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Rerearch Article

Application of Exploratory Factor Analysis on assessment of the community – based survey on environmental quality in Distric 1, Ho Chi Minh City, Vietnam

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Abstract: Research on people's evaluations and expectations for the living environmental quality has been conducted by many studies. In Vietnam, assessing people's opinions about the quality of the living environment, especially in densely areas, are still limited. However, people's judgments about the quality of the living environment have been considered as one of the assessing methods for the regional environmental protection results, approved by the Ministry of Natural Resources and Environment in 2019. Therefore, this research was carried out to provide the evaluation and expectations of the people about the quality of their living environment in District 1, Ho Chi Minh City. The study used Exploratory Factor Analysis (EFA), a multivariate evaluation method, to group the surveyed answers that best express the respondents' evaluations and expectations. From 07 proposed groups and 26 initial variables, the analysis results have been reduced to 3 evaluation groups with 18 variables; and 2 expectation groups with 18 variables. The analysis results of influencing factors including age, survey's location, and gender showed that although there is no difference in the two groups of gender, the age groups and respondents of 10 wards of District 1 revealed significantly different answers. The results of this pilot evaluation can therefore be applied as a premise to expand more in−depth studies on a larger scale and broader scope, and also an important reference for managers in designing regional environmental management options and plans, particularly in terms of age and location.

Keywords: Living environmental quality; Exploratory Factor Analysis; Principal component analysis; Varimax; Principal Axis Factoring.

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1. Introduction

The definition of human quality of life has long been studied by social scientists and managers. WHO defines the quality of life as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" [1]. Therefore in order to quantify these factors, a set of criteria for assessing the quality of life (Quality of life index) has been proposed to build. EU mentioned that this set of indicators should include aspects of employment, health status, social relationships, leisure time, education level, environmental quality, safety security, and administration [2]. For populated environments such as urban areas, the quality of life has been suggested as the level of happiness and quality of the place where the individual is living [3]. These indicators are a useful tool for sustainable urban development and should include environmental, economic, governance, and management aspects [4−5].

One of the very important aspects of this index is the living environmental quality. Research on environmental quality as a component of quality of life was mentioned quite early by UNESCO social scientists, in which they presented initial views on how to define the natural and man−made environment; and proposed environmental quality criteria such as purity of air, water, soil, noise level, the proportion of man−made structures such as bridges, roads, etc [6]. Studies focusing on sustainable environmental quality were also conducted, especially the Environmental Sustainability Index (ESI) consisting of 21 environmental indicators [7]; or OECD report on environmental indicators for assessing environmental quality (air, water, soil, solid waste, etc), along with assessing methods for each criterion [8]. Studies on assessing aspects of environmental quality in the context of people's quality of life have been conducted by many studies in Europe [9−12], Brazil [13], Iran [14], Malaysia [15], China [16], and Hong Kong [17].

In Vietnam, studies on quality of life have also been researched, including assessment of the quality of life of the elderly in Ho Chi Minh City [18], and comparative evaluation of the sustainability of the big cities Hanoi, Da Nang, Ho Chi Minh City, and Can Tho [19]. However, studies on assessing the quality of life of the residents, in particular the quality of the living environment in large urban areas and high population density such as Ho Chi Minh City, are still limited. In particular, the people’s opinions and evaluations of the living environmental quality in the area have received little attention and research. This is one of the major shortcomings in assessing the quality of the living environment, because the individual judgments reflect an overall environmental quality, together with the pollution conditions of the area.

Nonetheless, people’s assessments have been taken care of by managers and recognized as an important reference source. This is mentioned in Decision No. 2782/QD/BTMT dated October 31, 2019, of the Ministry of Natural Resources and Environment on promulgating a set of indicators for assessing environmental protection results of provinces and cities, which the level of people’s satisfaction is evaluated and accounted for 30% of the rating points by applying the sociological survey method. According to this regulation, the criteria are defined by ambient air, surface water, soil environment, natural landscape, and biodiversity quality [20].

