

## Article

# Impact of Building Environment on Residential Satisfaction: A Case Study of Ningbo

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**Abstract:** Population distribution has a huge influence on the development of port economic circle (PEC) in Ningbo. Residential satisfaction is one of key elements that determine housing location choice and, thus, the success of population distribution policy. To provide suggestions for the development of PEC, this study conducted a survey to investigate residential satisfaction and related factors in 11 port communities, which are located in the harbour area of Beilun, Zhenhai and Meishan in Ningbo. A total of 403 valid samples were collected through face-to-face interviews. The Likert scale was used to express satisfaction levels, with the highest level of 5 and the lowest level of 1. The survey data indicate that the mean value of residential satisfaction is 3.41, 3.40 and 3.49 in Beilun, Zhenhai and Meishan, respectively. Middle level residential satisfaction is noted in the port communities of Ningbo. A linear regression was performed to analyse the relationship between residential satisfaction and influence factors in terms of the demographic and socioeconomic features of the respondents and attributes of the house and neighbourhood. The results of the regression analysis show that household income, design of housing, type of community, population density and distance to the district commercial centre are the most influential factors of residential satisfaction. The findings suggest making regulations to enforce the design standards of new buildings. Moreover, measures to improve the accessibility and quality of public facilities and services in the communities should be encouraged to increase the attractiveness of neighbourhoods in the port area. Promoting land use with mixed commercial and residential functions is also suggested for the development of PEC.

**Keywords:** residential satisfaction; neighbourhood; port community; survey; Ningbo

## 1. Introduction

The rapid urbanisation and population concentration make urban development a crucial element affecting the long-term outlook of civilisation. Increasing income and vehicle ownership have made it possible for many families housed in suburban areas, resulting in the decentralisation of metropolitan areas [1]. There is an argument that efficient land use and land preservation are most environmentally effective now. The pattern of compact development has been gradually encouraged, which is believed to promote more efficient use of land and infrastructure [2–4].

As an important economic centre in the southern part of the Yangtze River Delta, the development of Ningbo is expected to be much denser, and the transport networks to be more efficient. It takes two

hours from Shanghai to Ningbo by bullet train. Ningbo has an area of 9816 square kilometres and a population of 8 million in 2017. It comprises the urban districts of Ningbo metropolitan, three satellite cities and a number of rural counties, including islands in Hangzhou Bay and the East China Sea. Ningbo has rich sea resources, with a sea area of 8355.8 square kilometres and coastline of 1594.4 km [5].

Ningbo-Zhoushan Port is one of the top five major ports in the world. It is one of China's major international cargo and container shipping ports and an important transshipping base for iron ore, crude oil, liquid chemicals, coal and crops in East China. In 2016, the total container throughput of Ningbo-Zhoushan Port is 21.56 million twenty-foot equivalent units (TEUs) [5]. The port industry and services are one of the major contributors to the economy of Ningbo. The annual shipping e-commerce turnover is expected to 50 billion yuan. The ship trade volume will reach 6 billion yuan, and the shipping insurance volume will reach 6 billion yuan in 2020 [6].

Considering the importance of the port and related industry, port economic circle (PEC) development has been promoted by the Ningbo municipal government since 2014. The port economic circle is a regional economic zone with mutual coordination, organic integration and common development in economic, social, cultural and ecological aspects. As the centre of Ningbo-Zhoushan Port, PEC is developed to build a port industrial chain through a background of a comprehensive transportation system and developed hinterland. Ningbo has been developing rapidly as 1 of 15 subprovincial cities designated by Chinese government ordinance since 1994. Now, it is undergoing a transition to Ningbo PEC development on the background of "One Belt One Road". This transition is bringing changes to the urban spatial distribution of the population, employment, land use and travel patterns. Residential satisfaction is an assessment of the extent to which the present dwelling of residents and the quality of the environment are close to aspiration of their ideal dwelling [7]. Therefore, to promote the development of PEC, it is essential to understand the residential satisfaction of residents before conducting urban planning in the main harbour area.

This paper aims to investigate the residential satisfaction and influential factors based on a survey in port communities of Ningbo. We would like to discuss the relocation strategies from the viewpoint of residential satisfaction. The paper begins with an introduction of the background and a literature review. Section 3 indicates the process of the survey in port communities of Ningbo. Descriptive analysis results of the survey data are provided in Section 4. Influence factor analysis results are presented in Section 5. Finally, the conclusion is given in Section 6.

