

# Effects of Community Communication Technology (ICT) Usage on Community Satisfaction: Case Study in Nanjing, China

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**Abstract:** Future or smart community, which mainly refers to the development of community information and communication technology (ICT) platforms or devices, has received considerable attention from urban governments and scholars. However, only a few studies have been conducted to test the actual effects of using these community ICT platforms or devices on the community satisfaction of residents. Therefore, the present study conducts a survey in 40 communities in Nanjing, China and uses a mixed linear regression model to determine the relationship between community ICT usage and community satisfaction. Results indicate that residents with high-level community ICT usage are more satisfied with their community than those with low-level community ICT usage. Moreover, evident differences are observed regarding the influence of new commodity, old commodity and affordable housing communities in Nanjing. These findings are meaningful for the construction and development of future communities.

**Keywords:** community communication technology (ICT) usage; community satisfaction; types of communities; future community; Nanjing

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## 1 Introduction

The world urban population is expected to double by 2050, making urbanisation one of the most transformative trends in the 21st century (United Nations, 2017). Rapid urbanisation gives rise to a range of urban problems, including mismatched infrastructure, limited public service, social differentiation and injustice and urban crime. To deal with these challenges, community developments have gained considerable attention from government officials and academic scholars because community is the fundamental unit for public service provisions and urban management. Community also

plays an important role in people's daily lives and social interactions. In 2016, the Third United Nations Conference on Housing and Urban Sustainable Development issued the New Urban Agenda, which emphasises that future human settlements should be participatory in nature. That is, future urban community developments should promote civic engagement, engender a sense of belonging and ownership amongst all their inhabitants and enhance social and intergenerational interaction; doing so meets the needs of all inhabitants and recognises the specific needs of those in vulnerable situations (United Nations, 2017). Accordingly, the following questions should be considered: 1) How should public

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services be provided? 2) How can neighbourhood harmony be promoted? 3) How can common community consciousness be nurtured? 4) How do we meet the needs of all residents to increase their community satisfaction in the future?

The New Urban Agenda also suggests that making information and communication technologies (ICTs) accessible can be crucial in enabling the public to develop and exercise civic responsibility, broadening participation and fostering responsible governance. Therefore, national ICT policies and e-government strategies should be developed, and citizen-centric digital governance tools should be promoted by tapping into technological innovations. Practices in European cities have shown successful examples of ICT applications to improve the local public sphere, reinforce local democracy, support local communities and enhance social participation (Van den Besselaar and Beckers, 1998). ICTs enable communities to collect, process, analyse and visualise information on public goods and services for residents' convenience (Giffinger et al., 2007; Batty, 2012). Moreover, residents can easily communicate with their neighbours, establish new friendships, participate in community groups and meet their interpersonal interaction needs through ICTs (Papacharissi and Rubin, 2000). In China, urban governments have considerably focused on the construction of a community service system. In 2011, the State Council passed the policy on 'Community Service System Planning, 2011–2015.' This policy emphasised the demands for community services and regarded residents' satisfaction as an important standard in evaluating the effectiveness of planning implementation. China has also made substantial progress in informatisation. In 2014, the Ministry of Housing and Urban-Rural Construction issued the Handbook of Smart Community, which aims to clearly enumerate the factors that constitute a smart community and establish ICT principles, educational and medical resources and other elements that should be integrated and applied in the smart community. However, many Chinese communities primarily focus on the construction of ICT systems (e.g. gated system, monitoring system, parking system) for community management. Few attentions have been paid to the usage of ICT systems (e.g., community websites, community APPs) for community services and neighbourhood communications, which may be the most crucial step in increasing the

community satisfaction of residents.

Several academic studies have identified factors related to community satisfaction, including physical, psychological, social and economic statuses of residents; available community services; and living environment (Shin and Johnson, 1978; Lyubomirsky et al., 2005; Brereton et al., 2008; Rehdanz and Maddison, 2008; Diener and Ryan, 2009; Berry and Okulicz-Kozaryn, 2011; Xia and Zhu, 2013; Zhang and Chai, 2013). Furthermore, several studies have analysed the effects of community ICT usage on information seeking related to community services or community participation; these studies generally highlight the positive roles of ICT usage (Katz and Aspden, 1997; Virnoche, 1998; Papacharissi and Rubin, 2000; Rainie et al., 2000; Hampton, 2001; Shah et al., 2001; Wellman et al., 2001; Dutta-Bergman, 2005a; b; Lee et al., 2008; Batty et al., 2014). However, previous studies have not clearly explained the relationship between community ICT usage and community satisfaction. A theoretical exploration should be conducted to support the development of future community. Therefore, this study attempts to explore the relationship between community ICT usage and community satisfaction on the basis of the survey data collected from Nanjing, China. We intend to ascertain if community ICT usage can influence residents' community satisfaction. If such an influence exists, then which types of community can receive high satisfaction by using community ICTs? What policies or measures should be implemented to promote community construction in the information era?

