

OUTSTANDING DISSERTATION 最佳碩士論文



Issues and Challenges of Tree Management in Private Residential Properties in Hong Kong



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Introduction

Trees are a valuable asset in cities and an important part of greening and beautifying the urban environment. People plant trees on roadsides and private residential areas to improve their quality of life. However, Hong Kong trees often collapse due to rainy and typhoon seasons. In particular, typhoons become stronger and more frequent owing to severe global climate changes. For example, the super typhoon “Mangkhut” in 2018 unprecedentedly destroyed over 60,800 trees (The Government of the Hong Kong Special Administrative Region, 2018). Tree problems can either be caused by natural factors or human factors. Perlman (1994) indicated that ignorance, negligence or incompetence associated with tree management could lead to fatal tree collapse. If tree management and risk assessment are not performed correctly, poorly maintained trees can

fall ill and cause major tree accidents, resulting in casualties and economic losses. Tragedies of private tree accidents occur from time to time and bring potential risks to the public.

Unlike public trees directly managed by the government, all trees on private land are managed by the private owners themselves. The quality of private tree management varies greatly depending on the tree-related knowledge, degree of participation and specific values of owners, owners' corporations, and property management companies towards trees. Currently, most researches focus on trees on public land, and only a little attention has been paid to trees on private land. Therefore, the study attempts to further reveal the knowledge, application and practice of private residential tree management by private property owners and their property management agents (i.e. frontline and supervisory staff of property management companies), examine the main issues and challenges facing them and make corresponding improvements.

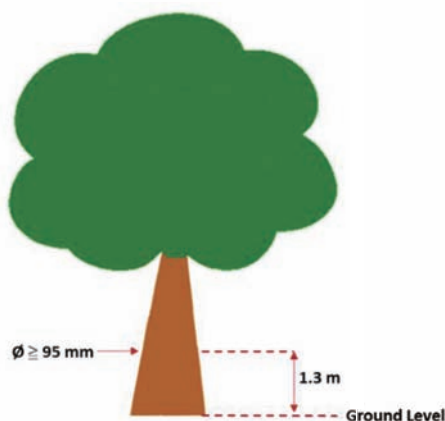
Literature Review

Cities around the world have invested tremendous resources in urban landscape greening to promote the city livability and sustainability, (Plant, Rambaldi & Sipe, 2017), and planting trees has become extremely important due to its relative durability, longevity and environmental benefits. The introduction of trees in built-up areas not only meets various environmental and decorative functions, but also meets the inherent psychological needs of human beings and their sincere impulse to establish contact with the natural world (Miller, Hauer, & Werner, 2015; Westhoff, 1983). As trees bring many tangible and intangible positive advantages (e.g. improving the residents' mental health and increasing the property asset value), it has become a common phenomenon to plant trees in and around residential development areas to increase canopy coverage (Boogaardt & Brown, 2019; Wong, Chen, Ong, & Sia, 2003; Anderson & Cordel, 1988). However, the existence of urban trees is not entirely positive and can come along with drawbacks associated with trees in the aspects of the environmental, social, economic, health, visual and aesthetic. Examples of such defects include tree canopies obstructing the view of the property, falling leaves and branches during storms, having the chance to damage the property, and occupying valuable limited private space (Donovan & Butry, 2010). Greene, Robinson and Millward

(2018) stated that many trees are inevitably close to residential buildings and public facilities. Many healthy trees will become sick and fragile over time and environmental changes (Smiley, Matheny & Lilly, 2017). Therefore, tree management has become very critical. It usually refers to a variety of measures taken from the beginning to the end of the trees, including tree planning and selection, planting, maintenance, assessment and risk management and protection.

Private trees are part of the common private property of property owners. Managing them requires sharing power, responsibilities and management among different stakeholders. The owners make most decisions about their own private trees, which greatly affect the condition and richness of the trees. In this study and the Hong Kong property environment, property managers or management companies, as the representatives of owners, play a pivotal role in the decision-making process of the trees. Agriculture Fisheries and Conservation Department Hong Kong SAR (2006) has defined trees with trunk diameter reaches 95 mm or more at a height of 1.3 m from the ground as trees in Hong Kong (see Figure 1). There is currently no official record of the number of trees in private residential properties in Hong Kong. Due to the dense population and crowded living condition in Hong Kong, most people can only share trees in public areas of private properties (Gilchrist, 1994).

Figure 1: Hong Kong Government's Definition of A Tree



Trees rarely have comfortable and sufficient growth space (Cooper, 1996). Jim (2000) indicated this severe lack of planting space limited the growth of trees and contained various tree growth problems. Poor health of trees would also reflect poor management performance, which made people question the management capabilities of the organization and its employees (Jim, 2001). Unquestionably, trees must be regularly assessed and managed to maintain their health. Research on public attitudes towards trees showed that although people generally liked trees, only a few people supported the regulation of trees on private land (Zhang, Hussain, Deng, & Letson 2007). Most owners had no incentive to bear the costs associated with tree management and maintenance (Ko, Lee, McPherson, & Roman, 2015).

Relying on the private market alone cannot provide sufficient support and incentives for owners to manage trees. In fact, many owners do not care much about their trees, leading to lack of regular inspection and maintenance of the trees, which can further reduce the tree safety and cause danger, especially when trees continue to grow. The lack of strict controls and standards for tree management has caused many mature trees to fall and become a public hazard (Avolio, Pataki, Pincetl, Gillespie, Jenerette & McCarthy 2015). The Hong Kong government has long been known for its positive non-intervention attitude towards the private domain. Managing private tree management is one example. Currently, Hong Kong does not have formal statutory tree regulations to ensure proper maintenance of private trees. It mainly relies on other indirect and ineffective legislative and administrative measures to ensure that trees on private land are not mistakenly trimmed, felled and stolen. Since the 1970s, it has added specific tree preservation clauses to land leases to protect trees on private land, requiring owners only to have sufficient reasons to remove trees, otherwise it is generally not allowed to do so (Environmental Transport and Works Bureau and Agriculture, Fisheries and

Conservation Department, 2003). Jim (1987a, b) implied that the trees on private land leased before the 1970s fell off the protection net and undoubtedly became unprotected, leaving gray areas or legal gaps to protect these trees. This shows that the mechanism of protecting trees is imperfect and flawed. If tree laws and regulations could properly be formulated and implemented, they could promote health, safety and well-being in the community (Abbey, 1998). Jim (2002) further explained this by saying that the government and private property developers are unwilling to support the tree laws. They are plainly worried that this may further restrict the pace of private land development in Hong Kong and delay efficiency. Therefore, the tree management performance (ability and level of tree management) of different private residential properties in Hong Kong is widely affected by the quality, level of participation and collaboration of all participating stakeholders.