Considerably, the criteria for people's quality of life may be different based on individuals’ assessment and the actual environmental quality. Therefore, this study was carried out to assess people’s satisfaction with their living environmental quality. This study was carried out on a pilot scale (small scale) in the 10 wards of District 1, Ho Chi Minh City. The results of this study are expected to contribute to the development of a set of criteria and evaluation weights suitable to the actual conditions in the locality. The results of this study can then be applied as a reference for local authorities to develop parameters and how to calculate people’s satisfaction with the quality of life, and contribute to the process of assessing the results of local environmental protection.

2. Methods and data

2.1. Study area

As a central area of Ho Chi Minh City, District 1 has an area of 7.72 km^2. According to the information on the District's web portal, the current population of the area is 142,625 people (in 2019), accounting for 1.59% of the total population of the city; population density 18,479 people/km^2; gender ratio is 86 men/100 women. The study is focused on people who have lived or worked for more than one year in District 1, Ho Chi Minh City. Surveyed people were randomly introduced and selected by the Ward People's Committee in the area. This study, therefore, uses the questionnaire dataset answered by selected citizens for the analysis.

2.2. Research framework

The implementation process of the study is illustrated in Figure 1.

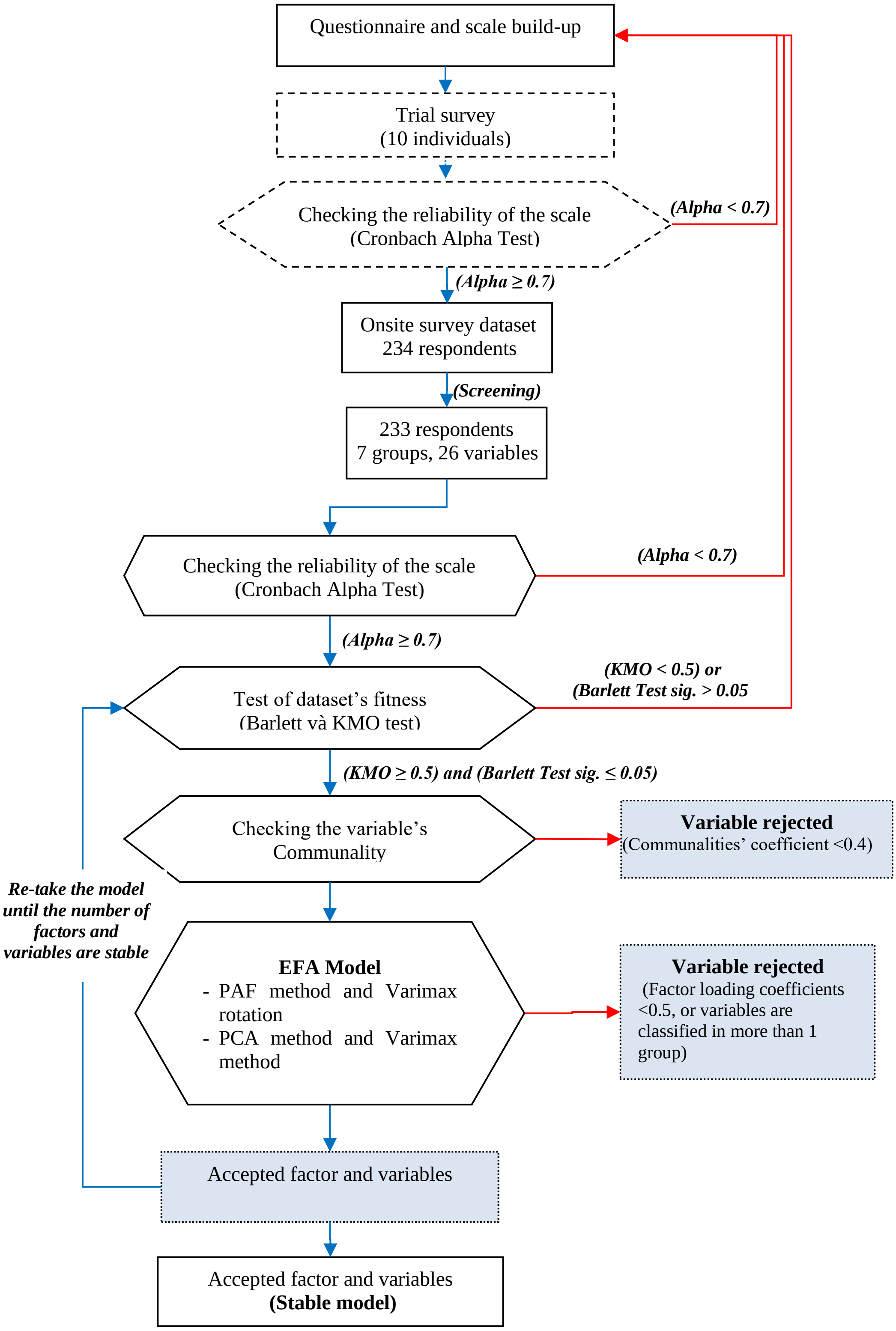

Figure 1. The study's workflow.

2.3. Methods

2.3.1. Questionnaires' development

Questionnaires' contents: The Questionnaires are designed with short questions and scoring answers to get the necessary information without causing difficulties [21]. The content of the survey focuses on two main objectives: (1) assessment and (2) expectations of the respondents for the quality of the living environment. The environmental indicators were referenced from previous studies with a research context close to Vietnam together with the practical experiences on the current situation in the area. The recommended set includes 26 evaluation indicators, divided into 07 main quality groups with 3 to 5 indicators in each group (Table 1). To facilitate the analysis of the results, the questions and scales for each question are designed unidirectionally (either positive or negative). Specifically, for the assessment purpose, the questions are designed in a negative direction (pollution is presented); and for the expectation purpose, the questions are designed in a positive direction (no pollution).

Table 1. The survey's questions.

Label	1. Personal assessment of the environmental quality	Label	2. Personal expectation of the environmental quality
	Group 1: Soil [22−23]		
C11	Subsidence conditions presented	C21	Subsidence conditions not presented or limited
