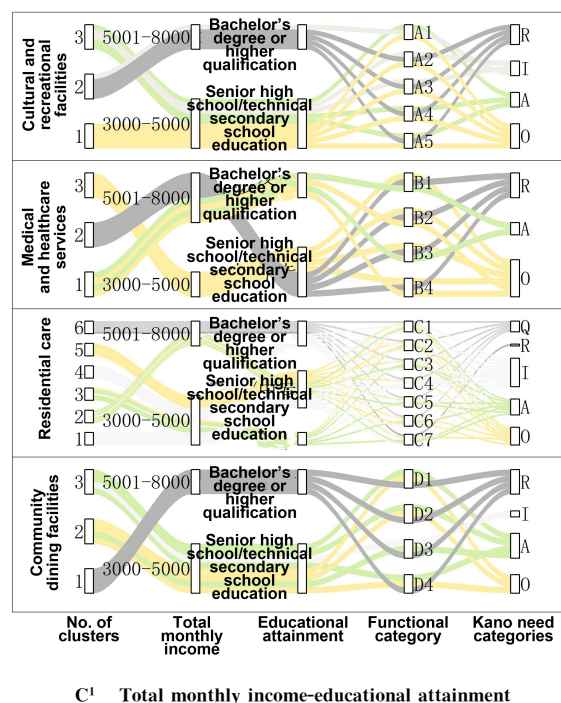
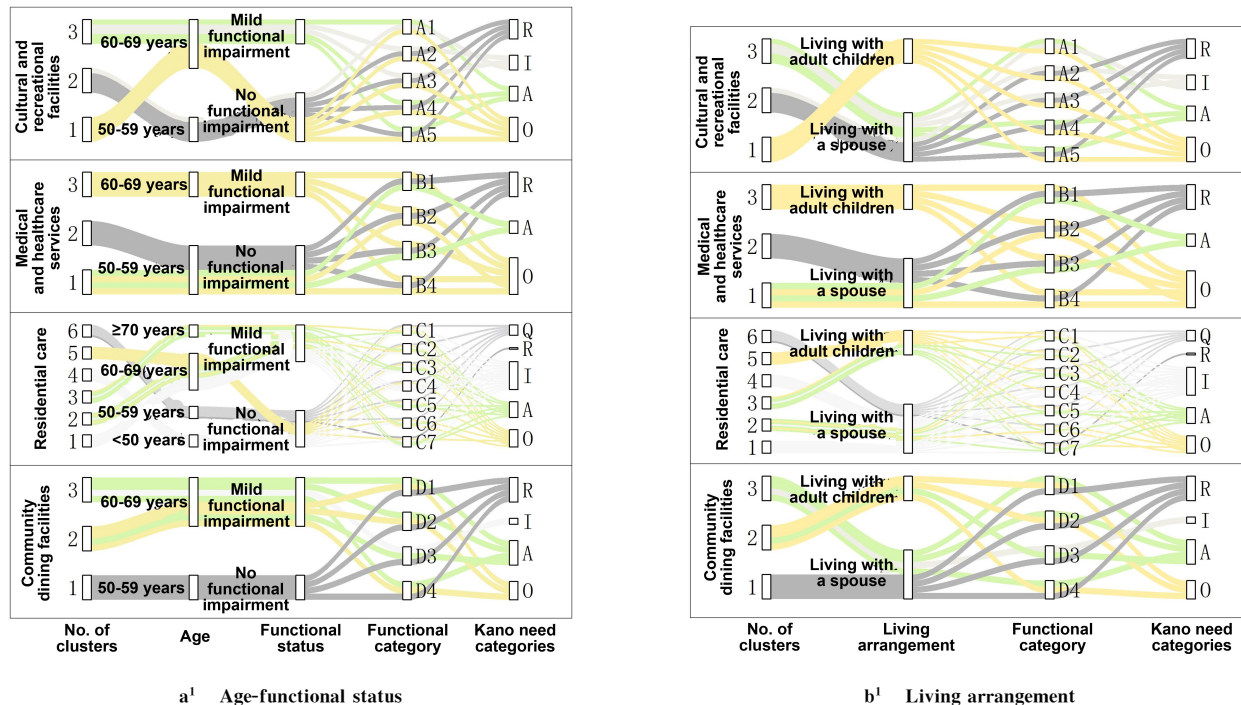
The cluster analysis demonstrates that functional-space needs differ substantially across population groups with different characteristics. Accordingly, the following sections examine these differences from three perspectives: individual characteristics, family characteristics, and socioeconomic characteristics.

4.2 Functional-space needs by individual characteristics

Based on individual characteristics, respondents were classified into three groups (Figure 5): respondents young-

ger than 60 years with intact or mildly impaired physical function (Group 1, a dotted line with square markers); respondents older than 60 years with intact or mildly impaired physical function (Group 2, a solid line with triangular markers); and respondents older than 60 years with moderate or severe physical impairment (Group 3, a

dashed line with circular markers). The Kano need category of each first-level functional-space attribute (A1-D4) was determined for each group. In Figure 5, Must-be, One-dimensional, and Attractive attributes are indicated in orange, yellow, and green, respectively. The same color scheme is used in Figures 6 and 7.



c¹ Total monthly income-educational attainment

¹ The number of clusters was determined based on cluster membership and the significance measure reported by the analysis. Solutions with 2-8 clusters were tested, and the solution with a relatively balanced distribution of cluster members and a comparatively large decrease in the significance measure was selected.

Figure 4 Cluster analysis of population characteristics based on factors associated with user needs