## 2 Literature Review

Life satisfaction is often used to measure the mental state and policy intervention of residents (Lyubomirsky et al., 2005). This factor also focuses on geographical values, including the differences in the evaluation of geographical space (Berry and Okulicz-Kozaryn, 2011) or the influence of geographical factors (Brereton et al., 2008). Urban locations, built environments, service facilities and neighbourhood environment are related to satisfaction (Rehdanz and Maddison, 2008). Community satisfaction is the most crucial component of life satisfaction (Kweon et al., 2010). Ladewig and McCann (1980) defined community satisfaction as the psychosocial reflection of resi-

dents on community services or their subjective perceptions on the quality of a community-built environment. Few studies have expanded this definition on the basis of other perspectives, including human environment, interpersonal interaction and value system, or life demands (Gans, 1968; Heller et al., 1981; Bardo and Bardo, 1983).

Previous studies have analysed factors related to community satisfaction from three aspects: social interactions, built environments and socioeconomic attributes. Garland (2013), Vrbka and Combs (1993) and Fitz et al. (2016) revealed that having friends as neighbours and feeling safe in one's neighbourhood are positive indicators of community satisfaction. In terms of built environments, the levels of community satisfaction can be predicted by the extent to which residents are satisfied with the proximity to shopping, ease of vehicular access and public transit and street conditions (Vrbka and Combs, 1993; Lee, 2010; Dawkins et al., 2015). Landscape components also play important roles in community satisfaction. For example, trees and pavements show positive effects on community satisfaction (Lee et al., 2008; Kweon et al., 2010). Gruber and Shelton (1987) discovered that the perceived neighbourhood quality of apartment residents is a relatively more important determinant of how they feel about their housing situations than that of conventional or mobile home residents. Previous research has also identified few socioeconomic attributes linked to community satisfaction. The presence of racial/ethnic heterogeneity and single-parent households consistently reduce community satisfaction (Hipp, 2009). Females are less satisfied with their community than males (Spain, 1988). High income and education are relevant to high community satisfaction (Hannscott, 2016), whereas occupational status and age are unrelated to community satisfaction (Rigby and Vreugdenhil, 1987).

The primary motives for using ICTs include seeking service information (e.g., searching for banking or shopping information, checking the news and using other web services) (Katz and Aspden, 1997; Papacharissi and Rubin, 2000) and fulfilling interpersonal needs (e.g., sending e-mails to family and friends, blogging and participating in groups) (Papacharissi and Rubin, 2000). Many scholars use the theory of social shaping of technology to explain such motives. Technology often reinforces pre-existing sociocultural patterns and should

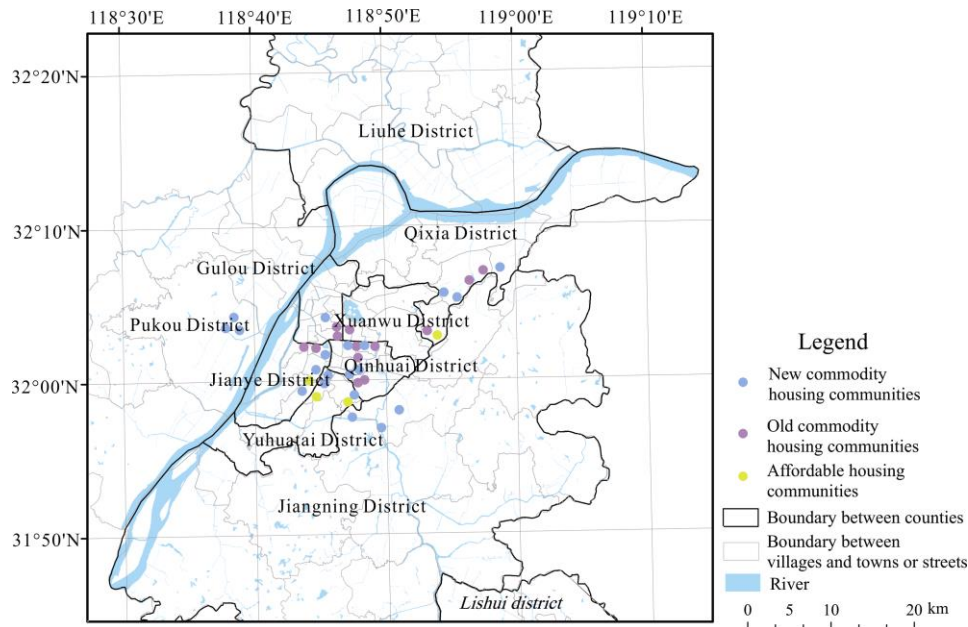
be analysed within the context that surrounds it (Virnoche, 1998; Matei, 2001; Matei and Ball-Rokeach, 2001). Individuals use technology as a resource to fulfil their needs, whereas technology shapes individuals' behaviours by satisfying (or not satisfying) such needs. At the community level, several scholars focus on the association between community ICT usage and community participation. Web pages or bulletin boards provide community-specific information to residents and 'are committed to the goals of local participation, community building and democracy,' thereby suggesting that an increased number of Internet users for community-related purposes is positively linked with community participation (Katz and Aspden, 1997; Virnoche, 1998; Rainie et al., 2000; Ball-Rokeach et al., 2001; Hampton, 2001; Shah et al., 2001; Wellman et al., 2001). Only few studies have concentrated on the relationship between community ICT usage and community satisfaction. Dutta-Bergman (2005b) employed hierarchical multiple regression to confirm that individuals who are satisfied with their community also likely participate in gathering online information on community-related affairs or services. However, whether online information seeking can impact community satisfaction was not investigated because of data limitations. Chen and Zhen (2016) found that Nanjing's elderly residents with high-level education more likely utilise ICTs to promote interactions with their families and neighbours, thereby enhancing their community satisfaction. However, they did not discuss the change of community satisfaction of other population groups who frequently use community ICTs. They also did not explore the effect of using community ICT to obtain community services on community satisfaction. Therefore, we assume that community ICT usage (for obtaining community services and increasing neighbourhood communications) positively affects residents' community satisfaction.