C12	Soil pollution presented	C22	Soil pollution not presented or limited
C13	Less percentage of green area	C23	High percentage of green area
	Group 2: Water [24−25]		
C14	Poor quality of supply water	C24	Good quality of supply water
C15	Poor quality of natural water	C25	Good quality of natural water
C16	Pollution of surface water and groundwater presented	C26	Pollution of surface water and groundwater not presented or limited
C17	Poor drainage condition	C27	Good drainage condition
C18	High level of groundwater extraction	C28	Low level of groundwater extraction
	Group 3: Air [26]		
C19	Pollution of dust and fine dust presented	C29	Pollution of dust and fine dust not presented or limited
C110	Pollution of vehicle smoke presented	C210	Pollution of vehicle smoke not presented or limited
C111	Pollution from business establishments presented	C211	Pollution from business establishments not presented or limited
C112	Pollution from outdoor burning of coal, garbage, or items presented	C212	Pollution from outdoor burning of coal, garbage, or items not presented or limited
	Group 4: Landscape [23, 27]		
C113	Poor surrounding green area	C213	Good surrounding green area
C114	Poor surrounding ecosystem	C214	Good surrounding ecosystem
C115	The openness of the surrounding environment is not presented or limited	C215	Good openness of the surrounding environment
	Group 5: Noise [23, 26]		
C116	Noise from transportation presented	C216	Noise from transportation not presented or limited
C117	Noise from business activities presented	C217	Noise from business activities not presented or limited
C118	Noise from construction activities present	C218	Noise from construction activities not presented or limited
	Group 6: Odor (onsite investigation)		
C119	The odor of untreated waste presented	C219	The odor of untreated waste not presented or limited

Label	1. Personal assessment of the environmental quality	Label	2. Personal expectation of the environmental quality
C120	The odor of sewer presented	C220	The odor of sewer not presented or limited
C121	The odor of production and business activities presented	C221	The odor of production and business activities not presented or limited
C122	The odor of solid waste transfer stations and landfills presented	C222	The odor of solid waste transfer stations and landfills not presented or limited
Group 7: Solid waste [24, 25, 28]			
C123	High volume of generated waste	C223	Low volume of generated waste
C124	Waste is not fully classified	C224	Waste is fully classified
C125	Low percentage of waste not collected/recycled at home/office	C225	High percentage of waste not collected/recycled at home/office
C126	Pollution from the litter on the streets presented	C226	Pollution from the litter on the streets is not presented or limited

Questionnaires' scale: The study applies a Likert scale of 4−5 levels depending on the purpose of the question (Table 2).