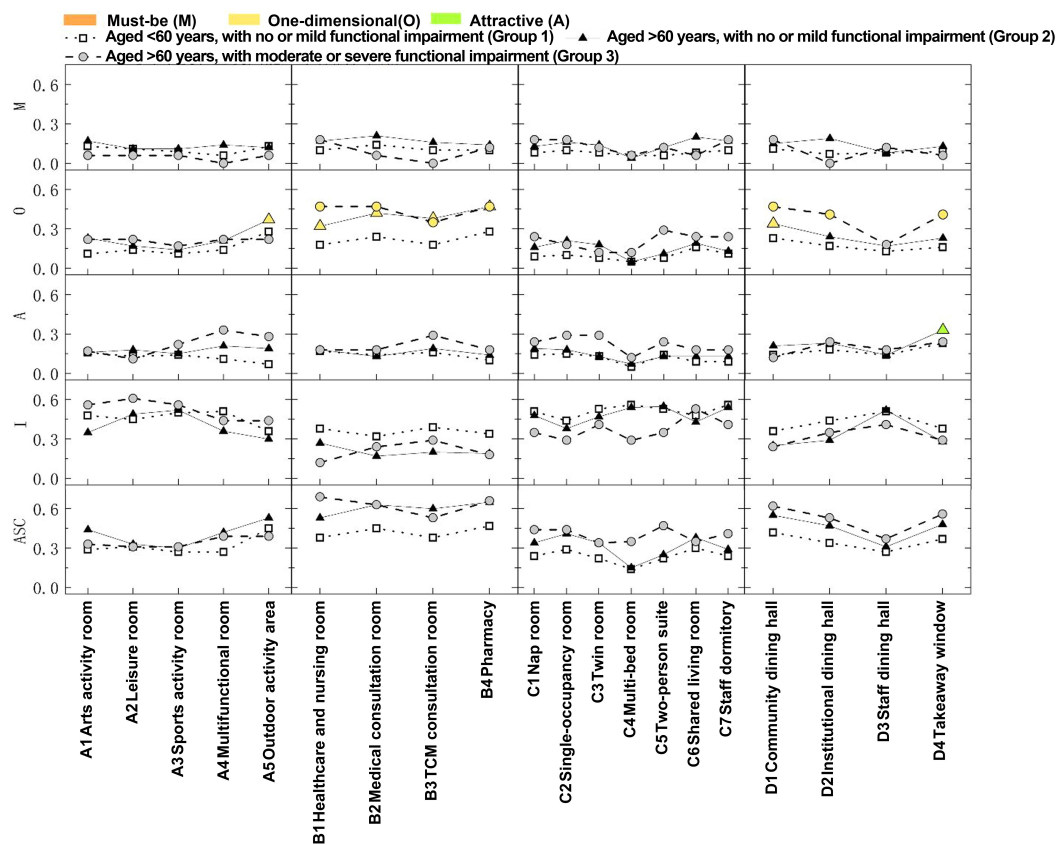


Figure 5 Distribution of Kano need categories by individual characteristics

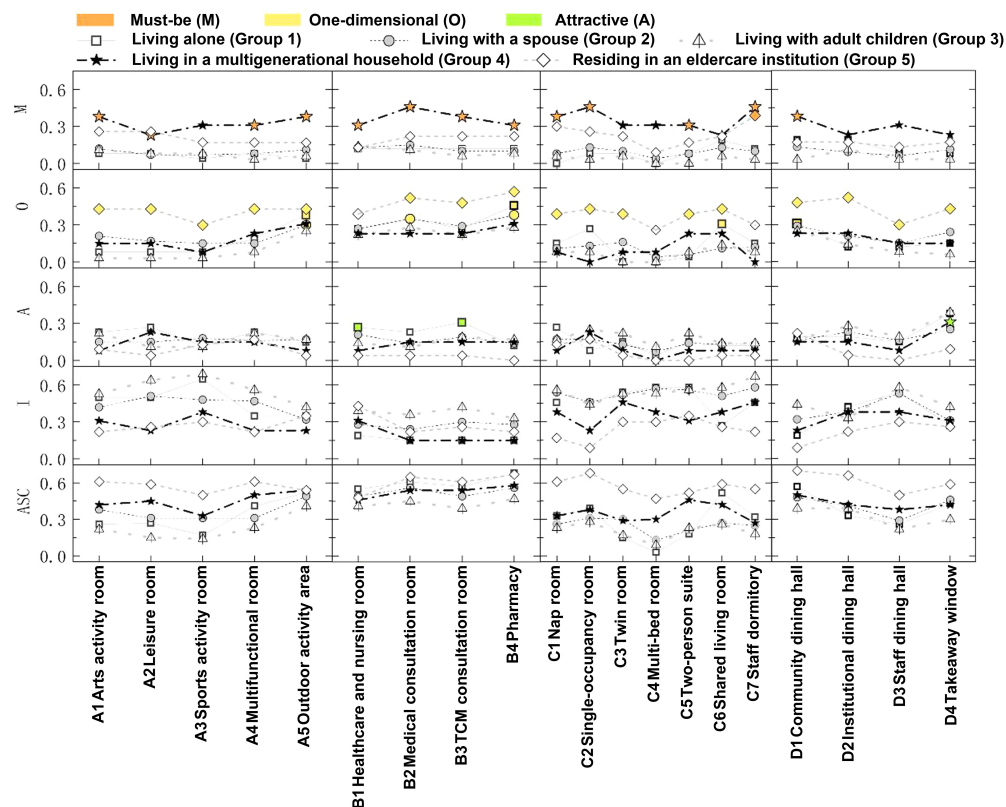


Figure 6 Distribution of Kano need categories by family characteristics

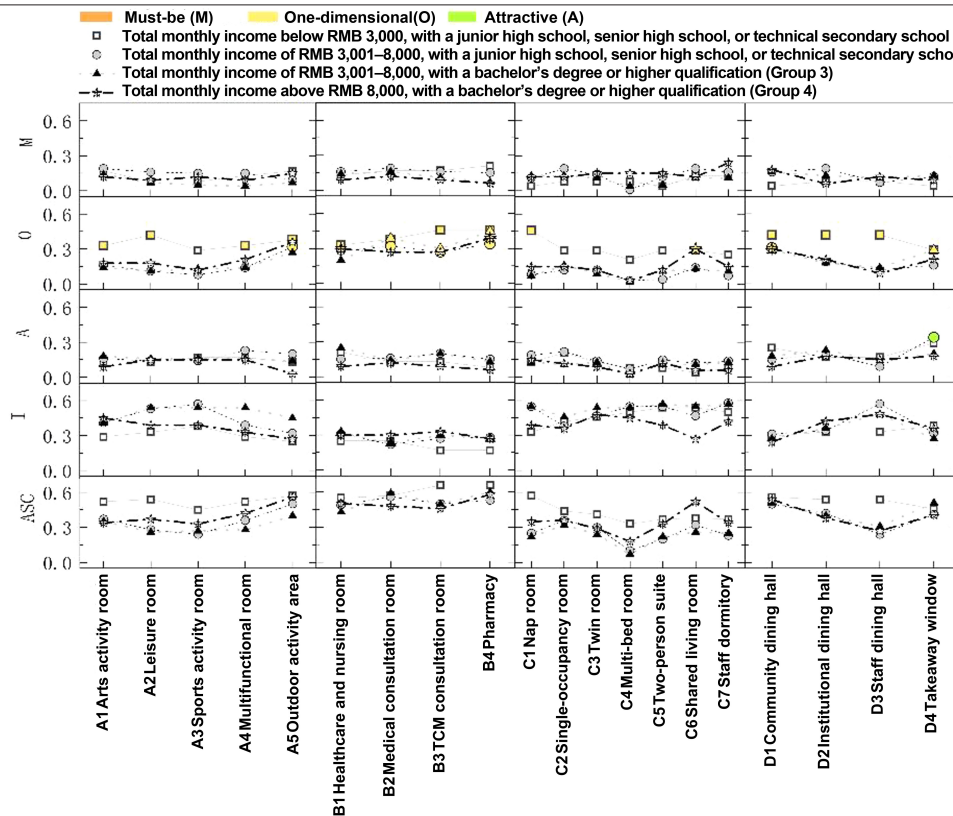


Figure 7 Distribution of Kano need categories by socioeconomic characteristics

Need for cultural and recreational facilities was most pronounced in Group 2. The functional spaces for this group were prioritized as follows: outdoor activity area > arts activity room > multifunctional room > leisure room > sports activity room.

For medical and healthcare services, Groups 2 and 3, both comprising respondents older than 60 years, exhibited greater need. Notably, comparison of the ASC values indicates that the degree of need for medical and healthcare services did not continue to increase as functional status deteriorated. A possible explanation is that respondents with poorer functional status generally sought inpatient treatment at general hospitals and therefore relied less on community-based medical services. For Group 2, the priority ranking was: pharmacy > medical consultation room > TCM consultation room > healthcare and nursing room. For Group 3, the priority ranking was: healthcare and nursing room > pharmacy > medical consultation room > TCM consultation room.

All residential care attributes were classified as Indifferent attributes. Groups 1 and 2 exhibited the lowest need for this functional category. However, need for shared liv-

ing rooms and single-occupancy rooms increased with age. Respondents in Group 3 showed relatively greater need for residential care facilities, with the following priority ranking: two-person suite > single-occupancy room > nap room > staff dormitory > shared living room > twin room > multi-bed room.

For community dining facilities, need was more pronounced among Groups 2 and 3, and both groups shared the same priority ranking: community dining hall > takeaway service window > institutional dining hall > staff dining hall. According to the interview responses, the relatively low preference for staff dining halls reflected respondents' expectation that staff members should dine together with older adults. Comparison of the ASC values across the three groups further indicates that the degree of need for community dining facilities tended to increase with advancing age and declining functional status.

4.3 Functional-space needs by family characteristics

Based on the correlation analysis and previous studies, living arrangement was the only family-related factor considered in relation to user needs. Accordingly, re-

spondents were classified into five groups (Figure 6): living alone (Group 1; a solid line with square markers), living with a spouse (Group 2; a dotted line with circular markers), living with adult children (Group 3; a dotted line with triangular markers), living in a multigenerational household (Group 4; a dashed line with star-shaped markers), and residing in an eldercare institution (Group 5; a dashed line with diamond-shaped markers).

For cultural and recreational facilities, respondents residing in eldercare institutions exhibited the greatest need, with all attributes classified as One-dimensional. Their priority ranking was: multifunctional room > arts activity room > leisure room > outdoor activity area > sports activity room. Respondents living in multigenerational households showed the second-highest level of need. Except for the sports activity room, all functional spaces were classified as Must-be attributes. Their priority ranking was: outdoor activity area > multifunctional room > leisure room > arts activity room > sports activity room. In both groups, sports activity rooms ranked lowest in terms of need, owing to the respondents' relatively advanced age.