### 3 Data Collection

#### 3.1 Sample description

Nanjing, which is located in China's east coast, is one of the core cities in the Yangtze River Delta area (the sixth largest urban agglomeration in the world). This city is the capital of Jiangsu Province. On the basis of the distribution density of urban population, this study selected

40 communities in Nanjing as survey places. Amongst them, 27 communities are located in the districts of the main city (i.e., Gulou, Xuanwu, Qinhuai, Jianye and Yuhua), whereas other communities are in suburban areas (i.e., Jiangning, Pukou and Qixia) (Fig. 1). These communities comprise 20 new commodity housing



**Fig. 1** Distribution of surveyed communities in Nanjing, China

communities (commodity houses built since the 1990s), 15 old commodity housing communities (commodity houses built before the 1990s) and five affordable housing communities (Affordable housing is a project proposed and implemented by the Chinese government to solve the housing problems of the resettlement or urban low-income groups. The affordable housing communities that this study selected are provided to the resettlement groups by the Nanjing government). Face-to-face survey was conducted from January to April 2016. The survey focused on gathering information on the types of community ICT usage (i.e., community websites, community QQ or WeChat groups, community public information platforms) and community satisfaction. Questions about community participation (i.e., interest, frequency and satisfaction), neighbourhood relationships (i.e., the number of familiar neighbours and the frequency of community participation), community services (i.e. usage frequency or satisfaction, accessibility of bus stop or bank) and socioeconomic attributes were also included. Home investigation was difficult to conduct because of the considerably high safety consciousness of household owners and the survey cost. Hence, questionnaires were randomly distributed in community public places (e.g., community squares and service centres) where many residents gather during their free time.

To improve the effectiveness of the survey, our researchers provided instructions to one person per household who is over the age of 18, and then invited him/her to finish the questionnaire independently. A total of 1600 questionnaires were collected. After excluding the incomplete ones, 1018 questionnaire answers were used for the final analysis.

Table 1 shows that 52.26% and 20.92% of the samples came from the new commodity and affordable housing communities, respectively. The remaining percentages were obtained from old commodity housing communities. Approximately 45.9% of the respondents were satisfied with their community, whereas 38.8% showed a neutral attitude. Very few were dissatisfied or strongly satisfied with their community. In addition, 70% never or seldom used community websites, whereas 30% frequently used community websites. With regard to community QQ or WeChat groups, 60% of the respondents never or seldom used them; only 40% preferred using such services. Moreover, 66.9% of the respondents never or seldom used community public information platforms, whereas 15.7%, 12.4% and 5% were respectively occasional, often and usual users, respectively. In general, only a small percentage of respondents use community ICT in normal or high frequency. Furthermore, male respondents slightly out-

numbered the females. Over half of the respondents graduated from college, 12.67% obtained master's

**Table 1** Descriptive statistics of the samples

Variables	Numbers of samples	Percentage (%)	Variables	Numbers of samples	Percentage (%)
<b>Types of communities</b>			<b>Gender</b>		
New commodity housing community	532	52.26	Male	524	51.47
Old commodity housing community	213	20.92	Female	494	48.53
Affordable housing community	273	26.82	<b>Education</b>		
<b>Community satisfaction</b>			High school or lower	311	30.55
Strongly disagree	0	0	College graduate	578	56.78
Disagree	61	6.0	Master's degree or higher	129	12.67
Neutral	395	38.8	<b>Marital status</b>		
Agree	467	45.9	Married	740	72.69
Strongly agree	95	9.3	Unmarried	265	26.03
<b>Frequency of community website usage</b>			Other	13	1.28
Never	476	46.8	<b>Age</b>		
Seldom	236	23.2	18–25 years old	161	15.82
Sometimes	178	17.5	26–35 years old	458	44.99
Often	103	10.1	36–50 years old	203	19.94
Usually	25	2.4	> 50 years old	196	19.25
<b>Frequency of community QQ or WeChat group usage</b>			<b>Family income (total annually)</b>		
Never	423	41.5	Below 100000 yuan (RMB)	426	41.85
Seldom	195	19.2	100000–200000 yuan	365	35.85
Sometimes	158	15.5	200000 yuan or above	227	22.30
Often	166	16.3	<b>Census classification</b>		
Usually	76	7.5	Local people	691	67.88
<b>Frequency of community public information platform usage</b>			Nonlocal people	327	32.12
Never	473	46.5	<b>Household composition</b>		
Seldom	208	20.4	Single person	117	11.49
Sometimes	160	15.7	Couple without children	137	13.46
Often	126	12.4	Parents	408	40.08
Usually	51	5	Three generations or more together	286	28.09
			Others	70	6.88