Table 2. Recommended scale for the questions in the survey.

Survey's purpose	Score	Explanation
1. Individual assessment of the environmental quality	1	This occurrence does not exist
	2	I have no ideas
	3	This occurrence exists but does not affect my life
	4	This occurrence exists, and affect my life
1. Individual expectation of the environmental quality	1	Very much disagree
	2	Disagree
	3	I have no ideas
	4	Agree
	5	Very much agree

Before conducting the survey, the research team conducted a scale test by randomly surveying 10 people. The reliability results of the trial test applying Cronbach Alpla method showed that the alpha coefficient is higher than 0.7, thereby showing that the scale is reliable, and therefore can be applied to the actual survey.

2.3.2. Sample size

According to recent studies on applying Factor Analysis method, there is no exact minimum sample size because of the respondents' communiality [29−31]. The ratio of the number of surveys to the number of questions (surveyed variables) is recommended either from 2:1 to 20:1 [32−34]. Mundfrom et al (2005) recommended the number of samples from 100 to more than 1,000 [34]. Consequently, with 26 variables stated in the survey, the minimum sample size is expected from 78 to 520 respondents [34]. Because this is a small−scale investigation, the research team surveyed 234 respondents. After screening, a number of 233 were qualified to run the Explanatory Factor Analysis model.

2.3.3 The Cronbach Alpha's test

The Cronbach Alpha test was conducted to check the consistency and reliability of the survey's scale. Although there are arguments about the acceptability interval of Alpha, its application, and interpretation, this method has been widely recognized and applied. In the study, the Alpha's coefficient greater than 0.7 is acceptable [35].

2.3.4 Barlett and Kaiser−Meyer−Olkin's test

The Bartlett and Kaiser−Meyer−Olkin (KMO) test is applied to assess the fit of the data before conducting the Factor Analysis. The Bartlett test checks the correlation between the variables in the matrix. The KMO value, range from 0 to 1, checks the fit of the dataset of the model. A suggested KMO value greater than or equal to 0.5 is acceptable to run the EFA model [29]. Therefore, in the study, the acceptable requirement to conduct Exploratory Factor Analysis is KMO coefficient > 0.5 and the Barlette's p−value < 0.05.

2.3.5. Explanatory Factor Analysis

The Exploratory Factor Analysis (EFA) is one of the multivariate statistical methods used to identify hypothetical or latent constructs. The method groups structures that are related to each other among a set of variables [30, 36]. In social and behavioral science research, factors are understood as unobservable characteristics, expressed by the subjective individual assessment by scoring in a survey. The results of the EFA through the respondents' scores will test whether the questions are correlated and combined closely related questions in a group (named components or Factors in EFA). Therefore, the results reduce the dimensions (groups) of the original dataset by diminishing unnecessary irrelevant data. This analysis is performed by SPSS 16.0. The EFA features are presented as follows:

a) Factor Extraction Models

Factor extraction models are indispensable components in the EFA model. These models include Common Factor Models (including Maximum Likelyhood method and Principal Axis method) and Principal Component Analysis (PCA) [29, 37]. According to Costello and Osborne (2005), depending on the dataset distribution, the Maximum Likelyhood method or Principal Axis Factoring (PAF) method is applicable for normal or non−normal distribution [33]. Principal Component Analysis (PCA) is targeted in reducing the number of observed variables by grouping them in a linear pattern while preserving as much information from the original dataset as possible [29, 30, 36]. As the purpose of the study is to understand the latent factors in the series of observed variables, together with retain as much information as possible, these two extraction methods PAF and PCA were applied.

b) Rotation method

The purpose of the matrix rotation method is to simplify and clarify the data structure. Many methods of matrix rotation are applied, of which orthogonal and oblique rotation methods. Some studies have shown unclear differences between the results of these two rotations, and the results of the oblique rotation can be quite complicated in interpretation [33, 38]. According to [39], the Varimax rotation maximizes the variance in a factor such that larger loads are increased and smaller loads are minimized. Therefore, Varimax rotation, one of the most popular orthogonal rotation methods, is applied in the study.

