علـوم محـيـطی سال هفتم ، شماره سوم، بهار ۱۳۸۹
ENVIRONMENTAL SCIENCES Vol.7, No.3 , Spring 2010
63-76

Developing a Framework of Indicator System for Measurement of Urban Environmental Quality A Case Study From Tehran

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Abstract

Cities are complex and dynamic entities which are the main habitat of mankind. Nowadays cities are facing various challenges that threaten their quality and consequently that of urban residential areas. Developing relevant indicators is a vital step toward assessing these environments' quality and can led to better decision making. The aim of this paper is to develop a tool comprising relevant indicators and to assess their relative importance for measuring the environmental quality of dwellings and urban neighborhoods. Impetus for the research was a need to inform planning and policy decisions in the Tehran metropolitan area. Residents of two Tehran neighborhoods participated in this study. During interviews, respondents were presented with five tasks: an inventory task, an importance selection task, a grouping task, a ranking and rating task for groups of attributes, and finally, a ranking and rating task for attributes within each group. After acquiring the needed data, attribute weights were calculated using four weight estimation methods. Next, the effects of neighborhood, sex, and age on the observed differences in attribute weights were examined, and a Comparison between the methods of attributes weight calculation was conducted. Based on two cluster solution methods, attributes were assigned to different clusters. These resulting clusters were then used to design the empirical model of urban environmental quality. In the end, after comparing the results of current study with those of previous studies, some amendments are suggested to be incorporated in revision of Iranian urban planning process, and some implications are presented for urban development policy.

Keywords: Urban indicators, Clustering, Policy making, Resident participation, Resident perception, Tehran

توسعه چارچوبی از سیستم شاخصی برای اندازه‌گیری کیفیت محیطی شهری: نمونه موردی تهران

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چکیده

شهرها به عنوان سکونتگاه اصلی نوع بشر، مکان‌هایی پویا و پیچیده تلقی می‌شوند. امروزه شهرها با چالش‌های گوناگونی مواجه هستند که کیفیت و به دنبال آن کیفیت نواحی مسکونی‌شان را با تهدید مواجهه کرده است. هدف این مقاله توسعه ابزاری متشکل از شاخص‌های مرتبط و ارزیابی اهمیت نسبی‌شان به منظور سنجش کیفیت محیطی منازل مسکونی و واحدهای همسایگی شهری است. روش شناسی تحقیق بر پایه انجام مصاحبه‌های حضوری بود و از مصاحبه شوندگان خواسته شد تا ضمن فهرست بندی کردن، انتخاب اهمیت، گروه‌بندی و رتبه‌بندی شاخص‌ها در نهایت به ارزیابی مشخصه‌ها و رتبه‌بندی و ارزیابی مشخصه‌های درون هر گروه بپردازند. سپس با استفاده از ۴ روش برآورد وزن، اوزان مشخصه‌ها محاسبه و آثار مولفه هایی چون واحد همسایگی، سن و جنسیت بر تفاوت‌های مشاهده شده در اوزان مشخصه‌ها مورد بررسی مقایسه‌ای قرار گرفت. با استفاده از دو روش خوشه‌بندی، طراحی مدل تجربی کیفیت محیطی انجام گرفت. با استفاده از آنالیز رگرسیون چند متغیره، مشخص شد که برازش مدل نسبتا بالا بود (۴۹٪). مشخصه‌های مهم عبارت بودند از: بوی بد، آلودگی، کمبود امکانات و مخاطرات ایمنی. سنجش های ذهنی و ادراک‌های ساکنین دو محله با هم تفاوت داشتند. مشخص شد که میزان رضایتمندی مسکونی در میان ساکنین زعفرانیه بیشتر است، هم چنین رضایت از منزل مسکونی و واحد همسایگی نیز در میان ساکنین زعفرانیه بیشتر است، اما در مورد رضایت از همسایه‌ها رضایتمندی مردم خانی‌آباد بیشتر است. در نهایت، پس از مقایسه نتایج، الزاماتی برای سیاست‌گزاری توسعه شهری ارائه گردید.

کلید واژه‌ها: شاخص‌های شهری، خوشه‌بندی، مشارکت ساکنین، ادراک ساکنین، تهران.

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Introduction

The emergence of cities as the unchallenged site of human development for the future and the goal of sustainable development have pushed hundreds of cities around the world to seek better means of assessing urban trends. Many forms of assessment, audit, and indicator systems for guiding and better evaluating the effects of urban development are now in place. However, their utility is still in question (Holden, 2006). This paper will introduce a new method for providing a framework to taking into account all indicators and their relative attributes which are important for Tehran city dwellers. Having a proper account of all indicators and their relative importance will provide public and private sector planners and other decision-makers at the urban and neighborhood levels with information about the status quo and areas where are in need for receiving more attention. This in turn will lead to a more democratic form of policy making, and more active participation of citizens. This paper is concerned mainly with the types of indicators that can be helpful in the process of urban planning and especially in planning for the neighborhood.