## 2. Literature Review

Although a body of literature has analysed the effect of compact development policy [8–10], little attention has been focused on the acceptability of it. There is a cost for residents moving into high-density areas, such as smaller home, small office at work, less open space, more noise and possibly higher crime rate. However, there are also benefits, such as high accessibility to public transport, lower operational energy demand and more opportunities for walking. Residents balance the benefits and losses of the lifestyle in a compact environment. Residential satisfaction with house and neighbourhood definitely influence the relocation willingness and, thus, the success of the compact development policy. It is essential to investigate the residential satisfaction of residents to discover the key influential factors.

Researchers investigated residential satisfaction either with the living environment or the building unit. There are two groups of studies. One group investigated residents' preferences towards different types of neighbourhoods through model simulation. Modelling the residential location choice is a primary concern. Residential location modelling could be traced back to land use modelling by Von Thunen (1826). He explained the effect of transport costs on activity locations and the land market in an agricultural region [11]. Alonso (1964) applied this model in a monocentric city and found that households chose their residential location by maximising a utility function depending on expenditure in goods, the size of the land lot and the distance to the city centre [12]. Later, studies described the residential satisfaction with the introduction of the discrete modelling framework [13–15]. This

framework quantifies the impact of different types of residential locations and their interaction with household characteristics. The residential satisfaction in residential locations were found be sensitive to socioeconomic characteristics, such as educational attainment, income, household tenure (rent or own), important events in the life cycle (particularly childbirth) and environmental awareness [16,17].

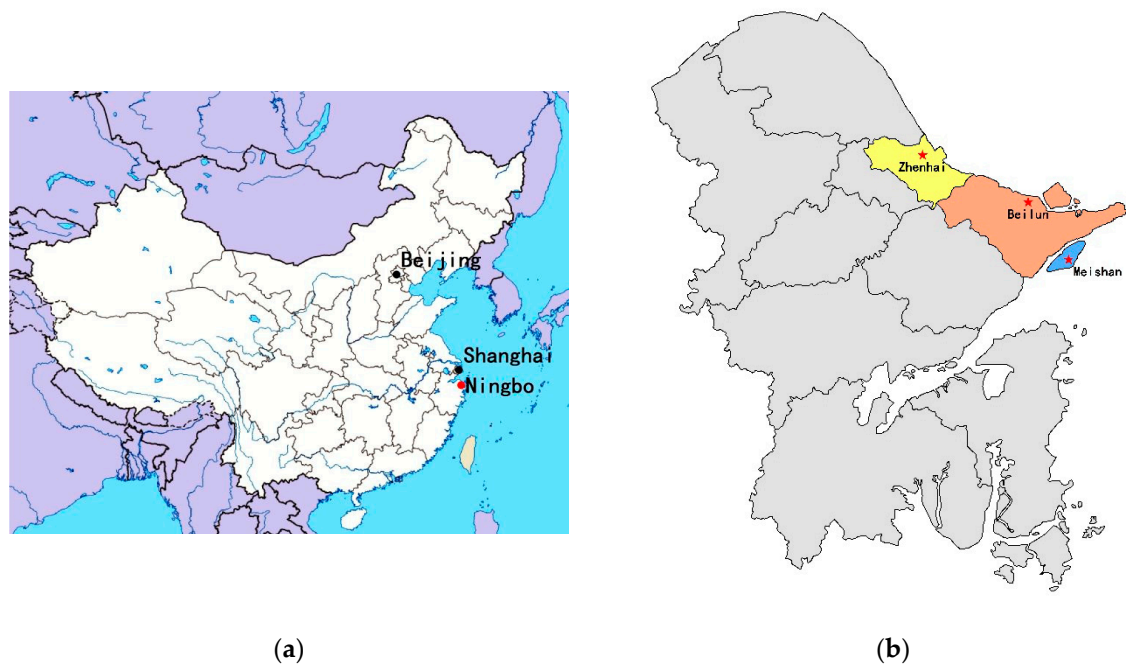
Except for residential location choice models, increasing attention has been focused on surveys to investigate influential factors of residential satisfaction in empirical cases [18]. By analysing the behaviours of residents who moved into high-density residential environments in the central area of Dublin city, Howley (2009) found that most residents prefer lower density locations, which call for more efforts for the long-term success of urban intensification [19]. Using a large-scale household survey and aggregated census data from Beijing, Wu et al. (2013) developed a framework to empirically measure the relative impact of location characteristics versus individual characteristics in determining the residential location choices of households. The local public goods accessibility was a significant factor for determining choices [20]. Tian et al. (2014) designed a stated-choice experiment, in which respondents were asked to choose housing scenarios with different attributes and prices. Results indicated that all respondents prefer living closer to workplaces or other destinations. In single-family neighbourhoods, residents prefer locations with parking in their own driveway on a street designed for cars/pedestrians/bicycles and close to transit [21]. Drawing upon a stated-preference survey in the Wasatch Front region in Utah, Liao et al. (2015) identified significant heterogeneity in residential location preferences over compact, walkable and transit-friendly neighbourhoods [22].