c) Communality's coefficiency determination

The communalities value indicates the contribution percentage of every observed variable. Accordingly, a variable's communalities coefficient lower than 0.4 means that the variable has a weak relationship with the group of factors [33, 40]. Therefore, in this study, variables with communalities coefficients lower than 0.4 were excluded from the EFA model.

d) Eigenvalue and Factor loading's coefficients

One of the methods to determine the number of groups (factors) is to use the Eigenvalue coefficient. Eigen coefficient, which is higher than 1, is believed to meet the requirements [36]. [29] also added a condition that the total load of variance must be greater than 60%, that is, the selected groups of variables must represent more than 60% of the original group of variables. Besides, Factor loading's coefficients show the degree of strong or weak relationship of the variable to the group of factors and are usually chosen in the range from 0.30 to 0.55 [41], in which the larger the load coefficient the stronger the correlation of the variable with the factor group. In this study, the loading factor 0.5 was chosen to group the variables into the factor group.

3. Results and discursion

3.1. Results

3.1.1. Grouped variables by EFA model

After screening, a total of 233 valid respondents were selected. The surveyors are distributed relatively evenly in 10 wards of District 1, of which the lowest number of respondents is in Ben Nghe and Da Kao wards (16 respondents) and the highest is Cau Ong Lanh ward (33 respondents). The male/female ratio of the dataset is 53.6% (male) and 46.4% (female), respectively. The average age of the surveyors is 38.7 years old (the highest is 72 years old, the lowest is 19 years old). The average working and living time is 9.73 and 19.22 years, respectively. The average income is about 455 USD per month (9.98 million VND per month).

For the question of environmental quality assessment, the average score ranged from 2.6 to 3.2, indicating that the respondents considered that pollution occurred but did not have too much impact on their lives. Regarding the question about the respondents' expectations about the quality of the living environment, the survey results showed a high level of consensus, with the average score for each question ranging from 3.76 to 4.02 points. This reflects the respondents' level of agreement, but not too high, for environmental quality improvement.

The initial input includes a total of 26 variables in two main groups: 1) The environmental quality assessment group (26 variables, labeled from C11 to C126, referred to as C1); and 2) The environmental quality expectation group (26 variables, labeled from C21 to C226, referred to as group C2). The dataset was tested for the scale’s reliability by Cronbach Alpha method in the first run. In the next runnings, the data series is tested for Communality without running Cronbach Alpha again. The results after three runs are presented in Table 3.

Table 3. Summary of EFA model’s results.

	1st run		2nd run		3rd run	
	C1	**C2**	**C1**	**C2**	**C1**	**C2**
No. of rejected variables	0	0	6	7	2	1
No. of tested variables	26	26	20	19	18	18
Cronbach Alpha’s test	0.957	0.979	–	–	–	–
Barlett test sig.	0.000	0.000	0.000	0.000	0.000	0.000
KMO ’s test	0.891	0.940	0.884	0.935	0.885	0.933
Communality’s test	Pass	Reject: C21	Pass	Pass	Pass	Pass
No. of recommended factors	4	2	4	2	3	2
Total cumulative variance (%) (based on the recommended factors)	72.46	72.27	74.7	75.9	72.1	76.5
Rejected variables (PAF method)	C114,C116,C121, C125,C126	C210,C211,C212, C213,C214,C215	C19, C110	C29	None	None
Rejected variables (PCA method)	C13,C114,C116, C121,C125,C126	C210,C211,C212, C213, C214,C215	C19, C110	C29	None	None

In the three runs, the Barlett and KMO tests showed that the results of the two groups of question were satisfactory: Alpha coefficient > 0.7, KMO coefficient > 0.5, and Barlette sig coefficient < 0.05 (Table 3). The total loads of variance of the three runs were higher than 60% (total cumulative variance % in Table 3), which meets the requirement for the number of factors. In the first run, variable C21 was excluded because the test result of communalities coefficient was 0.384 and 0.398 for PAF and PCA methods, respectively. This variable thus was not satisfactory and rejected from the EFA model.

The redistribution of groups of variables (Table 3) shows an association among the variables within the same group. The average survey scores for each variable after grouping are presented in Table 4.

Table 4. Average survey score of each grouped variable.