Kolcaba's comfort theory helps explain that why people start to manage and maintain trees in their properties. In psychological research, human comfort can refer to a state of mental relaxation, satisfaction, safety and usually no difficulties. Related to this study is that owners and property management practitioners believe that trees are healthy and safe and do not need to worry about their potential danger and related pressure. Human comfort is indeed related to three main attributes: 1.) Belief (a state of mind that thinks something is a fact); 2.) Attitude (thoughts, cognitions and tendencies towards things that are manifested through behavior); and 3.) Behavior (a behavior that learns through interaction with the environment and experience) (Kolcaba, 1994). Hence, the impact of dangerous trees (e.g. broken branches, fallen trees and trunks) directly affects the owners and practitioners' comfort. As reported by Jylhä and Suvanto (2015), previous studies repeatedly mentioned that different levels of knowledge and information may influence the recipient's commitment and actions. This makes people have different responses to tree management and maintenance in different residential properties.

Analytical Framework

Tree management includes a range of tree-related measures and processes, as shown in *Figure 2*.

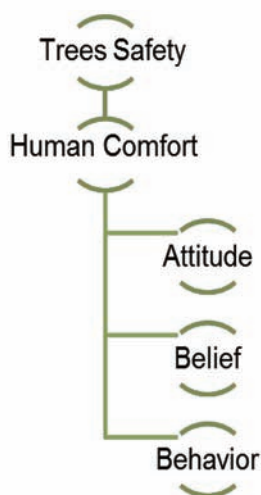
The identified issues and challenges related to tree management in private residential properties should also stem from them.

Figure 2: Key Stages of Tree Management in Urban Environment



*Private trees are a key component of the urban environment and are closely related to human habitation. Trees growing in different private residential properties have varying performances over tree management. Internal and external factors can influence people’s beliefs, attitudes and behaviors, and decide whether or not to implement safety tree measures to resolve dangerous trees, achieve tree safety and allow them to feel comfortable, as shown in *Figure 3*.*

Figure 3: Human Incentives for Implementing Safe Tree Management



In general, based on the previous sections, a specific analytical framework is developed to identify issues and challenges associated with tree management in private residential properties. The identified issues and challenges come from a variety of sources related to tree affairs, which could simply be categorized into six major areas as follows:

Table 1: Six Main Areas Identified for Issues & Challenges Related to Trees	
1.	Tree knowledge and tree work practice level of property staff;
2.	Property resources and capacity like economic and fiscal viability;
3.	Government tree legislation and policy;
4.	Property tree management training;
5.	Application and complexity of tree management and practice; and
6.	Owners’ beliefs, attitudes and behaviors towards tree risks and safety

Methodology

The study involved qualitative and quantitative methods, conducted in the form of case studies, field observations and surveys to obtain comprehensive results about tree management.

Method of Collecting Qualitative Data

In the qualitative approach, it was highly dependent on extensive review of existing literature and publications related to tree management in private residential properties in Hong Kong and overseas. Besides, primary data was collected through three-case studies for analysis, including direct on-site observations, and face-to-face and in-depth interviews with frontline security guards and gardeners, as well as property officers and managers. Six samples were drawn from three selected properties to analyze the issues and challenges related to stakeholder participation in private tree management. According to the size, height and living density of buildings, the selected properties had the following characteristics: 1.) Small-sized, medium-rise and high-density property on Hong Kong Island; 2.) Medium-sized, high-rise and high-density property in Kowloon; and 3.) Large-sized, low-rise and low-density property in New Territories. These properties could likely reflect the most common situation of people living and working with trees in the most typical private residential properties in Hong Kong. In addition, due to differences in the

number and size of trees for each property type, the level and quality of the owners' corporations and management companies involved in tree management, the performance of tree management would vary. It could be foreseeable that those willing to participate in this study might face internal and external pressures, worrying that the study was fundamentally to discover the key issues and challenges of tree management in private residential properties that would be closely related to the reputation and brand of properties and even property management companies. Therefore, the names and identities of the selected properties and participants were anonymized and made unknown to better protect their interests.

Method of Collecting Quantitative data

In the quantitative method, it was aimed at obtaining more standardized statistical data from targeted people at private residential properties. There were 36 questions in total and most questions were closed-ended. The survey successfully explored the overall view and knowledge of tree management from a sample of 120 residents and property management practitioners. The following four aspects were asked among those participants, namely 1.) Perception of tree condition in the property; 2.) Understanding the importance of tree management to property and private property owners; 3.) Knowledge of tree practices and regulations; and 4.) Issues and challenges of tree management.

Discussion of Major Findings

Limited & Tight Financial Resources

It is difficult for many private residential property owners in Hong Kong to start taking care of trees. Although most expressed their willingness to invest resources in trees in the study, they rarely did so, especially for older properties. They need resources to maintain and replace aging buildings and their auxiliary facilities and systems, resulting in fierce competition for internal resource allocation. Spending money on these essential and critical items seems more practical than trees. In reality, most owners are unwilling to bear the recurring costs associated with routine tree management and maintenance. It is also not cheap to treat diseased trees. All these could imply a direct increase in management fees. Even if some are willing to spend money on trees, many try to use the cheapest method to finish the works, and the awarded contractors are usually selected on the principle of “lowest bidder” in the tendering to save costs. Actually, due to cost issues, they accept to hire inexperienced, low-quality, unqualified contractors to carry out tree works, which will sacrifice service quality and bring potential future tree problems.

Shortage of Tree Talents & Lack of Staff Tree Knowledge Training

Not all private residential properties can hire tree management personnel to look after trees in their daily operations or have the flexibility to outsource works to external contractors. Instead, frontline security guards and management office staff are required to perform such tree duties. However, they often lack tree knowledge and management capabilities to take care of trees. Experienced practitioners may complete their works based on relevant experience, but this is not inevitable. Some properties seem to be able to professionally hire frontline gardeners to take care of trees. But arboriculture and horticulture (gardening) are actually two different things. Unlike horticulture, arboriculture emphasizes the health of trees, not the decorative nature of trees. Most gardeners may already have extensive experience in gardening

and know how to maintain flowers and plants, but they still see managing trees as a challenge. They are frequently instructed to perform tree care and pruning without formal and professional training in order to meet current property operation and management needs. This could backfire because wrong practices and knowledge in trees can destroy trees and endanger people's safety.

Planting Wrong Trees in Wrong Places

Many Hong Kong property developers actively improve the horticultural landscape of private residential properties by planting trees to meet the growing public demand for a green living environment. But most do not consider reserving enough space for the future growth and development of trees. In the past, most chose to plant fast-growing, large, cheap and unsuitable tree species to immediately grow into a good shape to facilitate the sales of properties. Since then, no appropriate measures have been taken to ensure the healthy growth of the trees. The growing environment of trees is generally poor. From the case studies, it is found that “Banyan” trees are commonly planted in many residential properties due to their resilience and tenaciousness. Such tree types are notoriously large in terms of the size and load, but their roots are usually planted in narrow tree pits. Under normal circumstances, the diameter of tree crowns and tree roots should be similar, and there should be enough space for the roots to grow and stretch to maintain health, firmness, stability and safety. Since most trees grow in relatively narrow spaces and are blocked by concrete or paving slabs, their roots cannot withstand the maximum tree load, and their wind resistance is weak, so they can easily fall under strong winds. It all starts with planting wrong trees at the beginning. Property management practitioners often feel powerless and find it difficult to rectify tree planting decisions made by developers or the government in the past. The conflict between people and trees always occurs because people live too close to trees. In this environment, the risk of trees is also increasing, which is not ideal.