Although lots of studies performed a deep investigation on residential satisfaction and a simulation of housing location choice behaviours, most work has focused on residential location behaviour in different city backgrounds. Residential satisfaction is the initial cause for the behaviours associated with residential location, which is the core point of population distribution. He and Qi (2014) found that residential satisfaction was an important factor influencing residents' intention to move [23]. It is accepted that population distribution plays an important role towards dense development. Therefore, more empirical cases should be studied to provide a deeper understanding of the residential satisfaction in different country and city backgrounds. Findings would give more cues for exploring the mechanism of housing location choice behaviour, which is the key element for urban planning policy.

### 3. Survey

#### 3.1. Study Area

A survey was conducted in the main harbour area of Ningbo-Zhoushan Port. Zhenhai Harbor Area and Beilun Harbor Area are the traditional harbour areas. Meishan Free Trade Zone was also investigated. Although it is new, the Meishan Free Trade Zone is the fifth free trade zone approved by Chinese central government in 2008. Figure 1 shows the location of the main harbour area of Ningbo-Zhoushan Port. Zhenhai Harbor Area, Beilun Harbor Area and Meishan Free Trade Zone are henceforth shortened as Zhenhai, Beilun and Meishan.



**Figure 1.** (a) Location of Ningbo in China; (b) Location of the main harbour area in Ningbo.

### 3.2. Sampling Technique and Investigated Port Communities

We employed multistage sampling techniques for sampling. There are four subdistricts (Jiedao) in Zhenhai, 11 subdistricts (Jiedao) in Beilun and 1 subdistrict (Jiedao) in Meishan. At the first stage, we chose the subdistricts that have the least distance to the harbour operational zone, considering the influence of the harbour. Second, each type of communities was chosen from the selected subdistrict. A simple random sampling method was used to select a community out of each type of community from the selected Jiedao. Last, we selected households randomly from each community and determined the sample size. Hence, sample sizes of 120 households ( $1 \text{ district} \times 4 \text{ Jiedao} \times 30 \text{ household heads} = 120$ ) were selected from Zhenhai. Likewise, a similar proportion of Jiedao and households were taken from Beilun. Meishan is a new development core of the PES of Ningbo. More samples were selected to obtain a greater understanding of the residential satisfaction in Meishan. We investigated 230 households in two communities located in Meishan Jiedao, and one community in Chunxiao Jiedao near Meishan. The sample size of the survey is designed as 470 subject households.

There are four types of communities in the port economic circle, namely, commercial housing community (CH, building in real estate company real estate zone), company-funded housing community (CFH, building in the state-owned company real estate zone), resettlement housing community (RH, building in the resettlement project real estate zone), and the self-built housing community (SBH, building in rural residence base zone). The commercial housing community is dominated by high-rise and compound apartments. This kind of community is developed by real estate companies. Individuals could obtain the ownership of apartments through commercial purchase from real estate companies. A company-funded housing community is characterised by residential buildings that are funded by state-owned companies rather than real estate companies. The company builds the apartments for its employees. Multi-storied buildings are the main type of housing in company-funded housing communities. A resettlement housing community is used to accommodate residents whose original real estate has been expropriated by the government. New apartments are built to resettle them in resettlement real estate zones by the government. Residents buy resettlement housing at a lower price with a subsidy from the government. Multi-storey buildings and high-rise buildings are the two main types of housing in the resettlement housing community. A self-built housing community is located in the suburban area. It is dominated by low block/buildings, such as a

low-rise apartment house, which is built by residents themselves. However, due to rapid urbanisation, it is becoming a mixture of low-rise apartment houses and high-rise buildings.