Wong (2006) states that Urban and social indicators started to emerge more than 50 years ago. In the 1990s, they grew worldwide (Wong, 2006; as cited in Martinez *et al.*, 2008). These indicators can inform public and private actions, and can be used to assess the city's progress in moving toward its overall goal of enhancing the quality of life of its residents (Marans, 2003). When planning for neighborhood, there may be a lot of indicators which come to mind but as button (2002) states, Indicators should in general be relatively small in number and reflect the important environmental trends of interest. Huang *et al.,* (1998) define indicators as bits of information that reflect the status of large systems. They have long been useful in science, health, economics and many public policy areas as feedback mechanisms to decision making. Indicators represent components or processes of real world systems. The development of indicators must start with a carefully defined concept of the purpose of indicators (Li Huang *et al.*, 1998). In our study the indicators and attributes are meant to assist planners and policy makers in Tehran to become aware of the view points and demands of citizens and make more efficient plans in future. Attempts to develop indicators to improve decision-making are long-standing in areas such as economic development, social progress, quality of life, environment and natural resources, healthy communities and sustainability (Hodge, 1997; Seasons, 2003). Different types of indicators have been developed for different purposes and therefore have different foci, and operate at different spatial and functional scales (Hezri and Dovers, 2006).

There is growing acceptance among policy makers that two quite distinct types of indicators, objective and subjective must be employed in the measurement process (Pacione, 2003; Golledge, 1991), and in the study of person-environment relationships (Cummins, 2000). Subjective indicators allow us to gain insight into the well-being/satisfaction of a person, and insight into what people consider important. They contribute to the commitment of people to their environment, and to the creation of public support. Objective indicators are necessary for aspects of the environment that are hard to evaluate, they form the point of departure for environmental policy and enable the validation of subjective measures (van Kamp *et al.*, 2003). Innes and Booher (2000, as cited in Hezri and Dovers, 2006) argue that indicators do not drive policy but may be influential under certain conditions, often through a collaborative learning process. In addition, they found that indicators must be clearly associated with a policy or set of possible actions as a prerequisite for instrumental use. More importantly, it was pointed out that the development of an influential indicator takes time (Innes, 1998). These findings reveal that sustained empirical studies over time and space are necessary to understand the behavior of indicators in policy processes (Hezri and Dovers, 2006). Therefore, the general aim of the present study is to develop a tool comprising relevant indicators and to assess their relative importance for measuring the environmental quality of dwellings and urban neighborhoods. Results can represent guidelines for orienting policies aimed to selectively intervene on neighborhood environmental features in order to foster inhabitants' attachment to their own neighborhood (Bonaiuto *et al.,* 1999).

Study area

Tehran, the capital city of Iran, is one of the most important cities in the Middle East (Nikpour, 2004). It is a metropolis of about 8 million inhabitants intramural, with greater Tehran accounting for as many as 12 million people (Balasescu, 2004). This high rate of concentration has caused a variety of major social, economic, and environmental problems. Due to this centralization it is expected that this trend will continue in coming years (Madanipour, 1999). One of the main features of Tehran is its north-south division; the North has higher and larger buildings, higher land prices, lower densities, smaller households and higher rates of literacy and employment. Whilst it is mostly residential, it accommodates higher concentrations of modern facilities and amenities. On the contrary, the South is poorer, with smaller buildings, lower land prices, higher densities, larger households, lower rates of literacy and employment, and a concentration of workplaces and traditional institutions (Madanipour, 1999). Residents of two Tehran neighborhoods participated in this study, Zafaranieh in the northern part of the city, and Khaniabad in its southern part. The main reason for this selection was to maximize the probability of taking into account the perceptions of all socio-economic groups of urban society.

Material and Methods

120 residents of two Tehran neighborhoods, Zafaranieh and Khaniabad, participated in this study. Interviewees were chosen as far as possible evenly spread throughout neighborhoods, sex and age category variables. In Table 1 an overview of the distribution of participants across the 12 cells of the design is given. The data were gathered by means of personal interviews conducted on the respondent's residence using a structured questionnaire. The survey was set up after a small pilot study. It was conducted in the August 2008. The average length of the interviews was 50 minutes. Respondents were first informed about survey's objective and answering procedure. Response formats were either closed (dichotomous, multiple choices), in ranking scale or open. Methods were used to improve the interpretability, analysis and presentation of indicators. Indicators used addressed a broad range of issues, ranging from physical attributes, environmental attributes, economical attributes and psycho-social attributes. In order to assess the attribute weights, the evaluation of attributes was split-up into several tasks, these tasks were separately performed for dwelling and(these tasks were all repeated, but now all tasks referred to neighborhood attributes) neighborhood attributes. In this study the procedure used by Van poll (1997) was followed. This procedure is a kind of cluster analysis which is a statistical technique that aims to classify areas into relatively homogeneous groups. The characteristics of each cluster can be identified from the descriptive statistics of each variable. Indicators within the bundle will be used in conjunction to explain a specific set of circumstances in relation to that particular aspect of the concept (Wong, 2006, table 6.2).Respondents were presented with five tasks: **inventory task; importance selection task; grouping task; ranking and rating task for groups; ranking; and, finally, rating for attributes within groups.**

After the groups were rank-ordered and rated the respondents rank-ordered and rated the attributes within each group. Attributes were rank-ordered and rated with respect to the importance.