For medical and healthcare services, the greatest need was observed among respondents living in multigenerational households and those residing in eldercare institutions. For respondents in multigenerational households, all medical and healthcare attributes were classified as Must-be (M). Among institutional residents, the pharmacy, medical consultation room, and TCM consultation room were classified as One-dimensional attributes (O). Respondents living alone and those living with a spouse exhibited the second-highest level of need. In both groups, the pharmacy and medical consultation room were classified as One-dimensional attributes, while respondents living alone further identified the healthcare and nursing room and the TCM consultation room as Attractive attributes. Across all five groups, the priority ranking remained consistent: pharmacy > medical consultation room > TCM consultation room > healthcare and nursing room.

For residential care facilities, the need was greatest among respondents residing in eldercare institutions, with the following priority ranking: single-occupancy room >

nap room > shared living room > staff dormitory > twin room > two-person suite > multi-bed room. Respondents in multigenerational households exhibited the second-highest level of need, with the following ranking: two-person suite > shared living room > single-occupancy room > nap room > twin room > multi-bed room > staff dormitory. Notably, among respondents living alone, only the shared living room was classified as a One-dimensional attribute (O), suggesting a strong desire to participate in small-scale communal activities.

For community dining facilities, respondents residing in eldercare institutions exhibited the greatest need, with all attributes classified as One-dimensional (O). Their priority ranking was: community dining hall > institutional dining hall > takeaway service window > staff dining hall. Respondents in multigenerational households and those living alone showed the second-highest level of need and shared the same priority ranking: community dining hall > takeaway service window > institutional dining hall > staff dining hall. It is noteworthy that respondents residing in eldercare institutions expressed a particularly high level of need for community dining facilities. According to the interview findings, this may reflect both a desire for more diverse dining options and a desire to return to home-based eldercare while overcoming difficulties in accessing meals.

4.4 Functional-space needs by socioeconomic characteristics

Respondents were classified into four groups according to total monthly income and educational attainment, as shown in Figure 7. Group 1 (a solid line with square markers): total monthly income below RMB 3,000, with a junior high school, senior high school, or technical secondary school education; Group 2 (a dotted line with circular markers): total monthly income of RMB 3,000-8,000, with a junior high school, senior high school, or technical secondary school education; Group 3 (a dotted line with triangular markers): total monthly income of RMB 3,000-8,000, with a junior college education, bachelor's degree, or higher qualification; Group 4 (a dashed line with star-shaped markers): total monthly income above RMB 8,000, with a junior college education, bachelor's degree, or

higher qualification.

For cultural and recreational facilities, Group 1 exhibited the greatest need. The priority ranking was: outdoor activity area > leisure room > multifunctional room > arts activity room > sports activity room. Comparison of the ASC values indicates that all socioeconomic groups showed a general need for an outdoor activity area.

For medical and healthcare services, all four groups demonstrated a substantial degree of need ($ASC > 0.40$). The overall priority ranking was: pharmacy > medical consultation room > TCM consultation room > health-care and nursing room. Compared with the other groups, Group 4 exhibited a relatively greater need for the health-care and nursing room. Moreover, the degree of need for this functional space tended to increase with total monthly income.