A total of 11 port communities are investigated. There are 6 CH communities, 3 RH communities, 1 CFH community, and 1 SBH community. Community samples in this study covered all four types. Moreover, the sample number rate of each type of community was determined based on the real market percentage. For example, CH communities have dominated the main percentage of housing types since the marketisation reform of the real estate market in China. Nearly half of the investigated communities are CH. Community samples are representative for different building environments and socioeconomic attributes. Communities are chosen based on different community population density, different floor area ratio and geographic position. Housing samples are representative of different ownership, building year, price and floor area.

### *3.3. Questionnaire Design and Survey Conduction*

The questionnaire includes four parts. The first part includes household individuals' demographic and socioeconomic condition, including gender, age, education level, income, occupation and family size. The second part investigates the characteristics of the housing and neighbourhood conditions, including house type, price and floor area, amongst others. The third part reflects the resident's satisfaction with the residential housing and neighbourhood. The Likert scale is used to express the satisfaction levels. The last part investigates the influence of port harbour operation on residential satisfaction.

This study employed qualitative research techniques that involved the collection of data through personal interviews. This method is effective for data collection as it gives an opportunity for feedback between researchers and respondents. The final survey was conducted by face-to-face interview with 470 individuals. The interviewed respondents were randomly selected from residential communities. The response rate was 90%, but some did not answer the complete survey or misunderstand the meaning of some choices. Thus, the final data bank had 422 observations where 403 completed all questions. Finally, we collected 403 valid samples. Based on the method of Rose and Bliemer [24], a minimum of 385 responses was required for the survey. Our figure was comfortably exceeded, and the sample size was considered adequate for analysis.

## **4. Data Analysis**

### *4.1. Demographic and Socioeconomic Features of Respondents*

Table 1 illustrates the demographic and socioeconomic features of the respondents. Out of 403 respondents, 52.6% were male and 47.4% were female. We investigated the individuals who were older than 20. Among them, young adults and elders accounted for a small percentage. Neither of them is larger than 10%, while individuals aged between 30 to 60 dominated the main percentage of respondents, at 82.9%. More than half of the respondents have an education background of college or a bachelor's degree. Nearly one-third of respondents have been educated at high school or middle school while 4.7% have a master's or doctoral degree.



**Table 1.** Basic social demographic information of respondents.

Variable	Attribute	Percentage (%)	Mean	Std. Dev.
Gender	Male	52.6	1.47	0.5
	Female	47.4		
Age	20–30 years	8.9	2	0.747
	30–45 years	59.3		
	45–60 years	23.6		
	>60 years	8.2		
Education	High school or less	31.5	2	0.556
	College and Bachelor	63.8		
	Master and Doctor	4.7		
Occupation	Workers in private companies	35.5	2.46	1.327
	Employee in state-owned companies, government and public institutions	23.3		
	College students	1.2		
	Self-employed	40		
Household income	<50,000 yuan/year	18.1	2.52	1.054
	50,000–100,000 yuan/year	31.8		
	100,000–240,000 yuan/year	35.2		
	240,000–420,000 yuan/year	9.9		
	>420,000 yuan/year	5		
Family size	Single	3.2	3.07	0.735
	Married without child	13.2		
	Married with one child	56.6		
	Married with two children	27		

Four types of occupations were investigated, which were indicated as employees in private companies, state-owned companies, the government, or public institutions, as well as college students and free self-employed individuals. Shown in Table 1, workers in private companies and self-employed individuals dominated the main part of respondents, which were indicated as 35.5% and 40%, respectively. Of the respondents, 23.3% are employees in state-owned companies, government, and public institutions. College students accounted for the least percentage, at 1.2%. Based on the survey data of the household income, it was shown that 67% of respondents have an annual household income between 50,000 to 240,000 yuan, which is 7142 to 34,285 dollars each year (currency rate at 1 dollar = 7 yuan). The lower income group was indicated as earning less than 50,000 yuan/year, which was 18.1%. The high-income group was indicated as earning more than 420,000 yuan/year, which was 5%. In China, the family size is small because of the birth control policy. Of the respondents, 56.6% have a family with one child, while 27% have a family with two children.