Lack of Government Supervision & Enforcement of Private Trees

At present, the Hong Kong government only requires owners to handle private trees through administrative means, but the relevant means have no legal effect. Although some leases have tree preservation clauses stipulating that trees cannot be felled at will, there are no clear and mandatory legal requirements for tree maintenance. Case studies and survey found that not all properties were fully compliant with the government's advices to establish a complete and up-to-date tree registration list to monitor the tree conditions, conduct tree risk assessments, and deal with problematic trees before and after the rainy season and severe weather by taking mitigation measures in time. The government only hopes that owners and property management companies will follow. This is just wishful thinking! Many people still choose to ignore it, even if they know that the government can fine owners who violate the tree preservation clauses. In fact, the government seldom actively checks whether the owners comply with these clauses. Even if the owners perform tree duties, the methods and quality of private tree maintenance will be greatly different given their tree works are not supervised and monitored.

Cumbersome Approval Process & Limited Transparency in Tree Removal

The Lands Department does not help owners and property management practitioners to easily understand the basic application procedures and knowledge for approval of felling trees, and the existing procedures are too cumbersome as well. Many people do not abide by the "Code of Practice" of the Lands Department, mainly due to the inconvenience of reading. There is only an English version without a simplified outline, and the content is too technical. This poses a huge challenge for applicants who are not proficient in English reading and have trouble understanding the meaning of each sentence. To obtain the Lands Department final's approval requires passing through multiple government

checkpoints. Many people question the lack of clarity and transparency of such approval process mechanism. In many cases, the approval process is further delayed due to incomplete and unsatisfactory documents submitted. Applicants do not understand all required procedures and therefore give up the official application method. They like to cut trees in an unauthorized way, which is faster, easier and cheaper. More importantly, they know that the Lands Department is short of manpower for law enforcement and inspection, or some breach the law mistakenly and unknowingly because they are unfamiliar with the provisions.

Inconsistent Tree Management Methods

Different private residential properties have different tree growth conditions, have their own tree management methods, and tend to solve tree problems according to their own wishes and methods. Mishandling of trees is a common phenomenon, and most do not even know it. Many properties do not have uniform, clear and objective tree management standards to maintain and monitor trees. For example, trees are often pruned directly by unqualified personnel without experience and cause irreparable damage to trees. In addition, most do not specifically inspect the tree conditions, and only arrange frontline staff to conduct an urgent and short inspection after heavy rains and typhoons so as to report potential insurance claims. They also rely on a daily complaint mechanism to respond to the "tree problems" that customers are concerned about and resolve them recklessly and unreasonably.



Conclusion

Trees undoubtedly bring different benefits to the urban environment and residents. Most private residential areas plant trees to beautify the living environment even in densely populated and limited environments, but as the trees grow, get older and bigger, many tree management and safety issues arise. This create problems because people live too close to trees and trees are exposed to repeated extreme summer weather (like typhoons) in which tree mismanagement can trigger tree collapse and cause casualties and property loss. Private property owners and property management companies (i.e. frontline and management staff) are fully responsible for the private management and maintenance, meanwhile, they encounter different issues and challenges when participating in and performing tree management and maintenance.

Recommendations

The government has a greater leadership role in improving tree management and maintenance. Given it has the ability to comprehensively manage and coordinate both public and private organizations and personnel to produce the best results, most of the recommendations are made to the government. Below please find the key issues and challenges and the corresponding improvement suggestions:

- Currently, since there is no legal regulation on whether owners should inspect and maintain trees, private trees pose a potential threat to life and property. When problematic trees are found, it is simply through the Lands Department to persuade owners to take actions to reduce tree risks via land lease terms. Existing regulations do not empower the government to force owners to take timely and necessary actions against problematic trees. Supervision and enforcement are clearly insufficient. It is recommended that the government establish a specialized tree department to study various areas of tree laws and regulations related to the quality of private tree management. It is expected that the entire legislative process will take time and require discussions and negotiations among different stakeholders (like property developers) to create conditions acceptable to all.
- Tree management involves professional knowledge, but practitioners lack relevant knowledge. It is recommended that the government consider increasing funding for publicity and education to attract them to pay more attention to tree management issues.
- Practitioners lack experience and knowledge in tree management and maintenance. It is recommended that the government fight this problem on two major fronts: For existing practitioners, it can provide relevant arboriculture and practical training to enhance their knowledge and understanding. Most importantly, the government can train new professionals and frontline practitioners about trees by requiring academic and training institutions to add tree management content to recognized property management courses and provide subsidies for these courses.
- Many owners encounter financial problems. In principle, it is their responsibility to manage private trees. However, under the premise of ensuring safety, it is recommended that the government consider giving appropriate assistance and subsidies to those who pass the eligibility test to inspect trees and conduct tree risk reduction works.
- It is difficult to judge the work experience, background and professional qualifications of horticultural and arboricultural contractors and practitioners due to high variance in performance and quality. It is recommended that the government and professional institutions consider jointly compiling a list of registered qualified contractors and practitioners to assist people in hiring qualified personnel to conduct tree works in private properties.

- Since the government has not formulated a set of clear, objective and unified practical tree management and maintenance guidelines for private residential properties, the methods and quality of tree management vary greatly among properties. It is recommended that the government consider reviewing all relevant tree guidelines and provide practitioners with simplified and easy-to-understand versions for compliance, so as to avoid violating the law due to vague information or misunderstanding of procedures.
- Private residential properties in Hong Kong generally lack long-term and sustainable tree planning plan. Due to the close distance between trees and people and the influence of climatic conditions, planting large invasive trees in urban areas is not suitable. Planting right tree species in the right places can reduce tree collapse risks. It is recommended that the government consider providing a reference list of tree species suitable for planting in private residential property environments. Doing so can enable property developers and management companies to select suitable tree species through early tree planning and evaluation, thereby minimizing the chance of future potential tree problems and facilitating long-term maintenance.

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Taking the Public Rental Housing in Hong Kong as the Case Study, Does Social Network Matter to the Elderly's Happiness with the Mediating Role of Perceived Public Support?



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Introduction

This research aims at studying the mediating effect of perceived public support on the relationship between social network and the happiness of the elderly while taking PRH as the case study.