Data analysis

The analysis and interpretation process is an integral part of indicator development (Wong, 2006). After completing five mentioned tasks, for every attribute the following data were available at an individual level: important selection (0, 1), group membership, group ranking (1-n_{group}), group rating (1-100), attribute ranking within a group (1-$n_{attribute}$), and attribute rating within a group (1-100). Attributes considered to be unimportant in the importance selection task were assumed to have a relative weight of zero (0). The relative frequency of importance, that is, the percentage of respondents indicating an attribute as important was calculated and used as an estimate of attribute weight at group level.

Each of the attributes considered important was assigned to a group. The group membership data were used in the cluster analyses. In short, for each respondent an incidence matrix was constructed (see below). Only attributes from the investigators' list were used. Attributes added by the respondents were not included in this analysis because not all respondents evaluated these attributes. So, the matrix is a 21 * 21 table for dwelling attributes and a 55 * 55 table for neighborhood attributes. In these matrices cell (k, l) represents the particular pair of attributes k and l. This cell is given a value of one (1) if those two attributes were put together in the same group and zero (0) if they were put in different groups by a particular respondent. These individual incidence matrices were summed across all respondents yielding incidence frequencies. The resulting matrix was used to calculate *similarity measures*. As a measure for the similarity between attributes, the *relative incidence* (I_r) of two attributes being sorted into the same group was used. I_r is the number of times two attributes actually were put together in one group divided by the maximum number of times these two attributes could possibly have been sorted into the same group. The reason for using this *relative* incidence measure was that the subjects grouped only those attributes rated as "important" in task 1. As a consequence, the number of respondents that actually sorted the same pair of attributes into the same group in the grouping task differed for different pairs of attributes. I_r was computed for all pairs of attributes; the resulting similarity matrices served as the input for the cluster analyses. *Cluster analysis* was performed following two procedures. Firstly, cluster formation and membership was defined as groups of attributes, for which all mutual pairwise I_rs were 0.50 or higher. Fixing the lower limit for I_r at 0.50 is an arbitrary choice, but this value was found to result in a reasonable number of clusters. Secondly, a so-called agglomerative hierarchical cluster analysis with average linking of attributes or clusters was performed. In an agglomerative hierarchical cluster analysis, clusters are formed by grouping attributes into bigger and bigger clusters until all attributes are member of a single cluster. Average linking refers to the way attributes and clusters are combined (for more information, see Landau and Everitt, 2004).

Group importance ratings and within-group attribute ratings were standardized. For each attribute, a weight was computed by multiplying the standardized group rating score, to which the attribute belonged, by its within-group standardized score. The calculated weights by the 'standardized ratings' rule

Table 1-1 Distribution of the 120 participants across the various categories of the three design variables: neighborhood, sex, and age.

	Woman			Man		
	15-39	40-59	More than 60	15-39	40-59	More than 60
Khaniabad	10	10	5	10	5	10
Zafaranieh	15	20	5	20	5	5

will serve as criterion for weight estimation of the dwelling and neighborhood attributes. The formula is shown below.

(1)

$$W_{attribute} = W_{group_j} * W_{attribute_{i\,groupj}} = \frac{X_{group_j}}{\sum_{k=1}^{n_g} X_{group_k}} * \frac{X_{attribute_{i\,group_j}}}{\sum_{l=1}^{n_{a\,group_j}} X_{attribute_{l\,group_j}}}$$

Standardized attribute weights may also be based on the subjects' rankings, instead of on their ratings. Attribute rankings may be transformed into standardized weights by applying either the 'rank-sum rule' or the 'rank-reciprocal rule' (Von Winterfeldt and Edwards, 1986). According to the 'rank-sum rule' weights for nested attributes are calculated as follows:

(2)

$$W_{attribute_i} = W_{group_j} * W_{attribute_{i\,groupj}} = \frac{\left(n+1-R_{group_j}\right)}{\sum_{k=1}^{n} R_{group_k}} * \frac{\left(n+1-R_{attribute_{group_j}}\right)}{\sum_{l=1}^{n} R_{attribute_{l\,group_j}}}$$

According to the 'rank-reciprocal rule' weights for nested attributes are calculated as follows:

(3)

$$W_{attribute_i} = W_{group_j} * W_{attribute_{i\,groupj}} = \frac{1/R_{group_j}}{\sum_{k=1}^{n} 1/R_{group_k}} * \frac{\left(1/R_{attribute_{group_j}}\right)}{\sum_{l=1}^{n} 1/R_{attribute_{l\,group_j}}}$$

ANOVA was used to test whether there are effects from the four subject design factors (city, SES, sex, and age) on the attribute weights as derived from the standardized ratings rule. Multivariate analysis was performed because respondents did not evaluate a single dependent variable but a series of dependent variables, a so-called vector. The weight vectors resulting from the five methods of weight calculation (standardized ratings-, rank-sum-, and rank-reciprocal rule, and the relative frequency) will be compared. Pearson's correlation coefficient is used to assess the extent to which different calculation methods for attribute weights lead to the same result.