#### 4.2. Housing and Neighbourhood Attributes

We investigated the housing attributes from the aspects of ownership of house, building year, floor area and price. Based on the data in Table 2, it is shown that most respondents have ownership of the house. The ownership rate reaches to 93% in Beilun and Meishan. Around 75.8% of respondents in Zhenhai have ownership of the house, compared to 25.2% living in leasehold houses. In Zhenhai, there are many famous middle schools in the district. People rent houses near these schools to accommodate their child who studies at the school. Older houses are also shown in Zhenhai. The building years of the houses range from 1990 to 2010, with a mean value of 1995. In Beilun and Meishan there are more new buildings. Especially in Meishan, most buildings were built in last five years as it is a new free trade zone. Four ranks of floor areas are indicated. As shown in Table 2, small houses are noted in Zhenhai, where 40% of houses have a floor area less than 60 m<sup>2</sup>. The percentage of this small type of house reduces to 5.9% in Beilun and 0.5% in Meishan. Respondents in Beilun have larger houses with a mean floor area of 90–130 m<sup>2</sup>. Houses with a floor area between 90 to 120 m<sup>2</sup> are popular in

Meishan. In Table 2, price means the average price of houses in the investigated communities. The highest housing price is shown in Beilun, with a mean value of 19,413 yuan/m<sup>2</sup>. The gap in housing prices in Beilun is very large, with the price varying between 14,424 yuan/m<sup>2</sup> to 26,665 yuan/m<sup>2</sup>. Due to the influence of the housing floor area and the building year, the housing price in Zhenhai shows the median average value as 12,783 yuan/m<sup>2</sup>. The lowest housing price is shown in Meishan, with a mean value of 11,441 yuan/m<sup>2</sup>. Undeveloped public facilities and the long distance to the district commercial centre has created a low housing price in Meishan.

**Table 2.** Housing and neighbourhood attributes.

Attribute	Variable	Harbour Area	Minimum	Maximum	Mean	Std. Dev.
Housing attribute	Ownership (own = 1, rent = 2)	Beilun	1 (93.1%)	2 (0.79%)	1.07	0.254
		Zhenhai	1 (75.8%)	2 (25.2%)	1.24	0.431
		Meishan	1 (93.1%)	2 (6.9%)	1.07	0.255
	Building year of house	Beilun	2009	2002	2005	2.6
		Zhenhai	1990	2010	1995	6.147
		Meishan	2012	2015	2012	1.405
	Floor area (1: <60 m <sup>2</sup> ; 2: 60–90 m <sup>2</sup> ; 3: 90–130 m <sup>2</sup> ; 4: >130 m <sup>2</sup> )	Beilun	1 (5.9%)	4 (37.3%)	3.17	0.822
		Zhenhai	1 (40.4%)	4 (2.0%)	1.76	0.744
		Meishan	1 (0.5%)	4 (17.8%)	2.94	0.651
	Price (yuan/m <sup>2</sup> )	Beilun	14,424	26,665	19,413	4818
		Zhenhai	11,034	14,792	12,783	1330
		Meishan	8948	13,474	11,441	1906
Community attribute	Community type (CF = 1, CFH = 2, RH = 3, SBH = 4)	Beilun	1 (49%)	4 (21.6%)	2.24	1.268
		Zhenhai	1 (43.4%)	3 (26.3%)	1.83	0.821
		Meishan	1 (65.3%)	3 (34.7%)	1.35	0.477
	Population density (person/km <sup>2</sup> )	Beilun	17,572	22,000	19,330	1769
		Zhenhai	15,994	19,400	18,210	1340
		Meishan	9098	15,558	12,194	2619
	Floor area ratio	Beilun	1.4	2.3	1.95	0.366
		Zhenhai	Null	Null	Null	Null
		Meishan	0.7	1.5	1.13	0.332
	Distance to district commercial centre (km)	Beilun	0.2	2.7	1.43	1.009
		Zhenhai	0.5	1.6	1.18	0.43
		Meishan	2.5	11.5	5.87	4.11
	Distance to harbour working zone (km)	Beilun	2.7	6.1	4.8	1.187
		Zhenhai	1	3	2.14	0.933
		Meishan	2.8	9.5	6.88	3

Note: () indicates the percentage of the value, Null means data is missing.