The present study formulates three objectives:

- 1) To examine social network and happiness of the elderly living in PRH;
- 2) To examine perceived public support from three housing aspects (i.e. quality of housing and environment, neighborhood and community environment, housing policy) on the happiness of elderly living in PRH; and

- 3) To explore the relationship among social network, perceived public support and happiness of the elderly living in PRH quantitatively and qualitatively.

Hong Kong and many Western industrialized countries have adopted aging in place as policy concern. Housing is not simply providing accommodation but also the place for the elderly living with the community, thus promote their level of happiness through social network. Aging in place is the social integration of accommodation, social network and related public services. Under this basis, it is worthwhile to examine residents' perceptions of public support in order to shed light on how the housing policy could promote the happiness of old PRH residents.



Literature Review

Many researches have conducted evaluation of the effectiveness of housing services but there is limited study on the relationship among social network, public housing support and elderly's happiness. Most empirical findings indicate that social network plays a significant role in elderly's happiness or subjective well-being, however, its causality was studied inadequately in the context of Hong Kong especially in PRH. Thoits (1982) reminded the interpretation of the researchers on social network should be extremely cautious with adequate conceptualization and operationalization of the study topic involving different dimensions such as quality and quantity aspects. In this study, the perceived social support, as a mediating actor contributes to the functional dimension of the social network and fills the gap in the causality between social network and happiness of elderly living in PRH.

Pinquart and Sorensen (2000) showed that there is higher correlation between elder groups' social network and subjective well-being than those of younger group. Hence, social support plays an essential role and is more significant to the happiness of elderly group than those of younger generation. So, the elderly was selected as target group in this study.

Social Network

In this study, the definition of social network is operationalized as the linkage of individuals to form the supportive network for specific purpose or function. Scholars had analyzed social network from different aspects. For example, Otte and Rousseau (2002) studied social network through structural analysis while Pinquart and Sorensen (2000) focused on the quality aspect that measures the emotional support, quality of social contact and relationship among the individuals.

Dimensions of Social Network

Classifying the social network into structural, quality and functional dimensions were adopted in the research and the key determinant was selected from each dimension for study. They are Network size (Structural Dimension), Quality of social relationship (Quality Dimension) and Perceived public support (Functional dimension).

a. **Structural Dimension: Network size**

Network size was identified as the key determinant of happiness that was measured by the number of members in the network who provide social support to the elderly. The social network size is not just the number of members in relation with the elderly, but also with the role who provide social support to the elderly.

b. **Quality Dimension: Quality of social relationship**

Quality of social relationship is the perceived feeling close to someone and was measured by getting emotional support from someone (Pinquart and Sorensen, 2000). It was measured in two aspects: Frequency of contact and Perceived social relationship. Pinquart and Sorensen (2000) showed that the number of contact partners and the frequency of social contact contribute to subjective well-being. Perceived social relationship is specific to the subjective perception feeling to the relationship with neighbors and the ease to acquire emotional or social support from them.

c. Functional Dimension: Perceived public support

Perceived social support refers to the subjective perception of the social support and the extent to which an individual is accepted from other social network members (Sarason et al., 1987) while perceived public support is the perceived social support initiated by public housing sector specifically.

In this study, the public support is specified as the social support function provided by the Hong Kong Housing Authority (HKHA) to the elderly residents through housing support and policy.

Happiness

Under the context of housing condition, the elderly's well-being is interpreted as a state of balance provided that their requests or needs are satisfied regarding the demands to the nearby environment or network (Phillips et al., 2005). In this study, happiness refers to the elderly's subjective assessment of their living environment and satisfaction to the housing support.

Mediating factors of Perceived Public Support

Empirical studies indicated that social network size largely affects the happiness in later life through the mediator role of perceived social support (Chan and Lee, 2006; Wang, 2016). The level of social support received and perceived by older people is affected and shaped by living environments in large extent (Tomaszewski, 2013). The finding was extended to this study which further examined the perceived social support under the housing context. Taking the PRH as the case study, the social support is specified as the public support provided by HKHA. Living environment and housing policy are likely to act as mediators in shaping social network and well-being in older age through the public support provided by HKHA. The mediating factors — perceived public support is going to be examined

under three housing aspects that are Quality of housing and living environment, Neighborhood and community environment, Housing policy. It is suggested that social network itself does not directly influence happiness of the elderly resident; rather it increases the elderly's happiness level with the mediating effect of perceived public support.

a. Quality of Housing and living environment

The housing or its objective quality does not directly affect the happiness of the residents; rather it contributes to the level of happiness through the subjective perception on the housing that is the housing satisfaction of residents. The satisfaction level on physical aspects of housing and the quality of living environment shape the pattern of social identity and interaction that influences psychological well-being of residents (Tomaszewski, 2013). So, this aspect was measured with housing satisfaction on flat design, security and cleansing services etc.

b. Neighborhood and community environment

Neighborhood and community environment supports the elderly residents to achieve subjective well-being through creating opportunities for social interaction, development of relationships and giving and receiving of support (Cook et al. 2017). Convenient transport of neighborhood increase mobility and enhance interactions among the elderly. Providing more recreational amenities and public space for communication among the elderly could increase their attachment to the living environment and thus enhance their happiness through increasing social interaction. So, this aspect was measured with the residents' perception on transport, recreational amenities and public space.



c. Housing policy

A study revealed that the elderly’s psychological happiness depends on the extent of their expectations on the housing policies or living satisfaction which are met (Phillips et al., 2005). Housing policy and planning such as PRH location is crucial for the elderly since their capability and mobility is limited. Social support is essential for them when they are getting old. As such, a continuous service with integration of social care and housing are necessary. The satisfactions of elderly residents on a series of housing policies or services provided by HKHA were the determinants of this aspect.

Conceptual Framework

Based on the empirical literature discussed, social network itself does not directly influence happiness of the elderly resident; rather it increases the elderly’s happiness level with the mediating effect of perceived public support. The conceptual model was constructed as follows:

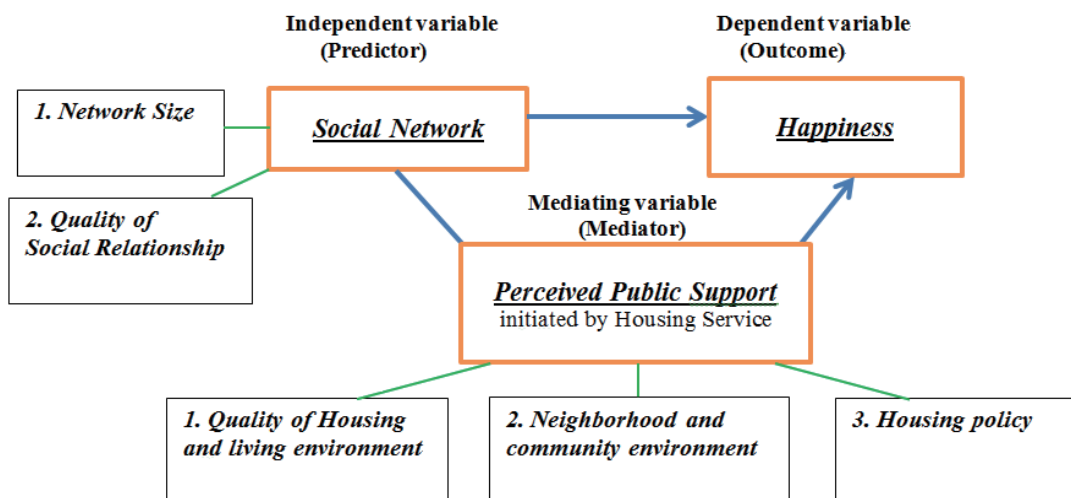


Figure 1: Conceptual framework model

Social network is an independent variable that will influence the dependent variable — happiness of the elderly through the mediating effect of three aspects of perceived public support. The independent variable is classified into 2 dimensions — ‘network size’ and ‘quality of social relationship’. It is believed that the housing