Results

In this section the results of the present study are presented. Successively, results are presented on the personal and household characteristics, the tasks for dwelling attributes and neighborhood attributes, on the empirical model of residential quality. The mean age of the respondents was 49.0 years. Analysis of variance revealed that regarding mean age of respondents, there is no significant difference between neighborhoods and males and females. 54.2 % of respondents were female (Table 2).

More Zafaranieh residents (58.3) than Khaniabad residents (41.7) participated in the study. By the way, the difference between two neighborhoods was not significant. 75 percent of respondents were home owners; in this case the percent of home owners in Khaniabad was more than that of Zafaranieh. But again their difference was not significant. Mean length of residence of respondents in dwelling and neighborhood was 12.5 and 20.5 years respectively. Although in these two cases the mean length of residence in Khaniabad was a little more than the mean length of residence in Zafaranieh, the difference between two neighborhoods was not significant.

In this section the results of the interview tasks concerning the *dwelling attributes* are presented. Successively, the results on importance selection, the

Table 2. The personal and household characteristics of respondents (the numbers in parenthesis are standard deviation).

Demographic variables	Khaniabad	Zafaranieh	Total
Age(mean)	45.6(18.5)	40.21(16.8)	42.46(17.34)
Gender(%of women)	50	57.1	54.2
Ownership(% of owners)	80	71.4	75
Distribution(% of respondents)	41.7	58.3	100
Length of residence in dwelling(mean)	13(7.38)	12.21(11.6)	12.54(10)
Length of residence in neighborhood(mean)	21.70(7.51)	19.71(16)	20.54(13)
Length of residence in Tehran(mean)	34.90(17.27)	31.29(17.78)	32.79(17.28)

grouping task, and the ranking and rating data are given. Of the 21 dwelling attributes the respondents were presented with, the mean number of attributes selected as important was 14.67 (s.d.:2) with a minimum of 10 and a maximum of 18 attributes. In Table 3 the 'relative frequency' is shown, indicating the proportion of respondents who marked an attribute as important.

Discussion

It can be seen that indoor malodor is the attribute most frequently mentioned issue of importance by respondents. Other dwelling features frequently mentioned as being important were: indoor facilities, indoor upkeep, natural light, noise by neighbors, and rent or mortgage. The importance of the presence of a garden and storage space was less in comparison with

Table 3. Calculated mean weights for the dwelling attributes according to four methods of attribute weight estimation.

Dwelling attributes	Standardized rule $*10^{-2}$	Rank-sum rule $*10^{-2}$	Rank-reciprocal rule $*10^{-2}$	Relative frequency
Rent or mortgage	8.19	13.33	14.18	0.79
Indoor air pollution	3.44	2.06	2.2	0.5
Outdoor facilities	5.25	1.5	1.53	0.75
View	4.99	3.17	2.19	0.63
Number of rooms	4.08	6.16	8.8	0.71
Indoor facilities	3.67	4.2	4.42	0.92
Location sun	5.41	5	4.23	0.75
Outdoor upkeep	2.82	2.22	2.92	0.63
Indoor upkeep	4.03	4.44	5.84	0.92
Indoor noise	3.88	3.56	2.71	0.54
Garden	1.29	1.01	1.71	0.38
Upkeep costs	7.02	7.78	6.59	0.71
Natural light	5.91	5.33	4.6	0.87
Age	3.48	3.9	3.03	0.63
Dwelling type	3.86	5.06	5.45	0.67
Storage space	2.8	2.41	2.19	0.46
Mould/vermin	4.44	4.78	4.82	0.63
Cost of heating and elect	5.9	5.56	5.23	0.63
Indoor malodor	5.11	6.72	6.89	0.96
Spacious rooms	3.87	5.6	5.42	0.79
Noise by neighbors	4.84	6.06	5.72	0.83

the other attributes. The primary method for finding homogenous groups in large data sets is cluster analysis. In cluster analysis, researchers use multivariate data to assign initially unclassified objects into homogenous groups. It has been used successfully in many social science studies as the primary method for classifying units of analysis into discrete groupings (Morenoff and Tienda, 1997, as cited in Sanford, 2008). In Figure 1 the results of cluster solution based on the groups of attributes with a mutual pairwise *relative incidence ≥0.5*, and the cluster solution of the agglomerative hierarchical clustering are presented. The first procedure led to a cluster solution of four clusters with six attributes being left out of the cluster solution, these attributes were: indoor air pollution, view, outdoor upkeep, presence of garden, natural light, and storage space. These clusters matched to a high extent with the cluster solution of the second procedure. The second procedure led to five clusters, the six attributes left out in the first procedure were assigned to clusters 2, 3, 4, and 5.