For residential care facilities, Group 1 exhibited the greatest need. The priority ranking was: nap room > single-occupancy room > twin room > shared living room > two-person suite > staff dormitory > multi-bed room. Group 4 showed the second-highest level of demand, with the following ranking: shared living room > single-occupancy room > nap room > staff dormitory > two-person suite > twin room > multi-bed room. Comparison of the ASC values suggests that the overall degree of need for residential care facilities declined as total monthly income increased. However, the degree of need for single-occupancy rooms and shared living rooms remained relatively stable, indicating that higher-income respondents placed greater emphasis on the quality of spatial provision.

For community dining facilities, Group 1 exhibited the greatest need, with the following priority ranking: community dining hall > institutional dining hall > staff dining hall > takeaway service window. The relatively low preference for the takeaway service window among this group may be attributable to financial constraints. Comparison of the ASC values further indicates that the degree of need for community dining facilities tended to decrease as total monthly income increased.

5 Spatial allocation model based on functionally independent modules for community eldercare facilities

Given the substantial differences in functional-space

needs across population groups, this study proposes a spatial allocation model for community eldercare facilities based on functionally independent modules. The proposed model comprises four functionally independent modules: cultural and recreational facilities, medical and healthcare services, residential care, and community dining facilities. Resource sharing with the urban community is encouraged, and a spatial allocation model is developed for each module.

5.1 Spatial allocation model for the overall population

Based on the analysis of the overall population, the first-level functional-space attributes were assigned to three allocation categories: priority, recommended, and optional. Priority spaces comprise attributes classified as One-dimensional (O) under the Kano model. Recommended spaces comprise attributes classified as Indifferent (I) with $0.40 \leq ASC < 0.50$. Optional spaces have ASC values of approximately 0.30 and may be provided according to actual conditions (Figure 8). Based on the overall ASC values, medical and healthcare services and community dining facilities should be prioritized.

Within the cultural and recreational module, the outdoor activity area should be included as a recommended space based on its Kano classification. The interviews indicated that the multifunctional room was classified as an Indifferent attribute partly because some respondents were unfamiliar with its potential uses. Given the diversity of recreational needs, however, it is also recommended for inclusion. Reading rooms and chess/card rooms may be introduced initially, while other functions can be determined according to local user preferences. With reference to the *Construction Standards for Urban Community Service Stations* (Jianbiao 167-2014) and the *Standard Design Atlas for Community Day-Care Centers for Older Adults* (14J819), a spatial allocation model for the cultural and recreational module was developed, as shown in Figure 9(a). Spatial organization should emphasize the separation of active and quiet areas. Compared with small, self-contained rooms, partially open multifunctional spaces facilitate flexible design and create an inviting recreational atmosphere.

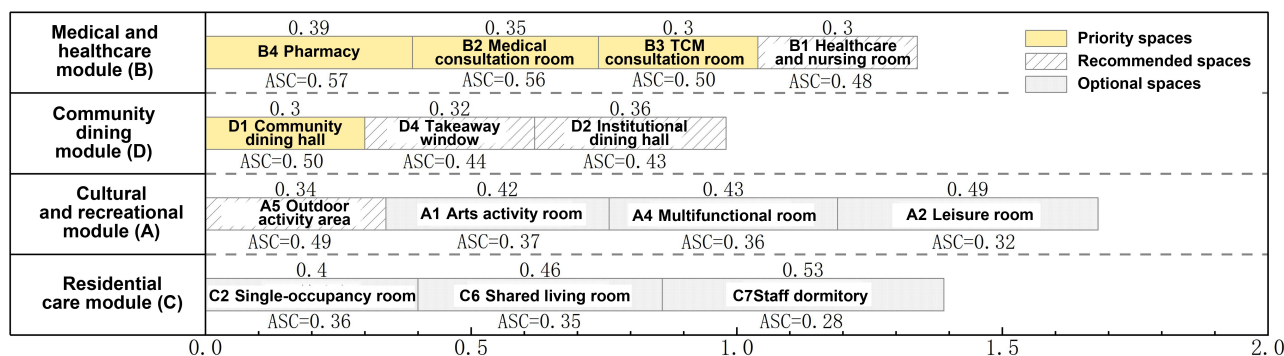


Figure 8 Statistics on functional-space allocation and degrees of need in community eldercare facilities