provision and services for the elderly will have mediating effect on the relationship between social network and the happiness of elderly people living in PRH through three aspects namely quality of housing and living environment, neighborhood and community environment and the housing policy.

Methodology

Social network was hypothesized to be the predictor with two aspects: network size (SNS) and quality of social relationship (SNQ); the happiness of the elderly (HPY) respondents was hypothesized to be outcome variable; and the three aspect

of perceived public support: housing & living environment (HLE), neighborhood & community environment (NCE) and housing policy (HPO) were hypothesized to be the mediators.

This study sought to test six main hypotheses:

Hypothesis 1 (H1):	"HLE" mediates the effect of "SNS" on elderly's happiness.
Hypothesis 2 (H2):	"NCE" mediates the effect of "SNS" on elderly's happiness.
Hypothesis 3 (H3):	"HPO" mediates the effect of "SNS" on elderly's happiness.

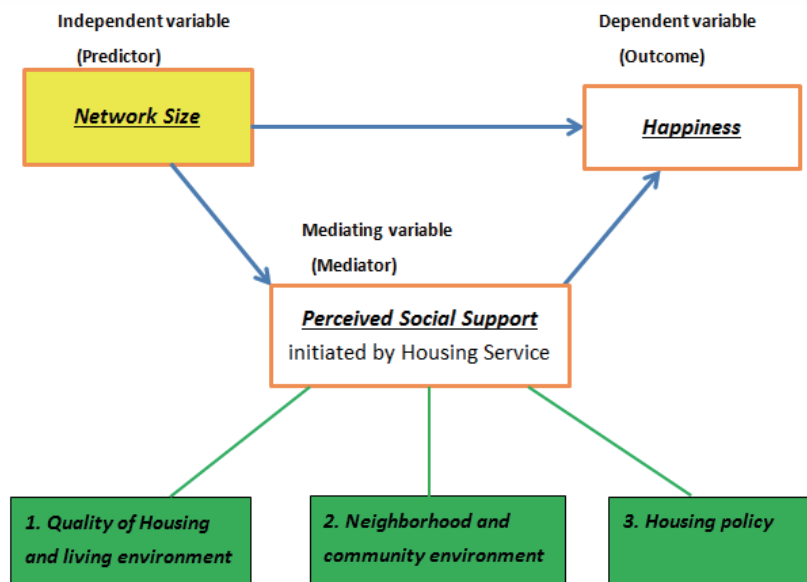


Figure 2: Hypothesis with network size (SNS)

Hypothesis 4 (H4):	"HLE" mediates the effect of "SNQ" on elderly's happiness.
Hypothesis 5 (H5):	"NCE" mediates the effect of "SNQ" on elderly's happiness.
Hypothesis 6 (H6):	"HPO" mediates the effect of "SNQ" on elderly's happiness.

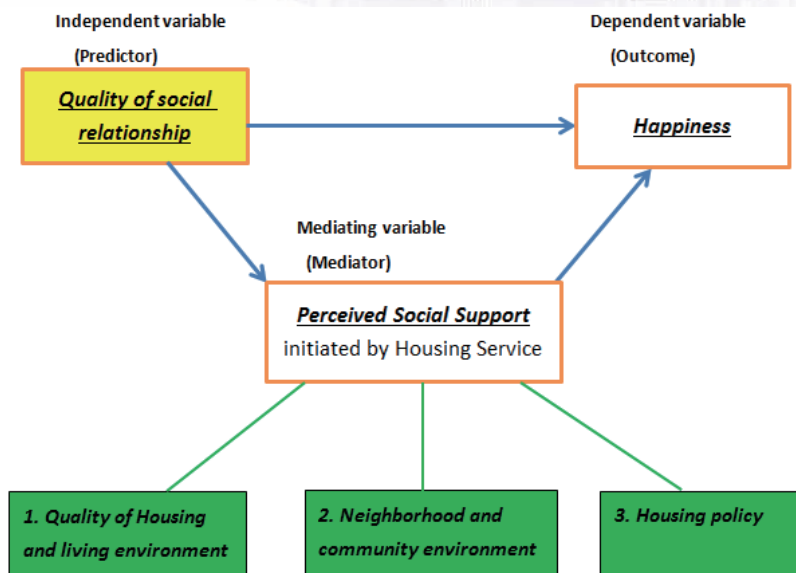


Figure 3: Hypothesis with quality of social relationship (SNQ)

Research Design

The study method adopted in this research was mixed approach (both quantitative and qualitative study) with questionnaires survey and in-depth interviews. With reference to the conceptual framework involving various types of housing services, properties of social network and happiness, the interview questions were classified into several parts including background information, social network size, level of happiness and perception on 3 aspects of perceived public support (HLE, NCE and HPO).

Sampling Method and Data Collecting Method

The target group was elderly, aged 60 or above who were with retirement status and lived in public housing. A total of 200 sample sizes were expected to be collected from the questionnaires. Due to the Coronavirus Infection in Hong Kong, the questionnaires were changed to online format and 10 in-depth interviews were further conducted by phone or Whatsapp.

Method of Data Analysis

To analyze the quantitative data, computer-based quantitative tools IBM SPSS Statistics v26 and PROCESS Macro for SPSS were used. In order to ensure the reliability and validity of the findings, we tested for both the robustness and reliability of the findings. Moreover, the inferential statistics were used to establish whether the study outcomes were significant for the sake of generalising to the entire population or not. The regression analysis is a statistical technique that is used to measure linear or curve linear relationships between dependent and independent variables. Finally, the Hayes SPSS Process macro was used for the mediation analysis, using the Sobel test and the mediating variables were HLE, NCE and HPO.

In-depth interview

10 respondents were selected from the questionnaire interviewees to participate in the in-depth interview. The aim of the case study is to understand and extract the interviewees' opinions and suggestions on the significant issues and further explore the research study.