1. Surveyors' assessment on environmental quality			
Factor 1:	**Factor 2:**	**Factor 3:**	**Rejected:**
C17: 2.94	C11: 2.59	C111: 2.66	C13: 2.95
C118: 2.90	C12: 2.67	C112: 2.57	C19: 3.20
C119: 2.80	C14: 2.60	C113: 2.75	C110: 3.24
C120: 2.81	C15: 2.77	C115: 2.78	C114: 2.62
C122: 2.78	C16: 2.78	C117: 2.70	C116: 3.02
C123: 2.84	C18: 2.82		C121: 2.56
C124: 2.94			C125: 2.63
			C126: 2.77

2. Surveyors' expectation on environmental quality		
Factor 1:	**Factor 2:**	**Rejected:**
C22: 3.91	C216: 3.80	C21: 3.88
C23: 3.84	C217: 3.76	C29: 3.82
C24: 4.02	C218: 3.77	C210: 3.80
C25: 3.96	C219: 3.85	C211: 3.90
C26: 3.85	C220: 3.86	C212: 3.90
C27: 3.82	C221: 3.89	C213: 3.90
C28: 3.88	C222: 3.89	C214: 3.91
	C223: 3.86	C215: 3.90
	C224: 3.76	
	C225: 3.81	
	C226: 3.84	

For the purpose of assessing the environmental quality, the mean score of each group is quite concentrated, which shows the similar assessments of the surveyed people for the variables of the same factor. The average scores of all three groups range from 2.59 to 2.94, showing the assessment of the occurrence of pollution but not too much impact on the people's quality of life. For the expectation purpose of environmental quality, the average score spectrum of the surveyed people for the two groups ranges from 3.76 to 4.02 which shows that people's great concern about environmental quality, especially the variables in factors 1 and 2.

The rejected variables have a fairly high mean score spectrum (from 2.56 to 3.24 for the assessment's purpose, and 3.80 to 3.90 for the expectation's purpose), which shows the respondents' opinion about the large influence of these variables. These variables are excluded due to violation of the principle of not being uploaded to more than 1 group or having unclear loading factors for different factors. Therefore, we believe that these variables should be kept in further extended studies to have a better evaluation of the model.

3.1.2. Affecting conditions including age, location and gender to the results

After conducting the normality test (Q−Q plot) which the results of all the variables are satisfactory, the chosen variables (Table 4) were then applied One–way ANOVA statistical test in term of age and location (Table 5).

Table 5. Sig. index results of One–way ANOVA statistical test of age groups and ward groups (statistically significant level α at 0.05).

Variable's label	**Sig.index of ANOVA test of the three age groups:** * Group 1: less than 30 * Group 2: from 30 to 50 * Group 3: more than 50		**Sig.index of ANOVA test of 10 ward groups** (Ben Nghe, Ben Thanh, Co Giang, Cau Kho, Cau Ong Lanh, Da Kao, Nguyen Cu Trinh, Nguyen Thai Binh, Pham Ngu Lao, Tan Dinh)	
	Statistical Differences (sig.< α)	**Not Statistical Differences (sig.> α)**	**Statistical Differences (sig.< α)**	**Not Statistical Differences (sig.> α)**
1. Surveyors' assessment on environmental quality – Factor 1				
C17		0.696	0.000	
C118		0.205	0.000	
C119		0.450	0.000	
C120		0.523	0.000	
C122		0.127	0.000	
C123		0.139	0.000	
C124	0.027		0.000	
1. Surveyors' assessment on environmental quality – Factor 2				
C11	0.003		0.000	
C12	0.000		0.000	
C14	0.040		0.000	
C15	0.033		0.000	
C16	0.005		0.000	
C18	0.002		0.000	
1. Surveyors' assessment on environmental quality – Factor 3				
C111		0.853	0.000	
C112		0.780	0.000	
C113		0.921	0.000	
C115	0.035		0.000	
C117		0.293	0.000	
2. Surveyors' expectation on environmental quality – Factor 1				
C22		0.186		0.137
C23		0.725		0.068
C24		0.127		0.098
C25		0.697	0.001	
C26		0.950	0.001	
C27		0.981	0.000	
C28		0.903	0.002	
C29		0.843		
2. Surveyors' expectation on environmental quality – Factor 2				
C216		0.437		0.099
C217		0.267	0.024	
C218		0.282	0.001	
C219		0.313		0.163
C220		0.232	0.005	
C221		0.313	0.012	
C222		0.921	0.042	