degrees or higher and 30.55% received high school education or lower. In terms of age, 64.93%, 44.99% and 19.94% were 25–50, 25–35 and 35–50 years old, respectively. With regard to household income, 77.70% of the respondents earn below 200 000 yuan (RMB) annually. Most of the survey participants were married local residents. With regard to household composition, 40.08% of the respondents were parents.

### 3.2 Variable design and measurements

To confirm the relationship between community ICT

usage and community satisfaction, we designed the following dependent and independent variables for the proposed model.

#### (1) Dependent variable

Community satisfaction was designated as the dependent variable. To measure community satisfaction, we asked the question ‘What is your overall satisfaction with community?’ The respondents expressed their satisfaction using a five-point scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

#### (2) Independent variables

This study considered community ICT usage as the most important independent variable, which can be described by three indicators: 1) frequency of community website usage; 2) frequency of community QQ or WeChat group usage and 3) frequency of community public information platform usage (e.g., WeChat public number). According to our investigation, residents frequently used community websites or community public information platforms, which are provided by community management departments to offer community services. These residents also frequently used their personal community QQ or WeChat groups to increase their neighbourhood communications. The respondents were asked to rate their usage frequency using a five-point scale (1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = usually). To measure the general effect of community ICT usage on community satisfaction, we performed principal component analysis (PCA) to calculate the general usage level of community ICT using the three indicators. The Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were also conducted. The KMO value (0.865) and  $P$  value of the Bartlett's test of sphericity (0.000) indicated that the evaluation data were suitable for PCA. Two principal components of cumulative contribution rate accounting for 81.75% were identified. To calculate the overall scores (i.e., the general usage level of community ICT), a comprehensive principal component calculation model was utilised after obtaining the scores of the two principal components ( $F_1$  and  $F_2$ ) and considering the proportion of each principal component corresponding to the sum of the total eigenvalues of the extracted principal components as weights.

$$F = A_1F_1 + A_2F_2,$$

where  $F$  is the score of the comprehensive principal component, and  $A_i$  refers to the weight coefficient of each principal component (variance contribution rate). Meanwhile, residents who live in different types of communities may exhibit different community satisfaction. Thus, we considered community types (new commodity, old commodity and affordable housing communities) as independent variables. We also utilised three types of variables to control the effects of community ICT usage on community satisfaction (Table 2). The first variable is built environments, which include the accessibility to bus stops, distance between community

and business centre, volume rate and green coverage rate. The second variable is neighbourhood relationships, which entail a number of familiar neighbours and the frequency of community participation. The last variable is the socioeconomic attributes, namely, age, education, household income, census classification, gender, marital status, household composition and occupation.

### 3.3 Description analysis

To support our model selection and results, we initially conducted a description analysis to estimate the relationships amongst several important variables. Table 3 shows that all variables of community ICT usage are significantly and positively correlated with community satisfaction. The number of familiar neighbours has a positive correlation with community satisfaction but does not have a significant correlation with all variables of community ICT usage. The frequency of community participation indicates a positive correlation with the frequency of community website and community QQ or WeChat group usage and the general usage level of community ICT. However, this frequency does not have a significant correlation with the frequency of community public information platform usage and community satisfaction. These findings indicate that in Nanjing, community ICT usage may directly affect community satisfaction, rather than impose indirect impacts that may affect the number of familiar neighbours or the frequency of community participation to increase community satisfaction.

We then checked the relationships amongst the types of communities, community ICT usage and community satisfaction. Table 4 demonstrates that residents living in new commodity housing communities have higher average usage frequency or level of community ICT than those living in old commodity or affordable housing communities. Compared with residents living in affordable housing communities, those living in old commodity housing communities have higher average usage frequency of community QQ or WeChat group and community public information platform but lower average usage frequency of community website and general usage level of community ICT. Moreover, residents living in new commodity housing communities have higher average level of community satisfaction than those from old commodity housing communities but lower



average level of community satisfaction than those living in affordable housing communities. We can