Result and Data Analysis

Robust Result

To test for the robustness of the model, the researcher incorporated two techniques that were the test for reverse causality and the test for endogeneity.

The causal effect of the independent variable on the dependent variable is wrongly computed when there is reverse causality present. From the Granger Causality Test, the reverse causality

of dependent variable HPY on SNS, SNQ, HPO, NCE and HLE had p-values that were all greater than 0.05 that is 0.219, 0.508, 0.288, 0.439 and 0.676 respectively. In this regard, the researcher confirmed that there was no reverse causality present in the link between HPY and the variables SNS, SNQ, HPO, NCE and HLE.

Correlation Result

With respect to the correlation analysis of sex, age and health along with the dependent variable and the mediating variables, the output is presented in Table 1.

Table 1: Correlation Matrix between significant control variables, mediating variables and dependent variable in the mediating effect

		Sex	Age	Health condition	HPY	HLE	NCE
r	Age	.033					
	Health condition	.007	-.210				
	Happiness	.086	-.241	.423			
	HLE	.077	-.067	.315	.763		
	NCE	.064	-.103	.286	.525	.528	
	Housing Policy	.013	-.119	.311	.521	.473	.543
p	Age	.323					
	Health condition	.459	.001				
	Happiness	.111	.000	.000			
	HLE	.140	.172	.000	.000		
	NCE	.183	.072	.000	.000	.000	
	Housing Policy	.428	.046	.000	.000	.000	.000

From the correlation matrix, there was significant and high correlation between each mediator variable and dependent variable, i.e. HLE and

happiness (0.763; $p < 0.05$), NCE and happiness ($r = 0.525$; $p < 0.05$), HPO and happiness ($r = 0.521$; $p < 0.05$).



Regression Result

Multiple regression analysis was adopted to establish the direct effect of independent variables SNS and SNQ on happiness.

It was tested with ANOVA and the results are presented in Table 2.

Table 2: Regression Model Fit – SNS/SNQ

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	77.445	2	38.723	99.185	.000b
	Residual	77.692	199	.390		
	Total	155.137	201			

- a. Dependent Variable: Happiness
- b. Predictors: (Constant), Social Network Quality, Social Network Size

From the findings, $F(2, 199) = 38.723$; $p=0.000 < 0.05$. Since the p-value was less than 0.05, the researcher confirmed the regression model was valid. The regression coefficients for the model are presented in Table 3.

Table 3: Regression Coefficients – SNS/SNQ

						Collinearity Statistics		
Model		B	Std. Error	Beta	t	Sig.	Tol	VIF
1	(Constant)	.889	.177	5.032	.000			
	Social Network Size	.299	.068	.251	4.413	.000	.780	1.282
	Social Network Quality	.618	.063	.553	9.740	.000	.780	1.282

- a. Dependent Variable: Happiness
- The p-values of SNS and SNQ were less than 0.05. It meant that both were significant predictors of happiness.

respondents to be the outcome variable; and the three aspect of perceived public support: housing & living environment (**HLE**), neighborhood & community environment (**NCE**) and housing policy (**HPO**) to be the mediators.

Hypothesis Result

The Sobel test was adopted as the mediation analysis in which **SNS** and **SNQ** were hypothesized to be the predictor; the happiness of the elderly

In order to ensure the covariance factors among the mediating effect did not produce misleading findings, the control variables were controlled for in the mediating analysis.

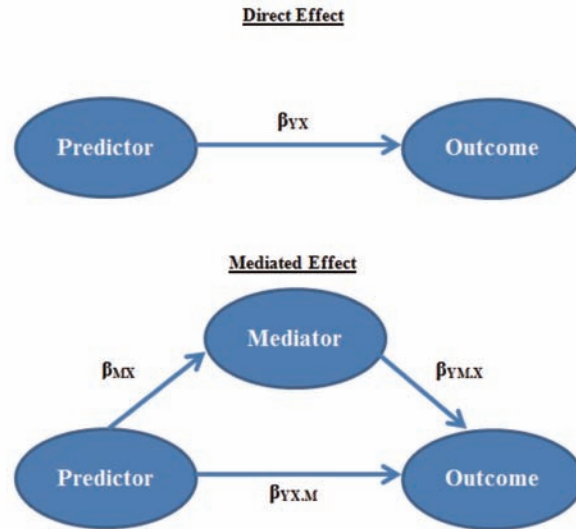


Figure 4: The diagram of direct and mediated effect

To establish whether predictor variables **SNS** and **SNQ** had the influence on outcome variable (happiness) with mediation effect, the test model is demonstrated in Figure 4. If the relationship between predictor and outcome variable has been significantly decreased (i.e. $\beta_{YX} > \beta_{YX.M}$) after inclusion of the mediator, the mediated effect is established.

This study sought to test six main hypotheses: H1 to H6.

The results are presented below, starting with HLE.

DIRECT AND TOTAL EFFECTS (SNS/HLE)					DIRECT AND TOTAL EFFECTS (SNQ/HLE)				
	Coeff	s.e.	t	Sig(two)		Coeff	s.e.	t	Sig(two)
b(YX)	.6086	.0725	8.3931	.0000	b(YX)	.7494	.0586	12.7974	.0000
b(MX)	.5722	.0663	8.6249	.0000	b(MX)	.6085	.0587	10.3665	.0000
b(YM.X)	.7397	.0570	12.9669	.0000	b(YM.X)	.6104	.0559	10.9126	.0000
b(YX.M)	.1854	.0627	2.9570	.0035	b(YX.M)	.3780	.0576	6.5650	.0000

Table 4: Direct and total effects on HLE

The mediating role of **HLE** was found to be significant between **SNS** and happiness; and between **SNQ** and happiness. The effect of **SNS** on happiness decreased from $\beta_{YX} = 0.609$ to $\beta_{YX.M} =$

0.185. The effect of **SNQ** on happiness decreased from $\beta_{YX} = 0.749$ to $\beta_{YX.M} = 0.378$. The mediation effect was shown to be significant in Sobel test of H1 and H4.

DIRECT AND TOTAL EFFECTS (SNS/NCE)					DIRECT AND TOTAL EFFECTS (SNQ/NCE)				
	Coeff	s.e.	t	Sig(two)		Coeff	s.e.	t	Sig(two)
b(YX)	.6086	.0725	8.3931	.0000	b(YX)	.7494	.0586	12.7974	.0000
b(MX)	.1956	.0621	3.1498	.0019	b(MX)	.4029	.0523	7.6955	.0000
b(YM.X)	.5764	.0720	8.0084	.0000	b(YM.X)	.3515	.0753	4.6690	.0000
b(YX.M)	.4959	.0648	7.6559	.0000	b(YX.M)	.6078	.0635	9.5793	.0000



Table 5: Direct and total effects on NCE

The mediating role of **NCE** was found to be significant between **SNS** and happiness; and between **SNQ** and happiness. The effect of **SNS** on happiness decreased from $\beta_{YX} = 0.609$ to $\beta_{YX.M} =$

0.496. The effect of **SNQ** on happiness decreased from $\beta_{YX} = 0.749$ to $\beta_{YX.M} = 0.608$. The mediation effect was shown to be significant in Sobel test of H2 and H5.