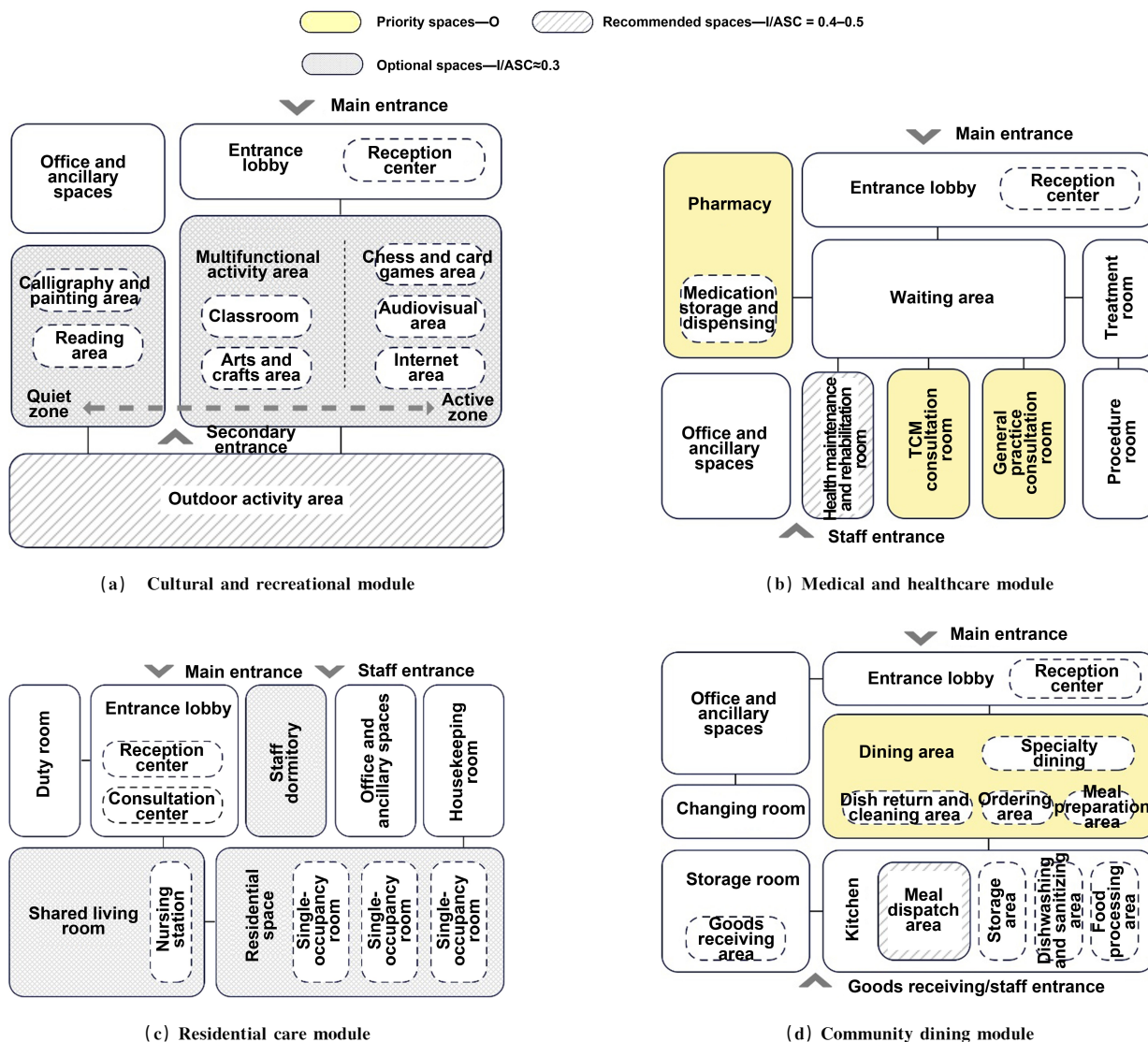


Figure 9 Spatial allocation models for community eldercare facilities

Within the medical and healthcare module, the pharmacy, medical consultation room, and TCM consultation room are identified as priority spaces, whereas the healthcare and nursing room is recommended. Based on the Basic Standards for Nursing Stations in Eldercare Institutions

(Trial), the Basic Standards for Medical Offices in Eldercare Institutions (Trial), the Basic Standards for Urban Community Health Service Centers and Stations, and the Construction Standards for Community Health Service Centers and Stations (Jian Biao 163-2013), the proposed spatial al-

location model is presented in Figure 9(b). Considering the physical conditions of older users, a waiting area should be incorporated to serve multiple purposes, including waiting to collect medication, waiting for consultations, and resting.

Within the residential care module, all functional spaces are regarded as optional. Among them, single-occupancy rooms, shared living rooms, and staff dormitories are recommended as the initial configuration. Although the staff dormitory had a relatively low ASC, it was retained as an optional space because it supports the operation and use of eldercare facilities and was not classified as a Reverse (R) attribute. The spatial allocation model for the residential care module was developed with reference to the *Standard for Design of Care Facilities for the Aged* (JGJ 450-2018) and the *Construction Standards for Community Day-Care Centers for Older Adults* (Jianbiao 143-2010), as shown in Figure 9(c).

Within the community dining module, the community dining hall should be provided as a priority space, with both dine-in and meal delivery services available. The ratio of dining area to kitchen area should be determined according to project-specific conditions. Based on the *Standard for Design of Dietetic Buildings* (JGJ 64-2017) and the *Standard for Design of Care Facilities for the Aged* (JGJ 450-2018), the proposed spatial allocation model is shown in Figure 9(d). The dining area may be integrated with complementary functions, such as cafés or bakeries, to at-

tract community residents and encourage intergenerational participation. A separate goods-delivery route and staff entrance and exit should be provided, and the circulation routes should be carefully organized.

5.2 Spatial allocation models for typical population groups

Based on the analysis of high-need groups across the three dimensions described in Section 4, the proportions of the different Kano need categories were calculated, as shown in Figure 10. Longer bars indicate a higher degree of need. The colors represent the Kano categories in the following order of priority: Must-be (M; orange) > One-dimensional (O; yellow) > Attractive (A; green); gray indicates no identified need. The results show that respondents residing in eldercare institutions and those living in multigenerational households exhibited more pronounced willingness to use community eldercare facilities and stronger functional-space needs, followed by respondents living alone and those older than 60 years. By synthesizing the characteristics of these high-need groups, two representative user profiles were identified: Typical Group I: adults aged over 60 years, living alone, with relatively good functional status; Typical Group II: adults aged over 60 years, residing in eldercare institutions, with relatively poor functional status. The proportions of need categories and the degree of need for these two representative groups are presented in Figure 11, while the corresponding spatial allocation models are illustrated in Figures 12 and 13.

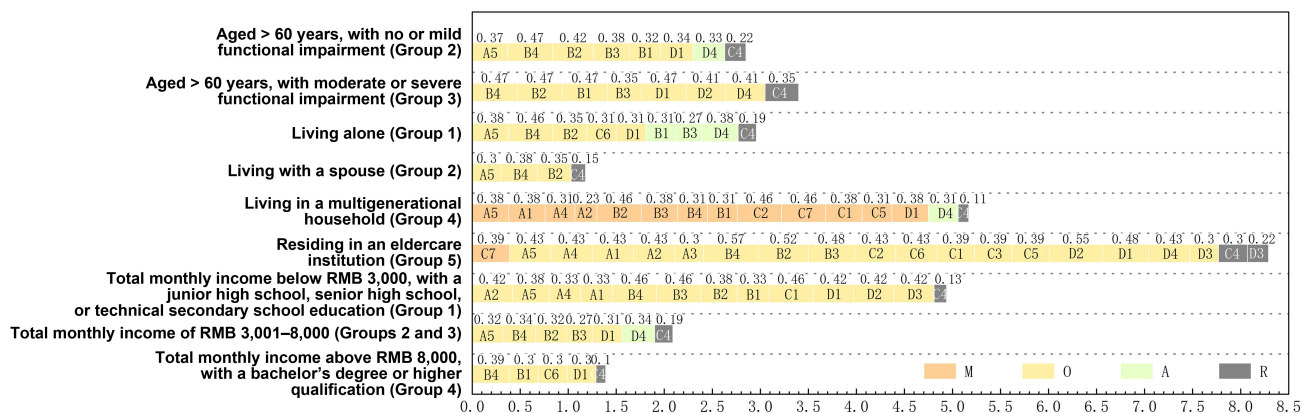


Figure 10 Functional-space allocation and proportions of Kano need categories by population characteristics

Compared with the overall population (Figure 9), both typical groups exhibited markedly greater overall need for community eldercare facilities, while the overall

degree of need in Typical Group I was clearly lower than that in Typical Group II. As shown in Figure 11, Typical Group I exhibited a pronounced need for a pharmacy and

a preference for a higher-quality living environment, as reflected in its need for single-occupancy rooms and shared living rooms. Typical Group II exhibited the highest degree of need for the takeaway service window, followed by the community dining hall, pharmacy, two-person suite,

and institutional dining hall. Most respondents in this group belonged to lower-income households. They exhibited the greatest need for dining services and expressed a preference for private space alongside a willingness to share accommodation.