**Table 2** Control variables and data descriptions

Variables	Control variables	Data descriptions
Built environments	Accessibility to bus stops (continuous variable)	Data source: Point of interest (POI) data from Baidu search engine Calculation: Using Geographic Information System (GIS) to calculate the number of bus stops (POI) of each community within 300 m
	Distance between community and business centre (continuous variable)	Data source: POI data from the Baidu search engine Calculation: Using GIS to calculate the distance between the geometric centre of the community and the nearest business centre
	Volume rate (continuous variable)	Data source: anjuke.com (one of the largest housing websites in China)
	Green coverage rate (continuous variable)	Data source: anjuke.com
Neighbourhood relationships	Number of familiar neighbours (ordered categorical variable)	Data source: Questionnaire (Question: Number of neighbours who say hello to each other) Categories: none, 1–5, 5–10, 10–20 and above 20 people
	Frequency of community participation (ordered categorical variable)	Data source: Questionnaire (Question: Frequency of community participation in educational activities, fitness activities, public welfare activities or recreational activities) Categories: never, seldom, sometimes, often and usually
	Age (ordered categorical variable)	Data source: Questionnaire (Question: How old are you?) Categories: 18–25, 25–35, 35–50 and > 50
Socioeconomic attributes	Education (categorical variable)	Data source: Questionnaire (Question: What is your last completed grade or class in school?) Categories: high school or lower, college graduate and master’s degree or higher
	Household income (ordered categorical variable)	Data source: Questionnaire (Question: How much does your family make in one year?) Categories: less than 100000 yuan (RMB), 100000–200000 yuan and 200000 yuan or above
	Census classification (categorical variable)	Data source: Questionnaire (Question: What is your census classification?) Categories: local people and non-local people
	Gender (categorical variable)	Data source: Questionnaire (Question: What is your gender?) Categories: male and female
	Marital status (categorical variable)	Data source: Questionnaire (Question: What is your marital status?) Categories: married, unmarried and others
	Household composition (categorical variable)	Data source: Questionnaire (Question: What is your household composition?) Categories: single person, couple without children, parents, three generations or above together and others
	Occupation (categorical variable)	Data source: Questionnaire (Question: What is your current occupation?) Categories: government, public institution, enterprise, self-employed, migrant worker, student, unemployed/retired and others

**Table 3** Correlation analysis of community satisfaction, neighbourhood relationships and community ICT usage

Community-related variables	Frequency of community website usage	Frequency of community QQ or WeChat group usage	Frequency of community public information platform usage	General usage level of community ICT	Community satisfaction
Community satisfaction	0.1059***	0.1057***	0.0713**	0.1039***	—
Number of familiar neighbours	0.0473	0.0360	0.0073	0.0276	0.1603***
Frequency of community participation	0.0659**	0.0912**	0.0456	0.0815**	0.1458

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

conclude that residents who live in the same type of community may have similar community ICT usage and community satisfaction. Residents from commodity housing and new communities have higher usage frequency or level of community ICT and receive higher community satisfaction than those from old communities. These results may be attributed to the fact that commodity housing and new communi-

ties have a similar living environment. However, residents from different types of communities show differences in community ICT usage and community satisfaction. Although residents from affordable housing communities have lower usage frequency or level of community ICT than those from commodity communities in general, they have high community satisfaction.

**Table 4** Compare mean analysis of types of communities, community satisfaction and community ICT usage

Types of communities	Frequency of community website usage	Frequency of community QQ or WeChat group usage	Frequency of community public information platform usage	General usage level of community ICT	Community satisfaction
New commodity housing community	2.05	2.48	2.28	1.07	3.58
Old commodity housing community	1.88	2.11	1.92	0.89	3.46
Affordable housing community	1.93	2.07	1.86	0.9	3.69

### 3.4 Research method

The correlation analysis in Table 3 shows a possible linear relationship between community satisfaction and community ICT usage (or neighbourhood relationships), thereby encouraging the selection of a linear regression model. However, the compare mean analysis in Table 4 suggests that residents who live in the same type of community may have similar community ICT usage patterns and levels of community satisfaction. A total of 1080 samples collected from 40 communities with group characteristics in Nanjing illustrate that a large proportion of residents live in the same community. This result may lead to a deviation in the estimation and hypothesis testing of factors. Therefore, we selected the mixed linear regression model for our analysis. This model can adapt to many data types (classification variables), expand the scope of the application of the traditional linear model (without the need to meet the conditions of normality, independence and variance homogeneity) and analyse cross-level interaction. Moreover, the mixed linear regression model increases the construction of random effect variables. The general formula for the model is shown below.

$$Y = X\beta + Z\Gamma + \varepsilon, \quad (1)$$

where  $\beta$  is the regression coefficient, and  $Z$  is the design matrix for the random effect variables. For the random effect parameter vector,  $\Gamma$  obeys the normal distribution of mean vector 0 and variance-covariance matrix  $G$ .  $\varepsilon$  is a random error vector.