The five resulting clusters were: dwelling costs (rent or mortgage, upkeep costs, and cost of heating etc.); upkeep (outdoor upkeep and indoor upkeep); outdoor dwelling facilities (outdoor facilities, location sun, view, and natural light); dwelling size and facilities (garden, storage space, age, dwelling type, number of rooms, indoor facilities, and spacious rooms); and finally hygiene situation (indoor air pollution, noise, malodor, mould/vermin, and noise by neighbors) .

In Table 3 the mean attribute weights, as computed according to the results of the rating task following the four methods of attribute weight estimation are shown. Here we discuss the results of standardized rule in weight estimation. A MANOVA revealed that the differences in weight among attributes were significant (($F_{(21,\ 3)}$): 281, P<0.001).Investigation of resulted weights revealed that five attributes had a relatively high mean weight. These attributes were: rent or mortgage, upkeep costs, natural light, cost of heating and electricity…, and location of sun. In contrast, five

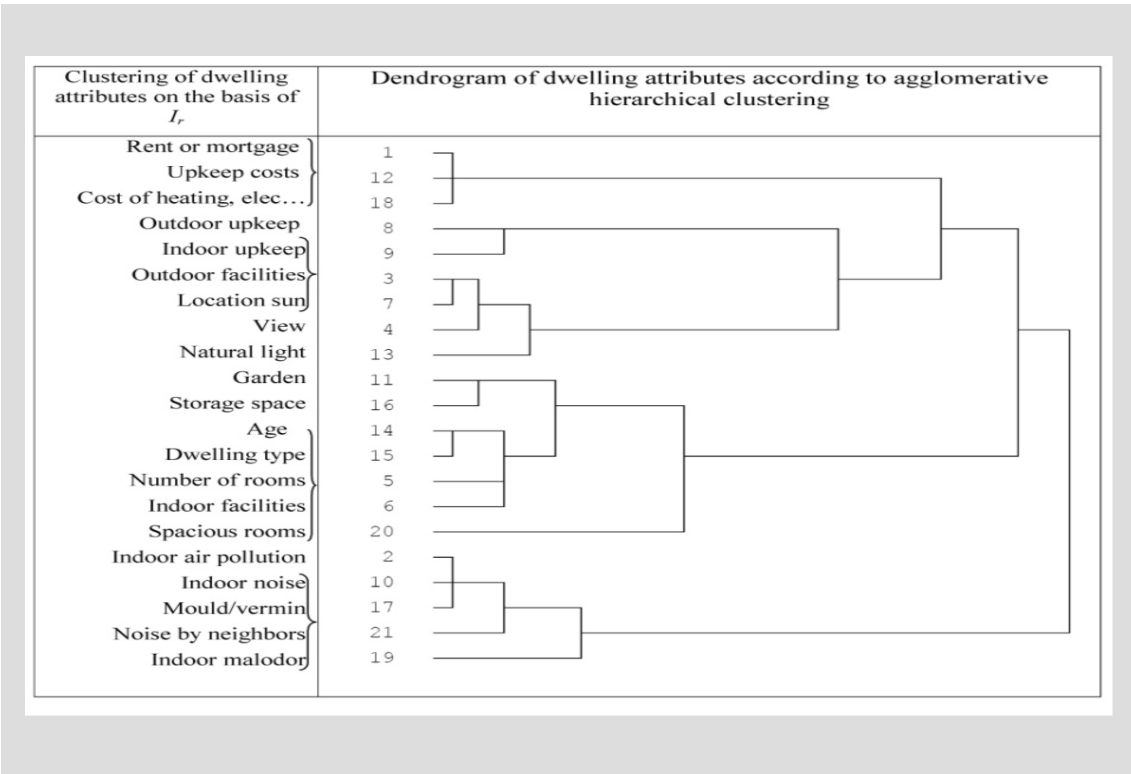

Fig. 2. Clustering of the dwelling attributes on the basis of the I_r (left panel) and dendrogram on the basis of the agglomerative hierarchical clustering (right panel)

attributes had a relatively mean weight. These attributes were: garden, outdoor upkeep, storage space, indoor air pollution, and age of dwelling. MANOVA was performed to assess the effects of neighborhood, sex, and age on the observed differences in attribute weights. In Table 4 the main effects and the first order interaction effects are shown. The results showed a significant effect for age and also significant interaction effects for neighborhood by age and sex by age. The univariate test for sex revealed that only mould/vermin had a significantly different mean weight. This attribute had more importance for people in the age category 40-59. The univariate test for sex by age interaction effect revealed that only two attributes (rent or mortgage and spacious rooms) had a significantly different mean weight. The univariate test for age by neighborhood interaction effect revealed that only the attribute mould/vermin had a significantly mean weight difference.