DIRECT AND TOTAL EFFECTS (SNS/HPO)					DIRECT AND TOTAL EFFECTS (SNQ/HPO)				
	Coeff	s.e.	t	Sig(two)		Coeff	s.e.	t	Sig(two)
b (YX)	.6086	.0725	8.3931	.0000	b (YX)	.7494	.0586	12.7974	.0000
b (MX)	.1833	.0824	2.2246	.0272	b (MX)	.4108	.0725	5.6647	.0000
b (YM.X)	.4581	.0533	8.5996	.0000	b (YM.X)	.3191	.0526	6.0684	.0000
b (YX.M)	.5247	.0628	8.3497	.0000	b (YX.M)	.6183	.0581	10.6436	.0000

Table 6: Direct and total effects on HPO

The mediating role of **HPO** was found to be significant between **SNS** and happiness; and between **SNQ** and happiness. The effect of **SNS** on happiness decreased from $\beta_{YX} = 0.609$ to $\beta_{YX.M} = 0.525$. The effect of **SNQ** on happiness decreased from $\beta_{YX} = 0.749$ to $\beta_{YX.M} = 0.618$. The mediation effect was shown to be significant in Sobel test of H3 and H6.

Discussion and Findings

The main objective of this research was to analyze social networks for the Hong Kong population aged 60 or above living in PRH and examine their perceptions of public support in order to shed light on how the housing policy could be improved and enhance the happiness of old PRH residents. The 6 hypotheses of the study were all confirmed to be positive.

First, regression analysis demonstrates the significant correlations between two aspects of social network (size and quality) and happiness. Then, correlation result reflected the significance relationship among housing services and happiness. Finally, it is going to elaborate how the relationship between social network and happiness was mediated by the three housing aspects of perceived public support.

Social network and happiness

Both the network size and quality aspect of social network were positively related to the happiness among older people according to the regression result. The result suggests that the bigger network size of the elderly residents in PRH, their level of happiness is higher. It also suggested that the higher quality of social relationship was important for enhancing the happiness of the respondents.

Housing services and happiness

The direct effect of housing service is significant with positive impact on the happiness of elderly respondents referring to Table 1. Both quantitative and qualitative findings indicated that the public services catering for the needs of the respondents and offering direct help from the services would acquire more satisfaction from the elderly residents. According to the in-depth interviews, it also reflected that the housing services provided by HKHA were not widely used and yet be acknowledged by the respondents. Therefore, the elderly could not enjoy the services even though they have the real need on it and thus their level of happiness would be undermined. It is worth noting for the implementation of housing policy.

Mediating effect of the three aspects of perceived public support

The main finding of this research was that social network in terms of network size (SNS) and quality of social relationship (SNQ), was associated with happiness of elderly living in PRH and this relationship was mediated by the perceived public support that includes 3 aspects: quality of housing and living environment, neighborhood and community environment and housing policy. Every hypothesis was found to be positive. It suggested that each aspect of perceived public supports the mediating effect between social network and happiness of the older residents in PRH.

a. Quality of Housing and Living environment

As one of the chosen housing aspects of perceived social support to be examined, mediating effect of housing and living environment was consistent with previous finding that the social network largely affected the happiness in later life through the mediator role of perceived social support (Chan and Lee, 2006; Wang, 2016).

According to Table 4, it showed that satisfaction at the living environment played a mediating role and the elderly with larger social network or higher quality social relationship were more likely to be satisfied with their living environment and with higher level of happiness. Access to well-designed public housing and public spaces enhanced the housing satisfaction and social interaction though the living environment and promote the happiness of older people who spend much time there with less mobility. The result is consistent with the findings of Tomaszewski (2013) indicating that what matters most for the happiness of the elderly residents is how people feel and how they perceive about their living environment, whether they find it safe, comfortable, rather than the objective criteria.

b. Neighborhood and Community environment

Another aim of this study was to investigate the relationship between social network and happiness via the mediating effects of neighborhood and community environment. According to Table 5, it showed that satisfaction with public amenities provided and maintained by HKHA was positively related and mediated to the level of happiness. It indicated that people who spent more time on communicating with friends and neighbors were happier. It is consistent with previous finding that elderly who had higher feelings of happiness were more likely to feel attached to their neighborhood (Kemperman, 2019). Favorable recreational and exercise facilities attracted older people do more outdoor activities and allow more opportunities to interact with neighbors. Good material conditions of public facilities and space kept close link with the social network interaction and give rise to the happiness of the elderly. As a result, they became more satisfied and attached to the local community and it enhances their happiness.

c. Housing policy

According to Table 6, it confirmed that housing policy served as a mediating role between social network and happiness, and between quality of social relationship and happiness. It was consistent with previous finding of Coates (2013). The elderly who have larger social network or better social relationship and those perceived well with the housing policies or services were having higher level of happiness.

Interpersonal communication is a crucial factor in social network. Larger social network and stronger social connections usually has more knowledge on public services or policies. The interpersonal communication among the network members shapes the

satisfaction on housing services or policy and affects the happiness of the residents eventually. This perception is aligned with Phillips et al (2005) that residential satisfaction has positive correlation with elderly's happiness.

Conclusion

The present research was a leading topic to explore social network and happiness with the mediating effect of perceived public support to the PRH elderly in Hong Kong. The research finding confirmed the relationship between social network and happiness was not simple direct effect but under the mediating effect of perceived public support. Quality of housing and living environment, neighborhood and community environment, housing policy were found to be significant mediators on the happiness of elderly residents. In light of the essential roles of public support and housing policy, the happiness of Hong Kong elderly should be enhanced and concerned in policy making.

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物業環境污染源入滲導致地下水污染之理論解

A Theoretical Solution of Groundwater Pollution Transmission Due to Property Environmental Pollution Source Infiltration



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一、研究背景、目的及方法

物業環境污染源入滲導致地下水污染是國際上共同面臨的難題以及亟待解決的問題，國際上如大陸、越南、印度…等從開發中國家歷經高度工業化過程中亦常見嚴重的地表污染源因降雨入滲以及水井灌入污染源導致不飽和含水層地下水嚴重污染。

台灣地區史上最嚴重的土壤及地下水嚴重污染事件是由於臺灣美國無線電公司(RCA)桃園廠長期挖井傾倒有機溶劑等有毒廢料，土壤及地下水污染治理從1997/3至2019/4完成歷時約22年，整個污染事件造成1,375人罹患癌症，其勞工509人因癌症死亡[RCA義務辯護律師群，2001]。

根據BBC報導[2016]中國環保部2015年6月發佈的《2014中國環境狀況公報》數據顯示，中國近三分之二地下水和三分之一地面水人類不宜直接接觸。2016年4月，中國水利部報告又稱，中國