Variable's label	Sig.index of ANOVA test of the three age groups: * Group 1: less than 30 * Group 2: from 30 to 50 * Group 3: more than 50		Sig.index of ANOVA test of 10 ward groups (Ben Nghe, Ben Thanh, Co Giang, Cau Kho, Cau Ong Lanh, Da Kao, Nguyen Cu Trinh, Nguyen Thai Binh, Pham Ngu Lao, Tan Dinh)	
	Statistical Differences (sig.< α)	**Not Statistical Differences (sig.> α)**	**Statistical Differences (sig.< α)**	**Not Statistical Differences (sig.> α)**
C223		0.342		0.088
C224		0.714	0.000	
C225		0.329	0.015	
C226		0.356	0.001	

Considering the three different age groups, the results of the expectation varibles showed similarity among the groups. However, for the assessment perspective, results revealed diffences in assessment groups of factor 2, variable C124 of factor 1, and variable C115 of factor 3. For the survey location factor, the survey groups of 10 different wards of District 1 answered differently about the pollution status, as shown by the zero-sig index of all the assessment variables of the One−way ANOVA statistical test. As for the desired variables, most of the answers are significantly different among the 10 survey groups of various wards. Only a few variables showed similarity in the responses of 10 survey groups, including C22 (Soil pollution not presented or limited), C23 (High percentage of green area), C24 (Good quality of supply water). C216 (Noise from transportation not presented or limited), C219 (The odor of raw waste not presented or limited), C223 (Low volume of generated waste)

On the contrary, the results of the two independent samples t−test of the two gender groups (male and female) revealed that there was no difference among the answers in most of the questionnaires (Table 6). Statistically different responses were C12 (Soil pollution presented), C14 (Poor quality of supply water) and C113 (Poor surrounding green area). For these three variables, the female tends to give higher scores than the male, which may indicate that the female's statements about the pollution status of these variables are more severe than the male.

Table 6. Sig. index results of independent statistical t−test of male/female groups (statistically significant level α at 0.05).

Variable's label	Male (N = 108)		Female (N=125)		Statistical Differences (sig.< α)	Not Statistical Differences (sig.> α)
	Mean	**StdDev**	**Mean**	**StdDev**		
1. Surveyors' assessment on environmental quality – Factor 1						
C17	2.86	0.990	3.01	0.996		0.261
C118	2.78	0.931	3.01	0.875		0.053
C119	2.78	0.960	2.82	1.100		0.735
C120	2.78	0.970	2.83	0.905		0.659
C122	2.69	0.954	2.86	1.019		0.170
C123	2.78	1.017	2.90	1.030		0.381
C124	2.88	1.011	2.99	0.920		0.376
1. Surveyors' assessment on environmental quality – Factor 2						
C11	2.48	1.054	2.68	1.182		0.180
C12	2.52	1.018	2.81	1.090	0.038	
C14	2.44	1.061	2.74	1.165	0.042	
C15	2.65	1.017	2.87	10.70		0.105
C16	2.75	0.987	2.81	1.127		0.679
C18	2.76	0.906	2.87	1.047		0.384