In order to compare the results of the five methods of attribute weight estimation, correlation coefficients for pairs of weight vectors were computed. In Table 5 the resulting correlation matrix is shown.

As can be noted from Table 5, results obtained by the rank-sum rule have the highest correlation with those obtained by the standardized rating rule.

In the next section the results of the interview tasks for the *neighborhood attributes* are presented. Following this, the results on importance selection, the grouping task, and the ranking and rating data are given. On average respondents selected 37.17(s.d:8.2) attributes as important. The minimum number of selected attributes was 20, the maximum number was 52. In Table 6 the 'relative frequency' is shown, indicating the proportion of respondents who marked an attribute as important.

Table 4. Results of multivariate analysis of variance of main and the first order interaction effects for the standardized dwelling attribute weights.

Main effects	*F* value	*P* value	First order interaction effects	*F* value	*P* value
Neighborhood	0.996	0.169	Neighborhood by sex	0.827	0.859
Sex	0.997	0.131	Neighborhood by age	1.768	0.005
Age	1.84	0.003	Sex by age	1.911	0.42

Table 5. Correlation matrix of the mean relative weights of dwelling attributes computed with four methods of attribute weight estimation.

Method of weight estimation	1	2	3	4
Standardized ratings rule	1	0.79	0.65	0.50
Rank sum rule	0.79	1	0.95	0.50
Rank-reciprocal rule	0.65	0.95	1	0.49
Relative frequency	0.50	0.50	0.49	1

Table 6- Calculated mean weights for the neighborhood attributes according to four methods of attribute weight estimation

Neighborhood attributes	Standardized rule $*10^{-2}$	Rank-sum rule $*10^{-2}$	Rank-reciprocal rule $*10^{-2}$	Relative frequency
Odor of garbage or waste	2.97	3.4	3.64	0.88
Public transportation	1.79	2.36	2	0.67
Greenery	1.79	1.86	1.99	0.63
Public health care facilities	2.64	3.16	3.27	0.75
Odor of animal droppings	1.39	1.08	0.98	0.67
Vibrations	1.1	0.84	0.73	0.54
Smog	2.19	2.54	2.96	0.79
Upkeep	1.26	1.21	0.77	0.54
Hold-ups or robberies	3.29	3.68	3.69	0.92
Unaesthetic buildings	1.03	0.91	0.84	0.63
Noise of neighbors	3.19	3.53	3.49	0.83
Number of people in the neighborhood	1.53	1.45	1.49	0.67
Sport facilities	2.11	2.7	4.05	0.63
Dust in the air	1.84	1.7	1.49	0.79
Pollution of soil	0.4	0.25	0.27	0.29
Noise of industrial activity	1.93	1.61	1.23	0.71
Noise of nightlife	2.39	1.89	2.04	0.79
Illumination at night	1.88	1.62	1.81	0.71
Odor of traffic	1.09	1.04	0.89	0.63
Location city center	1.18	0.99	0.67	0.5
Noise of animals	0.7	0.41	0.38	0.38
Time spending waiting in shops	2.01	1.34	1.09	0.75
Schools	1.54	1.9	1.83	0.54
A lively neighborhood	1.29	0.99	1.27	0.54
Graffiti	0.93	0.63	0.82	0.63
Noise of traffic	2.41	2.49	2.3	0.75
Parking space	1.7	1.82	1.36	0.75
Social ties with neighbors	1.51	2.00	1.64	0.63
Busy streets	1.82	1.84	1.77	0.71
Safety risks of industrial activity	1.4	1.1	1.06	0.58
Arterial roads	1.93	1.83	1.39	0.75
Odor from industrial activity	1.62	1.32	1.01	0.67
Shops	1.87	1.94	1.39	0.67
Strangers and unfamiliar faces	0.53	0.59	0.39	0.25
Litter from garbage or waste	2.76	2.93	2.36	0.92
Odor of sewage, surface water	3.17	4.01	5.49	0.92
Playgrounds	1.37	1.29	1.2	0.58
Vandalism	1.96	1.67	1.32	0.75
Noise of children playing	1.57	1.58	1.08	0.5
Traffic safety in the neighborhood	2.28	2.02	1.83	0.79
Nightlife	1.34	1.14	0.98	0.58
Demolished buildings	2.85	2.51	2.22	0.92
Burglary or theft	3.8	4.64	5.69	0.96
An orderliness neighborhood	1.2	1.26	1.35	0.71
Family or friends in the vicinity	1.87	2.34	2.33	0.67
Noise from airplanes	1.93	1.77	1.52	0.71
Litter from animal droppings	1.38	0.84	0.98	0.75
Walks	1.81	1.88	2.51	0.67
Community center	0.75	0.51	0.65	0.42
Pollution of surface water	1.87	1.72	1.73	0.79
Dense developments	0.77	0.66	0.67	0.46
Social ties with neighborhood's people	0.8	0.85	0.62	0.54
Safety risks from junkies or prostitution	3.53	4.46	6.77	0.96
Noise of construction activities	2.32	1.93	1.21	0.79
Location of work place	1.84	1.94	1.43	0.67