We investigated the community attributes from the aspects of community type, population density, floor area ratio, distance to district commercial centre and distance to the harbour operation zone. Based on data in Table 2, it is shown that half of the investigated communities are commercial housing communities. The highest population density of community is shown in Beilun communities as 19,330 person per square kilometre. A low population density of communities is noted in Meishan, with mean value of 12,194 person/km<sup>2</sup>. Beilun and Zhenhai are developed districts with high population density communities. Meishan is a new district with fewer residents. The floor area ratio reflects the building density. A high floor area ratio means high and dense buildings. Compared to Meishan, Beilun shows a high floor area ratio. The value of the floor area ratio is missing in Zhenhai because such data is missing for buildings built before 2000. There are commercial centres in Beilun and Zhenhai. The average distance to the district commercial centre in Beilun and Zhenhai is 1.43 and 1.18 km, respectively, whereas the value increases to 4.11 in Meishan because it is a developing area. The distance from the investigated communities to the harbour working zone is 4.8, 2.14 and 6.88 km in Beilun, Zhenhai and Meishan, respectively.

#### 4.3. Residential Satisfaction and Other Kinds of Satisfaction

The Likert scale was used to express the satisfaction levels, with the highest level of 5 and lowest level of 1. The mean value of residential satisfaction was 3.41, 3.40 and 3.49 in Beilun, Zhenhai and Meishan, respectively. The highest residential satisfaction was found in Meishan. Respondents in Zhenhai showed lower residential satisfaction. However, the difference in residential satisfaction among three harbour areas was not significant, as indicated by a significance level of 0.447.

We also investigated other kinds of satisfaction from the aspects of housing price satisfaction (HPS), building environment satisfaction (BES), nearby medical service satisfaction (MSS), nearby education service satisfaction (ESS), nearby shopping service satisfaction (SSS), public transport service satisfaction (PTS), and community culture satisfaction (CCS). Figure 2 illustrates these seven types of satisfaction in Beilun, Meishan and Zhenhai. Compared to Beilun and Zhenhai, high housing price satisfaction is found in Meishan. As a negative effect of the housing price, Beilun and Zhenhai have a low HPS (less than 3). The building environment satisfaction means satisfaction with the facility and services in the community. BES had a similar value, which was indicated as 3.25. We focus on four groups of facilities and services that are closely related to residential satisfaction. The first is medicine service satisfaction. Beilun and Zhenhai indicate around 3.5 for MSS. However, the mean value of MSS reduces to 2.75 in Meishan. Fewer hospitals and clinics lower the quality of service, which may contribute to the low MSS value in Meishan. Education service satisfaction is higher than MSS, which was indicated as high as 3.7 in three areas. There was no significant difference among the ESS values. Respondents have high satisfaction with shopping and public transport services. The values SSS and PTS are larger than 3.75 in three areas. Meishan shows a relatively low SSS and PTS compared to Beilun and Zhenhai. However, high satisfaction with the community culture is indicated in Meishan. A lower CCS is found in Beilun and Zhenhai.

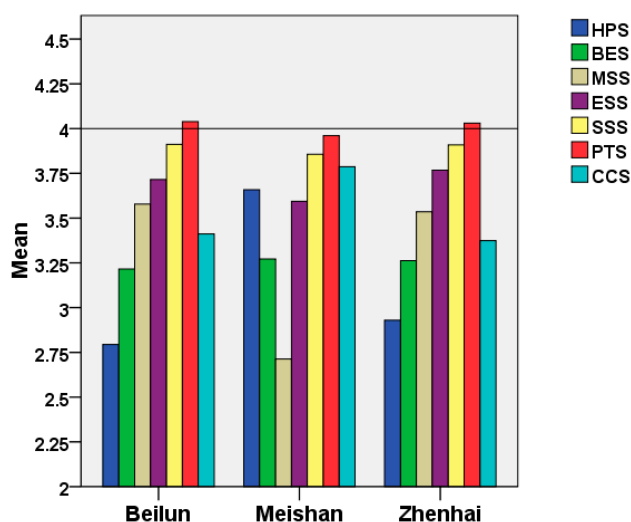


Figure 2. Seven kinds of satisfaction in three harbour areas.

#### 5. Influence Factors of Residential Satisfaction

Empirical studies have identified a number of important factors that influence residential satisfaction. In general, these factors can be grouped into three categories [25]. First, residential satisfaction is affected by respondents' socioeconomic status, such as age, education, gender, marital status, race and income. A second set of factors of residential satisfaction includes housing characteristics, such as housing size, housing price, building design and physical conditions. Third, neighbourhood characteristics also affect residential satisfaction. This study also analyses the influence of these factors on residential satisfaction in Ningbo.