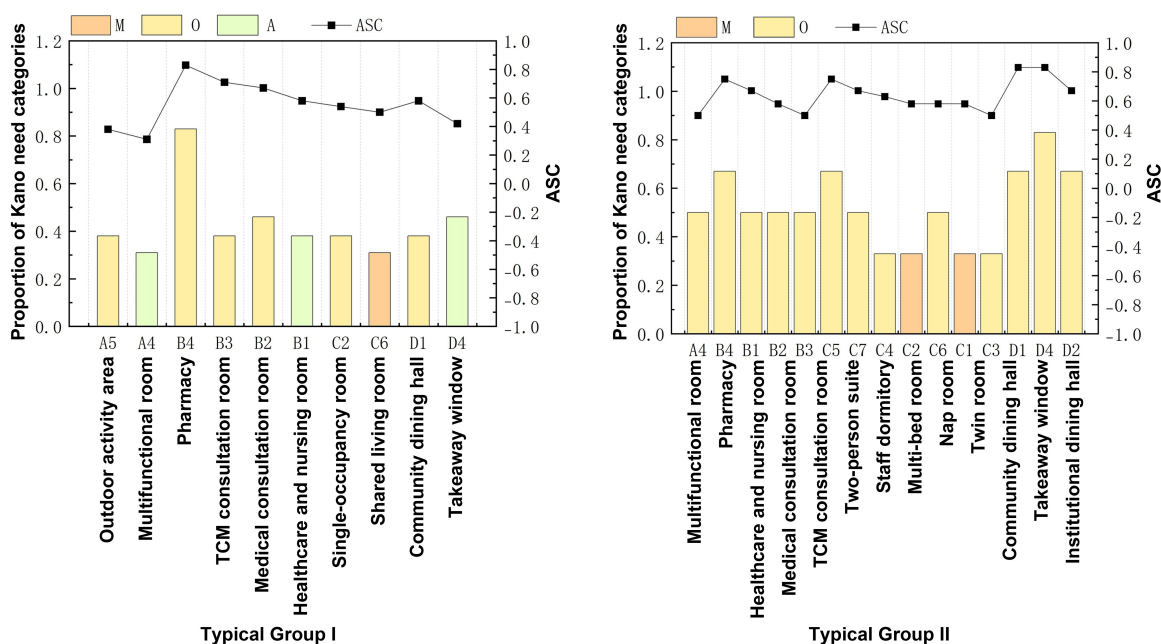


Figure 11 Degrees of need for spatial allocation and proportions of Kano need categories for typical groups

5.3 Summary of functional-space allocation needs

For the overall population, the ASC values for the four second-level functional categories, in descending order, were medical and healthcare services (0.53) > community dining facilities (0.42) > cultural and recreational facilities (0.37) > residential care (0.29).

For Typical Group I, that is, adults aged over 60 years, living alone, with relatively good functional status, the ranking was: medical and healthcare services (0.70) > community dining facilities (0.42) > cultural and recreational facilities (0.34) > residential care (0.31), which is consistent with that of the overall population. For Typical Group II, that is, adults aged over 60 years, residing in eldercare institutions, with relatively poor functional status, the ranking was: community dining facilities (0.77) > medical and healthcare services (0.63) > residential care (0.61) > cultural and recreational facilities (0.37).

As functional status declined, the degree of need for

community dining facilities increased markedly, with the next-largest increase observed for residential care. In addition, no clear preferences were observed for arts activity rooms or leisure rooms. Consequently, the provision of these functional spaces should be determined in conjunction with local demographic characteristics, regional culture, and project-specific planning objectives.

Conclusions

An increasing number of studies have recognized that the needs of community eldercare users vary across population groups with different characteristics [13]. Failure to adequately understand and incorporate these diverse needs may exacerbate existing problems in community eldercare facilities, including poorly coordinated functions, mismatches between supply and demand, and operational inefficiencies. Owing to the complexity and heterogeneity of community populations, accurately identifying local needs remains challenging, resulting in a lack of evidence-based guidance for functional-space allocation.