It can be seen that safety risks from junkies or prostitution and burglary or theft are the attributes most frequently considered important by respondents as being important. Other neighborhood attributes frequently mentioned as being important were: a bad odor from sewage and surface water, litter from garbage or waste, hold-ups or robberies, demolished buildings, and malodor of garbage or waste. The importance of noise of children playing, location with respect to city center, dense developments, community center, noise of animals, soil pollution, and strangers and unfamiliar faces was in comparison with the other attributes.

Clustering

The procedure for the cluster analyses of neighborhood attributes was similar to the procedure for the dwelling attributes. Again a matrix of pairwise I_r-scores was computed and served as an input for two types of cluster analyses. Clustering on the basis of pairwise I_r-scores led to seven clusters with fourteen attributes being left out of the cluster solution, these attributes were: noise of animals, noise of playing children, schools, community center, time spending waiting in shops, illumination at night, public transportation, busy streets, dense developments, family or friends in the vicinity, a lively neighborhood, strangers and unfamiliar faces, and soil pollution. With the exception of the aforementioned attributes, this cluster solution matched to a high extent with the cluster solution obtained from the second method.

The seven resulting clusters were: noise (noise of neighbors, construction activities, traffic, night life, industrial activity, animals, and playing children); neighborhood facilities (schools, community center, sport facilities, play grounds, greenery, walks, nightlife, health care facilities, shops, waiting in shops, and illumination at night); accessibility and accessibility paths (upkeep, location with respect to city center, streets, location with respect to work place, parking space, and public transportation); buildings and density (unaesthetic buildings, orderliness of neighborhood, number of people in the neighborhood, busy streets, and dense developments); social relationships (social ties with neighbors, social ties with neighborhood's people, family or friends in the vicinity, a lively neighborhood, and strangers and unfamiliar faces); security (demolished buildings, burglary or theft, hold-ups or robberies, graffiti, safety risks from industrial activity, vandalism, and vibrations); quality of environment's hygiene (smog, dust in the air, pollution of surface water, odor of garbage or waste, litter from garbage or waste, malodor of sewage and surface water, malodor of animal droppings, litter from animal droppings, malodor of industrial activity, malodor of traffic).

Weight Estimation of Neighborhood Attributes

In Table 6 the mean attribute weights, as computed according to the results of the rating task following the four methods of attribute weight estimation are shown. Here we discuss the results of standardized rule in weight estimation. A MANOVA revealed that the differences in weight among attributes were significant (($F_{(55, 6)}$): 1359, P<0.05). Investigation of the resulting weights revealed that five attributes had a relatively high mean weight. These attributes were: burglary or theft, safety risks by junkies or prostitution, hold-ups or robberies, noise of neighbors, and odor of sewage, surface water. In contrast these attributes had a relatively mean weight: community center, noise of animals, strangers and unfamiliar faces, and soil pollution. MANOVA was performed to assess the effects of neighborhood, sex, and age on the observed differences in attribute weights. In table 7 the main effects and the first order interaction effects are shown. From this table it can be seen that none of the effect studied reached the significant level.

Interestingly, separate investigation of the effects of each factor on single attributes, revealed that men gave more weight to public transportation and vibrations, while women paid more attention to unaesthetic buildings; in other words women paid more attention to the aesthetic attributes. Khaniabad residents gave a higher weight to number of people in neighborhood and noise of airplanes than did Zafaranieh residents.

The results of the four methods for neighborhood attribute weight calculation were pairwise compared. In Table 8 the correlation coefficients between each pair of methods are shown.

The correlation coefficients varied from 0.70 to 0.95. The highest correlations were between rank-sum rules and the standardized rating rule, and rank-sum rule and rank-reciprocal rule. But other methods performed well too. The *empirical* model of urban residential quality was designed on the basis of clusters obtained for dwellings and neighborhoods. Residential satisfaction is at the highest level of the model. Residential satisfaction is assumed to depend on two distinct attributes of the residential environment: the dwelling and the neighborhood. In turn, satisfaction with the dwelling depends on five attributes labeled as follows: (1) costs, (2) upkeep, (3) outdoor facilities, (4) size and facilities, and (5) hygiene situation. Satisfaction with the neighborhood depends on seven attributes: (1) noise, (2) facilities, (3) accessibility, (4) buildings and density, (5) social relationships, (6) security, and (7) quality of environment's hygiene. The five higher-level attributes of dwellings and seven higher level attributes of neighborhoods are dependent on various lower-level dwelling and neighborhood attributes.