### 5.1. Socioeconomic Factors of Respondents

The effect of socioeconomic factors of individuals on residential satisfaction was analysed by the ordinary least square (OLS) regression method for 403 valid samples in Ningbo. The regression analysis was performed by SPSS software. Table 3 lists the estimation results. The model value of  $F$  was 7.195, which indicated that a linear relationship between socioeconomic factors and residential satisfaction could not be rejected at the  $p < 0.01$  level. Relatively weak estimation power was indicated with a pseudo  $R$ -square of 0.336. The variance inflation factor (VIF) was also analysed to check the multicollinearity. If the (VIF) value is larger than 10, multicollinearity is supposed. The VIFs were suggested by the value of the condition number, and there was no multicollinearity among the variables. Considering the difference in the units of variables, standardised coefficients are used to show the relative influence of each variable.

**Table 3.** Linear regression analysis of socioeconomic factors of individuals influencing residential satisfaction in Ningbo port communities.

Variables	Standardised Coefficients	Std. Error	t	Sig.	VIF
Gender	0.102	0.077	2.114	0.035*	1.035
Age	0.092	0.056	1.748	0.081	1.221
Education	0.086	0.080	1.531	0.127	1.393
Occupation	0.066	0.029	1.352	0.177	1.073
Household income	0.266	0.039	5.132	0.000**	1.200
Family size	−0.046	0.054	−0.933	0.351	1.097

Note: Dependent variable is residential satisfaction; \* significant level at 0.05, \*\* significant level at 0.01; VIF, variance inflation factor.

As shown in Table 3, all variables except family size were found to have a positive relationship with residential satisfaction. The larger family size reduces residential satisfaction. Rossi also found that the household size led to residential dissatisfaction [26]. However, the influence of family size is not significant in this study. Residential satisfaction is higher for individuals who have a high education background and high household income. Meanwhile, residential satisfaction improves with increasing age. Lovejoy et al. also found that older respondents in California tend to be more satisfied with their neighbourhoods [27]. Women were found to be more satisfied with their residential environment compared to men. Types of occupation have an influence on residential satisfaction. Self-employed employees were found to be most satisfied. The flexibility of their free time makes their arrangement more satisfactory. Moreover, they chose their residential communities more carefully because they may spend more time in their communities for both working and living. Among the positive variables, gender and household income were found to be significant at the 5% level and 1% level, respectively. This means that female individuals with a high household income have higher residential satisfaction in Ningbo port communities. One possible reason is that women have a better understanding of their community because they use facilities and services in the community frequently. In China, they take on more duties such as housework and child care. Meanwhile, the high household income makes it is possible for individuals to enjoy the high quality of services, which is attributed to the high residential satisfaction. In other studies, respondents with higher income tend to be more satisfied with their residence [28].

### 5.2. Factors of Building Environment

The influence of the building environment is analysed based on housing and neighbourhood factors. The effect was also analysed by the ordinary least square (OLS) regression method by SPSS software for 403 valid samples in Ningbo. Table 4 lists the estimation results. The  $F$  value of the model is 49.9, which indicates that the linear relationship between housing and neighbourhood factors and

residential satisfaction could not be rejected at the  $p < 0.01$  level. The model shows strong explanatory power with a pseudo  $R$ -square of 0.730. As suggested by VIFs and the value of the condition number, there is no multicollinearity among variables. Considering the difference in the units of variables, standardised coefficients are used to show the relative influence of each variable.

**Table 4.** Linear regression analysis of housing and neighbourhood factors influencing residential satisfaction in Ningbo port communities.

	Standardised Coefficients	Std. Error	t	Sig.	VIF
Housing price	0.072	0.000	1.303	0.193	2.542
Ownership of the house	0.063	0.112	1.624	0.105	1.253
Floor area	0.035	0.051	0.681	0.496	2.178
New level of building	0.108	0.045	2.226	0.027*	1.977
Design of building	0.292	0.049	6.211	0.000**	1.859
Type of community	−0.221	0.041	−5.462	0.000**	1.381
Population density	−0.275	0.000	−4.293	0.000**	3.449
Distance to district commercial centre	−0.484	0.019	−6.311	0.000**	4.957
Distance to port working zone	−0.072	0.018	−1.253	0.211	2.769

Note: Dependent variable is residential satisfaction; \* significance level at 0.05, \*\* significance level at 0.01.