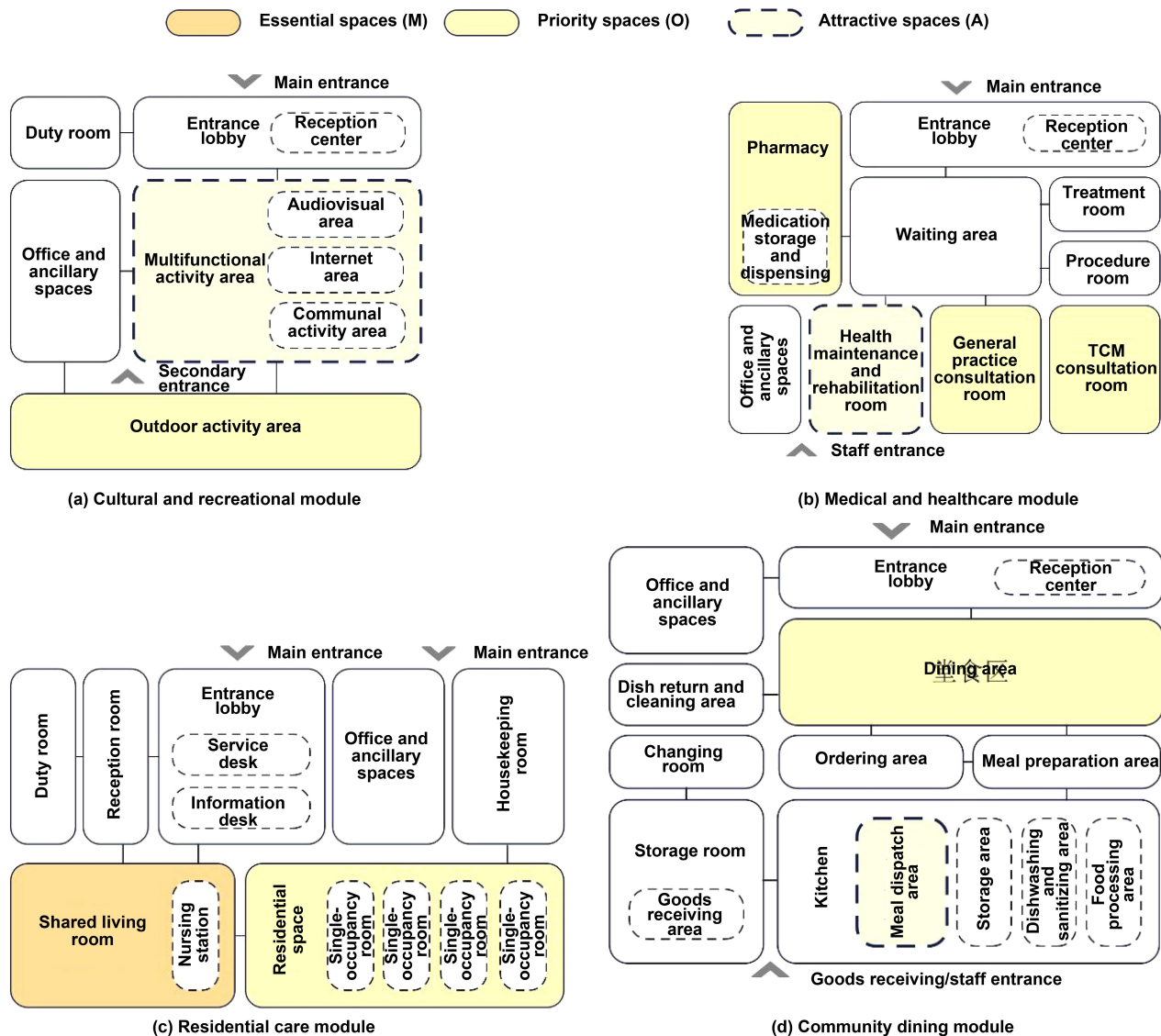


Figure 12 Spatial allocation model for Typical Group I

To address this issue, this study proposes a needs-based method for the spatial allocation of community eldercare facilities by integrating the Andersen Behavioral Model and the Kano model. The proposed approach first organizes population characteristics into multiple dimensions based on the Andersen Behavioral Model and then uses the Kano model to identify groups with distinctive characteristics across these dimensions according to their need categories and degrees of need. In addition to assessing the needs of the overall population, the proposed method identifies typical high-need groups and determines their spatial needs and corresponding allocation priorities. This method can identify how high-need groups within a community differ in their characteristics and willingness to

use eldercare facilities. It can therefore help designers make better-informed decisions about facility functions, target users, and management strategies, develop more appropriate and diverse eldercare spaces, and provide a methodological basis for allocating spaces according to user needs.

Application of the proposed method to community eldercare facilities in the central urban area of Tianjin further demonstrates the heterogeneity of user needs. Older adults in good functional status exhibited relatively greater need for cultural and recreational facilities, whereas older adults with poorer functional status showed substantially stronger need for community dining facilities. Lower-income respondents expressed greater need for single-occu-

pancy rooms, healthcare and nursing rooms, and community dining halls. Identifying differences in user needs can support more targeted design and prompt further consideration of their implications for facility planning. For example, spaces serving people of advanced age should provide appropriately located seating, incorporate smart technolo-

gies, and create an age-friendly environment. For users with poorer functional status, takeaway service windows should be integrated into community dining facilities to strengthen community eldercare service provision. Spaces serving lower-income groups should minimize user costs while remaining operationally viable.