Conclusion

This study was designed to develop the appropriate procedures for identifying and measuring attributes via sets of commonly recognized and accepted indicators that in turn allow evaluations of environments to be undertaken with a great degree of confidence, these evaluations can influence policy decisions in several ways other than simply serving as an information base for policy makers. They allow a continuous audit of the development and its sustainability, for a better understanding of the urban realities (Repetti and Desthieux, 2006). This study describes a methodology that could be used to incorporate public input into the planning process. As Herzog *et al*., (1982) states, it is difficult to deal directly with the question of how people feel about their environment. However, the comparison between obtained empirical model of residential quality and theoretical model of residential quality (Van Poll, 1997) indicates that citizen's perceptions and preferences differ from those of planners and experts in a number of ways. Here we compare the empirical model obtained from this study with the theoretical model of environmental quality mentioned in Van Poll's work. In our study *graffiti* and *demolished buildings* belong to cluster named security, whereas in the theoretical model this attributes are in the cluster entitled as litter. Scrutinizing the obtained empirical model shows that *vibrations* belong to security cluster, but in the

Table 7. Results of multivariate analysis of variance of main and the first order interaction effects for the standardized neighborhood attribute weights.

Main effects	*F* value	*P* value	First order interaction effects	*F* value	*P* value
Neighborhood	2.070	0.506	Neighborhood by sex	7.185	0.287
sex	3.376	0.408	Neighborhood by age	1.130	0.578
age	0.580	0.810	Sex bye age	5.365	0.169

Table 8. Correlation matrix of the mean relative weights of neighborhood attributes computed with four methods of attribute weight estimation.

Method of weight estimation	1	2	3	4
Standardized ratings rule	1	0.95	0.86	0.89
Rank sum rule	0.95	1	0.95	0.79
Rank-reciprocal rule	0.86	0.95	1	0.70
Relative frequency	0.89	0.79	0.70	1

theoretical model it is one of the sub-attributes of *pollution* cluster. In the theoretical model *time waiting in shops* belongs to crowding cluster but in empirical model it is one of the sub-attributes of facilities cluster. The important point is that in the empirical model more attention has been paid to social issues. The differences mentioned above, indicate that there are some differences between perceptions of experts and laypersons. Assessment research that involves laypersons can serve as an effective mechanism for redefining issues, for citizen participation, and also to alter communications networks among interested groups and to attract the media (Zube, 1991).

As one of the objectives of this study, here we compare empirical model of Van Poll's work with our study's empirical model. The interesting point is that both studies led to equal numbers of categories, but detailed investigation of attributes within each category indicates that there are some slight differences between them. In the first model vibrations belong to security cluster but in the second model they belong to *noise* cluster. In the Van poll's empirical model, malodor of surface water is not included but in this study it belongs to the cluster entitled environmental hygiene. In the first model, illumination at night is perceived to be one of the attributes having impact on security, whereas in the second model this attribute is perceived to have impact on facilities. In the Van poll's empirical model *livable neighborhood* belongs to *building/space* cluster, but in our study this attribute belongs to the *social relationships* cluster. Comparing two models indicates that waiting in shops belongs to accessibility and facilities clusters respectively. These differences go back to the difference in people's perceptions due to various social, economic, physical, and psychological conditions and characteristics of different contexts. As Repetti and Desthieux (2006) states, the ideal set of indicators will vary from one city to the other, in regard of the development conditions, traditions, and policies. Above findings demonstrate that urban planning is not a panacea, nor a dogmatic concept. It must be adjusted and tailored according to local circumstances and the desired results (Steinberg, 2005). In other words, models from the developed world cannot be applied without major adaptations (Sharifi, 2008). In Table 9 an overview is given of ten most important dwelling and neighborhood attributes.

Table 9. The most important dwelling and neighborhood attributes in descending order of attribute weight (standardized ratings).

Dwelling attributes	Neighborhood attributes
Rent or mortgage	Burglary or theft
Upkeep costs	Safety risks by junkies or prostitution
Natural light	Hold-ups or robberies
Cost of heating and elect	Noise of neighbors
Location sun	Odor of sewage, surface water
Outdoor facilities	Odor of garbage or waste
Indoor malodor	Demolished buildings
View	Litter from garbage or waste
Noise by neighbors	Public health care facilities
Mould/vermin	Noise of traffic

From this table it can be stated that various attributes affect the quality of dwellings and neighborhoods. In summary, diverse attributes affect the quality of residential environment and as Van Poll (1997) suggested next to some physical attributes, psycho-social attributes and attributes of the built environment appear to have the highest effect on the quality of residential environments. The results of statistical analyses and weighting methods show that citizens who live in two different neighborhoods have different perceptions of environmental quality and the weights they assign to most of attributes are not the same. This implies that plans and guidelines set up to apply to a whole city are bound to be too generalist when one comes down to practice in a neighborhood context (Peterson, 2005). Results allow the identification of the sensitive areas in which compromises and negotiations should be undertaken, the potentially conflicting goals and the potential action points (Repetti and Desthieux, 2006).

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