Housing attributes have a significant impact on residential satisfaction. Studies in the literature have found that positive housing characteristics, including larger size and better housing facilities, are important factors for residential satisfaction [28–30]. In this study, although the floor area, housing price and ownership of the house are positively related to residential satisfaction, they are not important factors in Ningbo. It is interesting to note that a new level of building and design of buildings are significant factors. Building design, in particular, is the most influential determinant that affects residential satisfaction (with a  $p$ -value less than 1%). It seems that residents in Ningbo emphasise the quality of housing more than price and area.

The influence of the neighbourhood on residential satisfaction is strong. There are four variables to express the features of neighbourhood, indicated as community type, population density, distance to the district commercial centre and distance to the port working zone. All four variables are negatively related to residential satisfaction. Among them, the community type, population density and distance to the district commercial centre are the most influential determinants that affect residential satisfaction (with a  $p$ -value less than 1%). This finding is consistent with the result of other studies. Parkes et al. found that neighbourhood factors, especially the location and condition of the neighbourhood, are much more important in predicting residential satisfaction [31]. The regression result shows that residential satisfaction is significantly affected by the type of community, which supports the hypothesis that the determinants of residential satisfaction could be different depending on the community type. High housing price must be paid to buy houses in commercial housing communities due to the good quality of housing and the high level of service. The commercial housing community attracts wealthier residents. Facilities and good services are not sufficient in most of the self-built housing communities and resettlement housing communities compared to the commercial housing community. Residents in both communities are farmers and workers who are indigenous people in villages or small towns. Among the neighbourhood characteristics, the distance to the commercial centre factor has the largest standardised coefficient, followed by the population density. Residents prefer to live in a neighbourhood with a low population density. The commercial centre is a hot place for recreation for citizens. A shorter distance to the commercial centre will increase the accessibility of shopping facilities. However, people do not care much about the distance to the port working zone. The influence of the port working zone on residential satisfaction is insignificant. Compared to the commercial centre, the port has less influence on the residential satisfaction of residents.

## 6. Conclusions

The present study provides an empirical case study of residential satisfaction in the port communities of Ningbo. A survey was designed and conducted in 11 communities that are located in the port harbour area of Beilun, Zhenhai and Meishan, in 2018. These communities cover four types called the commercial housing community (CH), company-funded housing community (CFH), resettlement housing community (RH) and the self-built housing community (SBH). Among the 11 communities, there are 6 CH communities, 3 RH communities, 1 CFH community, and 1 SBH community. Respondents who were older than 20 were chosen randomly to answer the questionnaire. A total of 403 valid samples were collected through face-to-face interviews in these communities.

The OLS regression was performed by SPSS software to analyse influential factors of residential satisfaction based on survey data. The results suggest three findings. First, personal attributes, such as demographic and socioeconomic features, have an influence on residential satisfaction. Household income, occupation and education background have positive effects on residential satisfaction. Family size has a negative effect on residential satisfaction. Gender and household income are the most influential factors of residential satisfaction. Second, housing attributes were found to be influential on residential satisfaction. Although the housing price, ownership and floor area have an effect on residential satisfaction, new levels of the building and the design of the building are the most influential factors of residential satisfaction in Ningbo. Finally, it is important to consider the neighbourhood attributes. The type of community, population density and distance to the district commercial centre were found to be the most significant factors influencing residential satisfaction. However, the distance to the port working zones seems to have less influence on residential satisfaction.

Our research findings provide additional evidence of the residential satisfaction in port communities of Ningbo. By investigating the influence factors of residential satisfaction, the present study suggests three policy implications for improving the residential satisfaction in Ningbo. First, as new levels of the building and the design of the building are the most influential factors of residential satisfaction, housing renewal projects should be promoted in the harbour area of Ningbo-Zhoushan Port. Many traditional communities in the harbour area were built many years ago for the purpose of accommodating workers in the port, especially in Zhenhai. Meanwhile, regulations by government should be promoted to provide a housing design standard for real estate companies. In Ningbo, most commercial houses are designed by different companies with different standards. Regulations and standards of housing design of new residential buildings ensure the design and quality of housing, which are attributed to high residential satisfaction. Second, at the neighbourhood level, policies for improving the accessibility of facilities and services in the community, especially medicine services, are suggested. Meanwhile, promoting compact development in Ningbo needs to be reconsidered. A population density that is too high would reduce residential satisfaction, thus decreasing the number of residents who would like to relocate there. A proper population density should be suggested, based on both compact development and residential satisfaction. Finally, it is important to encourage the commercial development of harbour areas. Land use with mixed residential and commercial functions is suggested for the planning of port economic circle (PEC) in Ningbo.

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