The types of community should be included in the model as random variables because the samples came

from different communities in Nanjing. We also assessed the differences in community satisfaction under the fixed effects of the usage level of community ICT, types of community, built environments, neighbourhood relationships and socioeconomic attributes. In addition, we explored the rule on the differences of community satisfaction under the community ICT usage and types of community. Moreover, we selected classical maximum likelihood estimation as the estimation method. Furthermore, we estimated the model fitting effect by using the Akaike information criterion (AIC) and Bayesian information criterion (BIC). The analysis model of this study is as follows:

$$Y = \beta + X_1\beta_1 + X_2\beta_2 + X_1X_2\beta_3 + X_3\beta_4 + X_4\beta_5 + \dots + Z\Gamma + \varepsilon \quad (2)$$

where  $Y$  is the community satisfaction;  $\beta$  is a constant term;  $(\beta_1, \beta_2, \dots, \beta_m)$  are the regression coefficients of community ICT usage [ $X_1$ ], types of community [ $X_2$ ], built environment [ $X_3, \dots$ ], neighbourhood relationships [ $X_m, \dots$ ] and socioeconomic attributes [ $X_n, \dots$ ];  $X_1$  and  $X_2$  are the interaction matrices for the usage level of community ICT and types of community, respectively.  $Z$  is the design matrix for the random effect variables. For the random effect parameter vector,  $\Gamma$  obeys the normal distribution of mean vector 0 and variance covariance matrix  $G$ .  $\varepsilon$  is a random error vector.

## 4 Results and Analyses

We used mixed linear regression in estimating the parameters to evaluate how community ICT usage affects

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community satisfaction. We built four models for our analysis. Models 1, 2, 3 and 4 measured the effect of the frequency of community website usage, community QQ or WeChat group usage, community public information platform usage and the effect of the general usage level of community ICT, respectively. The findings revealed that AIC and BIC in the mixed effect model were lower than those in the traditional linear regression model, indicating that the overall fitting effect of the simulation is acceptable. We also checked collinearity and confirmed that no collinear variables exist in our models. Therefore, we accepted the results of the estimation and obtained the detailed results of the effects (Table 5).

**Table 5** Results of the mixed linear regression model

Community satisfaction	Model 1	Model 2	Model 3	Model 4
Community ICT usage	0.0534**	0.0422*	0.0291	0.1058*
Types of communities				
New commodity housing community <sup>a</sup>				
Old commodity housing community	-0.1477*	-0.1391*	-0.1462**	-0.1389*
Affordable housing community	0.1269**	0.1391**	0.1342**	0.1382**
Interactions between community ICT usage and types of communities				
Community ICT usage and New commodity housing community <sup>a</sup>				
Community ICT usage and Old commodity housing community	-0.1221	-0.1171	-0.0907	-0.1417
Community ICT usage and Affordable housing community	0.2675**	0.2699**	0.3029***	0.2482**
Accessibility to bus stops	0.0152**	0.0144**	0.0147**	0.0151**
Distance between community and business centre	-0.9800	-0.9650	0.0000	0.0000
Volume rate	-0.0399	-0.0411	-0.0337	-0.0450
Green coverage rate	-0.0006	-0.0007	-0.0004	-0.0009
Number of familiar neighbours	0.0709**	0.0723**	0.0721**	0.0729**
Frequency of community participation	0.0336	0.0320	0.0340	0.0323
Age				
18–25 <sup>a</sup>				
26–35	-0.0145	-0.0231	-0.0205	-0.0223
36–50	-0.0713	-0.0790	-0.0841	-0.0776
> 50	-0.0419	-0.0449	-0.0471	-0.0417
Education				
High school or lower <sup>a</sup>				
College graduate	-0.0909	-0.0925	-0.0890	-0.0909
Master's degree or higher	0.1025	0.1028	0.1066	0.1034
Household income (total per year)				
Less than RMB 100000 <sup>a</sup>				
RMB 100,000–200,000	-0.0249	-0.0282	-0.0302	-0.0274
RMB 200,000 or more	-0.1121*	-0.1104*	-0.1091*	-0.1085*
Census				
Local people <sup>a</sup>				
Non-local people	-0.0182	-0.0186	-0.0138	-0.0171
Gender				
Male <sup>a</sup>				
Female	0.0819*	0.0829*	0.0858*	0.0840*
Marital status				
Married <sup>a</sup>				
Unmarried	0.0840	0.0834	0.0869	0.0829
Others (widowed and divorced)	0.1688	0.1629	0.1604	0.1621
Household composition				

Single person <sup>a</sup>				
	Continuing Table			
Community satisfaction	Model 1	Model 2	Model 3	Model 4
Couple without children	-0.0191	-0.0199	-0.0190	-0.0173
Parents	0.0012	0.0059	0.0072	0.0064
Three generations or more together	0.1653	0.1617	0.1705	0.1642
Others	0.0614	0.0663	0.0686	0.0682
Occupation				
Government staff <sup>a</sup>				
Institution staff	0.0973	0.0924	0.1019	0.1009
Enterprise staff	-0.0140	-0.0200	-0.0135	-0.0088
Self-employed person	0.1748	0.1696	0.1768	0.1798
Migrant worker	-0.3833**	-0.3744**	-0.3693**	-0.3673**
Student	0.2209	0.2027	0.2207	0.2207
Unemployed/retired person	0.1009	0.0929	0.1039	0.1057
Other	0.0431	0.0335	0.0456	0.0474
Cons	3.1215***	3.1472***	3.1348***	3.2373***
AIC	2226	2226	2228	2226
BIC	2393	2394	2396	2394