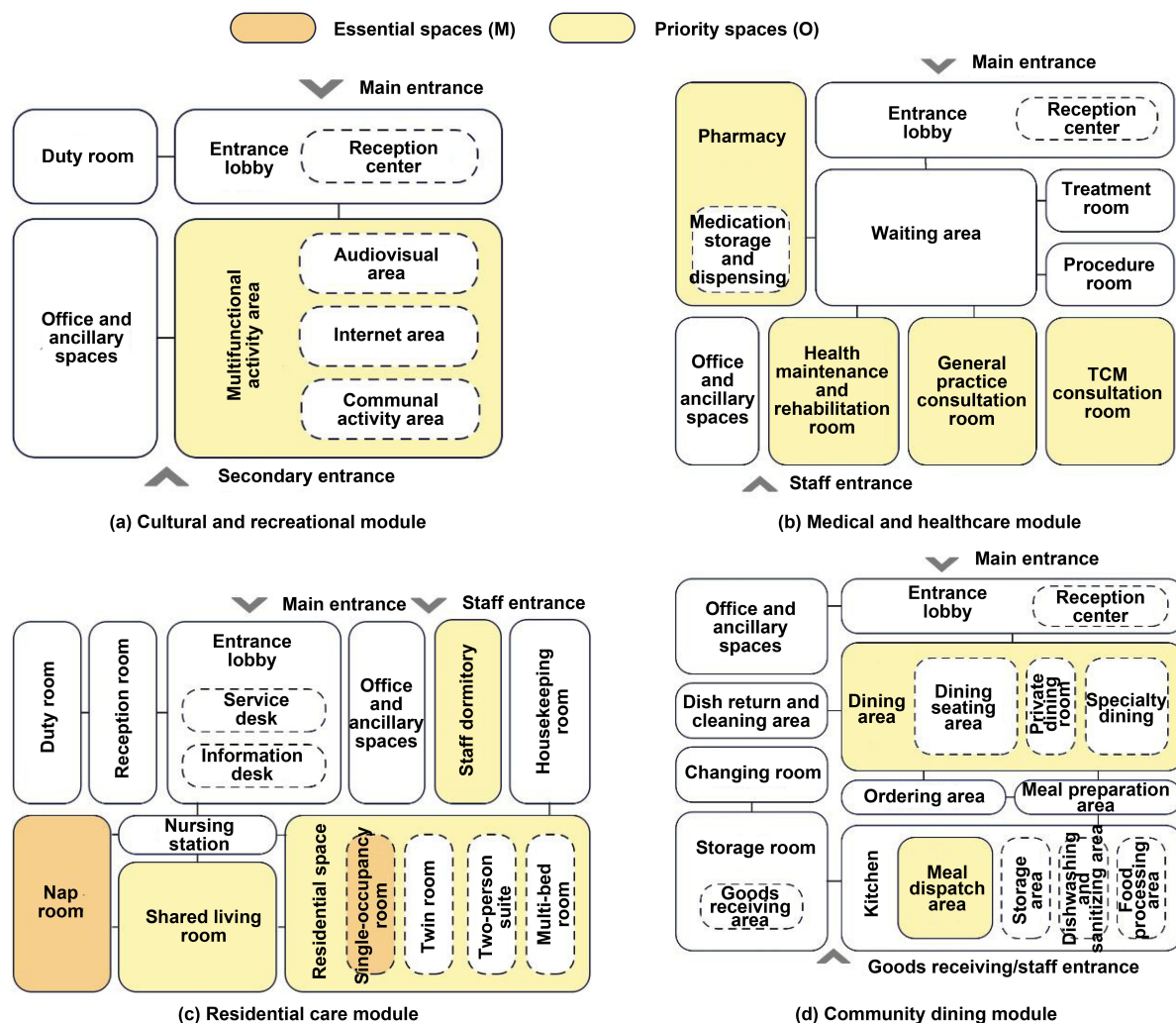


Figure 13 Spatial allocation model for Typical Group II

Although the findings of this study may not be directly applicable to every community, the proposed method for identifying user needs and allocating functional spaces provides a useful reference for the planning and design of community eldercare facilities. Future research should expand the sample size to further investigate the needs of population groups with different characteristics. It should also compare these needs with the existing supply of urban eldercare services to examine spatial allocation more comprehensively and inform the development of eldercare models suited to the Chinese context.

Sources of Figures and Tables

Figures 1-13: Prepared by the authors.

Table 1: Ref. [19].

Tables 2-5: Prepared by the authors.

References

- [1] State Council. Notice of the 14th Five-Year Plan for development of the aging and elderly service system planning issued by the state council [Internet]. 2021 Dec 30 2021 [cited 2022 Feb 21]. Available from: https://www.gov.cn/zhengce/zhengceku/2022-02/21/content_5674844.htm.

- [2] Ministry of Housing and Urban-Rural Development of the People's Republic of China. Standard for urban residential area planning and design. GB50180-2018. Beijing: China Architecture Publishing. 2018: 22-25.
- [3] Institute of Party History and Literature Academy of the CPC Central Committee. Excerpts from Xi Jinping's discourse on urban development. Beijing: Central Party Literature Press. 2023: 45-66.
- [4] Cheng T, Liu CH, Yang HW, Wang N, LIU YS. From service capacity to spatial equity: Exploring a multi-stage decision-making approach for optimizing elderly-care facility distribution in the city centre of Tianjin, China. *Sustainable Cities and Society*. 2022; 85(1):104076.
- [5] Yao Dong, Hao MG, Shi MG. Community care in Nandan: from community elderly facility to community integration. *Architectural Journal*. 2020;(2):56-61.
- [6] Zhou YM, Chen Y. Summarizing the design experience of care facilities for the elderly. *Architectural Journal*. 2019;605(2):38-43.
- [7] Anderson DC, Grey T, Kennelly S, O'Neill D. Nursing home design and COVID-19: balancing infection control, quality of life, and resilience. *JAMDA*. 2020;21(11):1519-1524.
- [8] Zhang XZ, Liu CH, Yang HW. Analysis on the space configuration of community-embedded facilities for the elderly based on CCRC mode: a case study based on construction of CCRC in Tianjin. *South Architecture*. 2022;(5):73-82.
- [9] Zhou YM. Analysis of the development status and contradictory problems of residential buildings for the elderly in China. *Construction Science and Technology*. 2019;(13):14-17.
- [10] Chen Z, Liu RQ, He YJ. A study of the integrated medical and nursing facilities and buildings in Beijing urban communities under the social support system. *Architectural Journal*. 2023;(S1): 20-25.
- [11] He J, Zhou D, Dai JH. Study on evaluation system of urban elderly living related facilities based on demand theories. *Architectural Journal*. 2020;(S2):37-44.
- [12] Li JQ, Zhang Y. Public space demand in elderly care institutions and influencing factors: an analysis based on the Kano model. *South Architecture*. 2021;(6):76-84.
- [13] Yang XD, Li HL, Zhang JY. Implementation countermeasures of urban home-based community caring pattern from the perspective of supply and demand matching. *Urban Problems*. 2020;(9): 43-50.
- [14] Cao JS, Hao ZS, Yang JW, Yin JB, Huang XY. Prioritizing neighborhood attributes to enhance neighborhood satisfaction: an impact asymmetry analysis. *Cities*. 2020;105(1):102854.
- [15] Li JQ, Wang QQ, Xuan YT, Hao Z. User demands analysis of Eco-city based on the Kano model: An application to China case study. *PLoS ONE*. 2021, 16(3): 0248187.
- [16] Zhang J, Li J, Lü Y, Li M. Demand behavior analysis and optimization suggestions of public space in subway station area based on Kano model. *Architectural Journal*. 2022;(S1):131-135.
- [17] Fan CW, Jin YQ, Zhong LP, CHEN X, Wu KL, Liu Q. Research on social support system of national sports service for the elderly. *China Sport Science*. 2019;39(4):39-50.
- [18] Malinka C, von Jan U, Albrecht UV. Prioritization of quality principles for health apps using the Kano model: survey study. *JMIR Mhealth Uhealth*. 2022;10(1):e26563.
- [19] Berger C, Robert B, David B. Kano's method for understanding customer-defined quality. *Japanese Soc Qual Contr*. 1993;2(4):7-10,18.
- [20] Mkpojiogu EOC, Hashim NL. Understanding the relationship between Kano model's customer satisfaction scores and self-stated requirements importance. *Springerplus*. 2016;5(1):197.
- [21] Li B, Wang YM, Li X, Li H. The need and influence factors of the elderly care services in urban community. *Architectural Journal*. 2016;(S1):90-94.
- [22] Wang Q. Demands and determinants of community homebased care services for urban elderly: Based on the 2010 national elderly survey in China. *Population Research*. 2016;40(1):98-112.
- [23] Xiao CC, Zhang Y, Lei X, Luo J, Zhao GH. The demands and influencing factors of community embedded pension service among older adults. *Journal of Nursing Science*. 2022;37(9):91-93.
- [24] Ning Y, Wang GX, Yin ZX, Xiao L. Predisposing, enabling and demand factors of preference for institution-based care among Chinese elderly empty-nesters. *Chinese Journal of Public Health*. 2022;38(10):1237-1240.
- [25] Hu ZY, Jin XY. On the regional differences of elderly-care policy supply in China. *China Population, Resources and Environment*. 2020;30(7):151-161.
- [26] Andersen RM. Revisiting the behavioral model and access to medical care: does it matter. *Journal of Health and Social Behavior*. 1995;36(1):1-10.