Variable's label	Male (N = 108) Mean	StdDev	Female (N=125) Mean	StdDev	Statistical Differences (sig.< α)	Not Statistical Differences (sig.> α)
1. Surveyors' assessment on environmental quality – Factor 3						
C111	2.63	1.064	2.68	1.097		0.723
C112	2.52	1.037	2.62	1.162		0.503
C113	2.59	0.886	2.89	0.900	0.013	
C115	2.70	1.044	2.84	0.893		0.284
C117	2.69	0.891	2.70	1.064		0.990
2. Surveyors' expectation on environmental quality – Factor 1						
C22	3.90	0.723	3.93	0.825		0.771
C23	3.86	0.703	3.82	0.794		0.708
C24	4.01	0.619	4.02	0.735		0.870
C25	4.01	0.555	3.92	0.852		0.350
C26	3.87	0.685	3.83	0.905		0.719
C27	3.82	0.895	3.82	0.984		1.000
C28	3.88	0.770	3.89	0.900		0.940
C29	3.83	0.952	3.80	1.024		0.798
2. Surveyors' expectation on environmental quality – Factor 2						
C216	3.85	0.905	3.76	1.011		0.469
C217	3.81	0.866	3.71	1.030		0.415
C218	3.78	0.868	3.77	0.952		0.935
C219	3.84	0.929	3.86	0.970		0.864
C220	3.91	0.933	3.82	1.040		0.523
C221	3.95	0.813	3.83	0.922		0.290
C222	3.96	0.784	3.83	0.881		0.231
C223	3.89	0.824	3.83	0.905		0.618
C224	3.80	0.915	3.73	1.042		0.598
C225	3.86	0.841	3.78	0.966		0.485
C226	3.90	0.937	3.78	1.028		0.380

3.2. Discussion

After testing for 26 surveying variables in 7 initial groups with the EFA model, the results obtained are 18 variables categorized into 3 groups for environmental quality assessment; and 18 variables allocated into 2 groups for environmental quality's expectation. Groups of variables and interpretations are presented in Table 7.

The results of the EFA model have significantly reduced the dimension of the survey questionnaire, from initially 7 groups and 26 variables to 3 groups and 18 variables for the assessment target) and 2 groups (for expectation target). Unrelated variables have also been omitted by the model, including 8 variables in each assessment and expectation purposes. The results from the PCA extraction model always show a higher factor loading and a greater number of retained variables than PAF. However, the PAF showed a clearer distinction among groups and therefore the subgroup results were also more discriminatory.

4. Conclusion

The study results show that the EFA model have narrowed and clarified the respondents' assessments of environmental quality in the area divided into 3 groups, along with expressing people's expectations about environmental quality divided into 2 groups. The results of this model can serve as a baseline study, and as a reference for building public opinion survey models at an expanded level and more focused on variables that have been kept by EFA model. This EFA result can also serve as a theoretical model of people's evaluation factors and expectations about environmental quality, thereby becoming an important input in a Confirmatory factor analysis model, which is a tool used to confirm or disprove a measurement theory.

Besides, although groups of gender have similarity in the responses, the influence of individual factors such as age, living and working location greatly affects the survey results. Therefore, these factors need to be considered, included in a detailed survey plan, and carefully analyzed to develop appropriate environmental protection and management strategies for the area.

Table 7. Grouping results on quality of the living environment.

1. Surveyors' assessment on environmental quality	
Factor 1	
C17	Poor drainage condition
C118	Noise from construction activities present
C119	The odor of untreated waste presented
C120	The odor of sewer presented
C122	The odor of solid waste transfer stations and landfills presented
C123	High volume of generated waste
C124	Waste is not fully classified
Factor 2	
C11	Subsidence conditions presented
C12	Soil pollution presented
C14	Poor quality of supply water
C15	Poor quality of natural water
C16	Pollution of surface water and groundwater presented
C18	High level of groundwater extraction
Factor 3	
C111	Pollution from business establishments presented
C112	Pollution from outdoor burning of coal, garbage, or items presented
C113	Poor surrounding green area
C115	The openness of the surrounding environment is not presented or limited
C117	Noise from business activities presented
2. Surveyors' expectation on environmental quality	
Factor 1	
C22	Soil pollution not presented or limited
C23	High percentage of green area
C24	Good quality of supply water
C25	Good quality of natural water
C26	Pollution of surface water and groundwater not presented or limited
C27	Good drainage condition
C28	Low level of groundwater extraction
Factor 2	
C216	Noise from transportation not presented or limited
C217	Noise from business activities not presented or limited
C218	Noise from construction activities not presented or limited
C219	The odor of untreated waste not presented or limited
C220	The odor of sewer not presented or limited
C221	The odor of production and business activities not presented or limited
C222	The odor of solid waste transfer stations and landfills not presented or limited
C223	Low volume of generated waste
C224	Waste is fully classified
C225	High percentage of waste not collected/recycled at home/office
C226	Pollution from the litter on the streets is not presented or limited

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