Notes: \* is  $P < 0.1$ , \*\* is  $P < 0.05$ , \*\*\* is  $P < 0.01$ ; <sup>a</sup> is the Reference Category; AIC is the Akaike Information Criterion and BIC is the Bayesian Information Criterion

### 4.1 Effects of community ICT usage

#### (1) Effects of the four types of community ICT usage

Table 5 shows that the frequency of community website usage is approved by significance tests with an influence coefficient of 0.0534, which indicates that this frequency positively affects community satisfaction. Residents who frequently use community websites are more satisfied with their community probably because community websites often provide people different kinds of community services to improve their living. The frequency of community QQ or WeChat group usage is also a significant variable and has a positive influence (the influence coefficient is 0.0422) on community satisfaction. Residents who frequently use community QQ or WeChat groups can easily connect with their neighbours to enhance their neighbourhood relationships or community belongings. However, the frequency of community public information platform usage has no significant impact on community satisfaction because community public information platforms have limited functions of publishing information and do not provide direct services to residents. The general usage level of community

ICT is also approved by significance tests with an influence coefficient of 0.1058, which indicates that the usage level of community ICT has a direct and positive effect on the community satisfaction of residents. This result is consistent with the effects of the frequency of community website and community QQ or WeChat group usage, thus supporting our hypothesis. That is, residents who frequently use community ICTs likely achieve high community satisfaction. In recent years, an increasing number of communities in Nanjing have become interested in the establishment of smart communities. Many of these communities focus on the construction of information systems and installation of ICT devices for excellent management. These measures provide additional service information for residents' convenience and offer additional opportunities for neighbourhood communication, thereby enhancing community satisfaction.

#### (2) Effects on the three types of communities

We considered the relationship between the types of communities and community satisfaction and examined the effects of community ICT usage on the satisfaction

of different types of communities. All four models demonstrate that residents from old commodity communities have lower community satisfaction than those from new commodity housing communities. This finding may be related to the fact that new commodity housing communities often have a better living environment and are equipped with more service facilities than old commodity housing communities. Meanwhile, residents from affordable housing communities likely experience higher community satisfaction than those from new commodity housing communities. In China, residents from affordable housing communities generally belonged to the same village before their relocation. Moreover, most affordable housing residents lived in urban villages or suburbs prior to relocation, whereas residents from new commodity housing communities often rented houses in the city or had more than one commodity houses. Therefore, the living environments of residents from affordable housing communities prior to relocation were less desirable than those living in new commodity housing communities. After relocation, residents from affordable housing communities likely experience more community satisfaction than those from new commodity housing communities (Gruber and Shelton, 1987).

We performed interaction influence analysis on the usage level of community ICT, types of community and community satisfaction. The interaction influence of community ICT usage and old commodity housing community on the four models indicates positive coefficients but do not pass the significance test. Although residents from old commodity communities have lower community satisfaction than those from new commodity housing communities, they may have similar expectations from and dependence on community ICT. Most old commodity communities are located in the main city, thus residents who live in these communities more likely accept community ICT usage, according to diffusion of innovation theory (Farg et al., 2006). Residents who live in new commodity communities also likely use community ICT because their living locations have a long distance to city centre. The interaction influence of community ICT usage and affordable housing community on the four models shows positive coefficients (0.2482, 0.2675, 0.2699 and 0.3029) and significance, indicating that all kinds of community ICT usage are

positively and significantly related with community satisfaction in affordable housing communities. Compared with new commodity housing communities' residents who have high-level community ICT usage, those who live in affordable housing communities more likely experience high community satisfaction when they also use high-level community ICTs. This phenomenon is explained by the fact that affordable housing communities are often provided with less offline service facilities and smaller neighbourhood communication space than new commodity housing communities in China. Therefore, compared with community ICT users who live in new commodity housing communities, community ICT users in affordable housing communities can obtain more online community services (e.g. online shopping, online bank, online payment) than offline services through community websites or community public information platforms. They also interact with their neighbours online more than offline through community QQ or WeChat groups—factors that may increase their community satisfaction. Moreover, community ICT users who live in affordable housing communities have lower expectations and are more dependent on community ICT than those who live in new commodity housing communities whose satisfaction can significantly increase when the frequency or level of their community ICT usage increases.

#### 4.2 Effects of control variables

The influences of built environments, neighbourhood relationships and socioeconomic attributes on community satisfaction in all models are further analysed in accordance with previous studies. We identified a positive relationship between accessibility to bus stops and community satisfaction. The influence coefficients are positive and significant ( $P < 0.05$ ). This finding suggests that the high convenience of bus traffic is beneficial for increasing community satisfaction (Vrbka and Combs, 1993; Dawkins et al., 2015). However, no significant relationship was observed between other built environment variables (distance between community and business centre, volume rate and green coverage rate) and community satisfaction. Neighbourhood friendships also exhibit a positive influence on community satisfaction. In the four models, residents with more familiar neighbours are more satisfied with their community than

those who have less familiar neighbours. This outcome reveals that receiving social support or neighbourhood communication is beneficial to the enhancement of residents' community belongingness, which is an important aspect of community satisfaction (Heller et al., 1981; Garland, 2013; Fitz et al., 2016). However, no relevance was determined between the frequency of community participation and satisfaction.

In terms of socioeconomic attributes, all models pointed out that residents with a household income of RMB 200 000 yuan (RMB) or above are significantly less satisfied with their community than those with a household income of below 100 000 yuan (coefficients of influence are negative and  $P < 0.1$ ). A possible reason for this finding is that middle-income households have more expectations and higher affordability for their community life than low-income households. However, these expectations may not be fulfilled by their community. Females are more satisfied with their community than males (influence coefficients are positive;  $P < 0.1$ ), and they often stay longer in their community to take care of their families and use more community services to enhance their community belongingness than males. With regard to occupations, we discovered that migrant workers have significantly negative effects on community satisfaction compared with government staff members (influence coefficients are negative;  $P < 0.05$ ). Most migrant workers reside in communities that offer cheap rent, have a poor living environment and lack community belongingness, thus resulting in their low community satisfaction (Xia and Zhu, 2013). Moreover, several variables, such as age (Rigby and Vreugdenhil, 1987), education, household income (total annual), census, marital status and household composition, exhibit no significant relationships with community satisfaction in Nanjing.

## 5 Conclusions

We confirmed our hypothesis that community ICT usage can enhance residents' community satisfaction. Although no significant impact of the frequency of community public information platform usage was determined, residents who frequently use community websites are satisfied with their community because they can utilise community services from websites. Commu-

nity QQ or WeChat group usage can also help residents easily connect with their neighbours, thereby enhancing residents' neighbourhood relationships or community belongingness. That is, residents who use high-level community ICT are considerably satisfied with their community because community ICTs provide additional services for residents' convenience and offer additional opportunities for neighbourhood communication. Dutta-Bergman (2005b) argued that individuals who are satisfied with their community also likely use community ICT for gathering information on community-related affairs or services. In this study, we not only confirmed the opposite direction of the aforementioned relationship but also discovered the positive effect of increased neighbourhood communication opportunities imposed by community ICT users on community satisfaction. We also expanded the scope of Chen and Zhen's (2016) study that focuses only on elderly residents with high-level education in Nanjing considering all age groups. We determined that residents likely use community ICT to promote interactions with their neighbours, thus enhancing their community satisfaction. We also found interesting results in the relationships amongst types of communities, community ICT usage and community satisfaction. When residents use high-level community ICT, residents living in old commodity communities have high-level community satisfaction compared with those from new commodity communities, whereas residents from affordable housing communities likely experience high community satisfaction. Moreover, variables such as types of communities, accessibility to bus stops, and number of familiar neighbours, household income, gender and occupation show significant effects on community satisfaction. However, no significant relationship exists between community satisfaction and the remaining variables, including the distance between community and business centre, volume rate, green coverage rate, frequency of community participation, age, education, census, marital status and household composition.

This study has two main limitations. Firstly, we focused on the effects of website and smart phone application usage in communities instead of other ICT devices, such as intelligent monitoring or entrance guard systems, which may improve community satisfaction by increasing residents' sense of security. These devices are



also important equipment in the construction of smart communities in China. Secondly, Dutta-Bergman (2005b) determined that relationships may exist amongst community ICT usage, community service facility usage (or community participation) and community satisfaction. That is, ICT forms a link in the communication infrastructure, thereby directly or indirectly contributing to service facility visits or attendance to community activities and enhancing residents' community belongingness or satisfaction. Therefore, we will conduct additional research to investigate these relationships in detail. We may also apply structural equation or hierarchical modelling to ascertain meaningful connections.

In the information era, communities should not only be interested in the construction of community ICT devices for community management but also pay attention to the supply of community ICT platforms related with community services (e.g. community online payment applications, self-help express, home energy management and kinds of community groups). Additional offline service facilities should be provided to residents from affordable housing communities to balance their usage of online and offline services. Policies should also be formulated to encourage people to use their community ICT platforms or devices (e.g. reducing property fee for online participants, regular skill training for elders or other vulnerable groups and setting related performance assessment criteria for community managers or properties in residents' usage level of ICT). Moreover, communities must build unified databases of residents' daily activities collected from community ICT platforms or devices and connect them to urban data resource centres. Certain professionals may be employed to analyse the rules of residents' behaviours and activities for improved community management and services.

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