逾80%被測地下水污染嚴重。根據2017年2月22日駐越南台北經濟文化辦事處[2017]網頁公開資訊報導，根據越南環境總局的統計，越南大部分城市地區，特別是河內和胡志明市的地下水¹。

2011年1月18日 BBC報導越南地下水污染情況嚴重，研究人員警告，越南人口稠密的紅河三角洲有超過四分之一的飲用地下水井含有超過安全值的砷。報告執筆人伯格警告說，當地大約700萬人有相當高的慢性砷中毒風險。很多國家都有地下水遭砷污染的問題，比如阿根廷、澳大利亞、孟加拉國、智利、中國、匈牙利、印度、墨西哥、秘魯、泰國和美國等²。

由於地下水污染是國際上共同面臨的難題，故本研究之目的為探討地表污染源入滲導致不飽和含水層地下水污染之解析解，可透過理論解析模式探討地下水污染傳輸的影響範圍並可作為政府部門針對重點地下水污染區佈設電子監測儀器範圍之參考。

¹ 資料來源網址 :<https://www.roc-taiwan.org/vn/post/8483.html>

² 資料來源網址 :https://www.bbc.com/zhongwen/trad/world/2011/01/110118_vietnam_water_wells.

本研究之方法為利用質量守恆原理來求解非拘限含水層淺層地下水降雨補注導入污染源污染地下水之理論解，將以線性化理查(Linearized Richards Equation)方程式以及對流擴散方程式(Advection Dispersion Equation)為控制方程式進行耦合方程式求解，應用函數轉換求解理查(Richards)方程式，求解任意降雨量及固定土壤體積含水比之條件下的染物傳輸之解析解。

二、文獻回顧

S. Ahmed[2019] 探討印度北方邦馬圖拉市地下水的重金屬污染和地質累積指數，研究指出印度城市地區的重金屬污染非常嚴重和復雜。研究發現水中重金屬總濃度依次為Ni> Fe> Pb> Cr> Cd> Zn> Mn> Cu沉積物質量指標，如重金屬污染指數(HPI)和地質累積指數(Igeo)。證實馬圖拉市地下水中重金屬污染對Pb, Cd, Ni, Fe和Cr的影響還評估了地下水中重金屬的相關矩陣。在大多數這些重金屬中沒有觀察到顯著的相關性，表明有不同人為和自然污染源。

廉新穎[2018] 探討地下水污染修復技術驗證評價方法研究，採用層次分析法建立了由目標污染物去除效果、副產物情況、固體廢物、廢水、廢氣、噪音、自動化水準、故障情況、適用場地類型、基建費用、藥劑投加量、能源消耗和資源回收利用共13個指標組成的地下水污染修復技術驗證評價指標體系。

塗婷[2017] 探討贛南稀土礦區地下水污染現狀、危害及處理技術與展望，贛南稀土礦區由於受離子型稀土礦開採的影響，地下水污染嚴重。研究指出贛南稀土礦區礦山開採和原地浸礦導致的地下水稀土元素、三氮(離子態的氨氮、亞硝酸鹽氮和硝酸鹽氮)和硫酸鹽污染現狀，分析了該類型地下水污染的危害，總結目前已有的地下水修復方法並分析其應用局限性，提出適用於贛南稀土礦區的地下水污染治理思路。

莊詠傑[2016] 探討應用自然電位法於土壤與地下水污染場址的監測研究指出，他嘗試引入地球物理探勘技術中的自然電位法(Self-Potential Method, SP)以克服土壤與地下水污染物和整治藥劑作用範圍在地下難以界定，該研究以飽和食鹽水灌注的砂箱實驗，以逆推自然電位剖面探討流動電位的分布，發現以驗證研究場址的監測結果，得到流體源頭為負電位；入滲前緣為正電位的特徵。

三、物業環境地表污染源入滲非飽和層地下水污染傳輸解析模式

對於地表污染源入滲非飽和層地下水污染傳輸問題之求解本文將分成三個部分求解，第一部分為求解線性化理查方程式解析解，將利用函數轉換之方法將理查方程式轉換成線性的擴散方程式，求出擴散方程式之解析解後再逆轉換求得理查方程式之解析解，可求得地表污染源入滲非飽和層的流速分佈；第二部分為求解對流擴散方程式解析解，將求出污染物濃度分佈的解析解；第三部分為求解理查方程式與對流擴散方程式耦合解，將第一部分求得地表污染源入滲非飽和層的流速分佈帶入第二部分為求解出污染物濃度分佈的解析解，即可求得地表污染源入滲非飽和層地下水污染傳輸分佈的解析解。本章將分別探討地表污染源入滲非飽和層地下水污染傳輸問題之三個求解過程，求解流程圖如圖3-1所示，以一維入滲問題為例進行求解，分別說明如下。

3-1、一維線性化理查方程式解析解

考慮一維無地下水位之半無窮區間入滲問題如圖 3-2 所示，而理查方程式之可列出如下：

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z} \left(k(\theta) \frac{\partial \psi}{\partial z} \right) - \frac{\partial k(\theta)}{\partial z} \quad (3-1)$$

上式中 θ 表體積含水比 (Volumetric water content)， t 表時間， z 表深度定義向下為正， k 表水力傳導係數， ψ 表張力水頭。上式為非線性微分方程式，為使理查方程式線性化易於求解，本文假設比擴散度 D 為常數並採用 Srivastava and Yeh [1991] 相同之假設，水力傳導係數及體積含水比與張力水頭之指數函數關係如下：

$$k(\psi) = k_s \cdot e^{\alpha \psi} \quad (3-2)$$

$$\theta = \theta_r + (\theta_s - \theta_r) \cdot e^{\alpha \psi} \quad (3-3)$$

上式中 k_s 為飽和之水力傳導係數， α 為土壤孔隙分佈係數， θ_s 表飽和體積含水比， θ_r 表殘存體積含水比。則線性化之理查方程式可列出如下：

$$\frac{\partial \theta(z,t)}{\partial t} = D \frac{\partial^2 \theta(z,t)}{\partial z^2} - k^* \frac{\partial \theta(z,t)}{\partial z} \quad (3-4)$$

上式中 $D = k^* / \alpha$ ， $k^* = dk / d\theta = k_s / (\theta_s - \theta_r)$ 。

起始條件及邊界條件列出如下：

$$\theta(z,t) \Big|_{t=0} = \theta_r \quad (3-5)$$

$$\theta(z,t) \Big|_{z \rightarrow \infty} = \theta_r \quad (3-6)$$

$$q(t) = -D \frac{\partial \theta}{\partial z} \Big|_{z=0} + k \Big|_{z=0} \quad (3-7)$$

上列 (3-4) 式至 (3-7) 式可求得解析解如下 [Chen et. al.'s 2001]。

$$\theta(Z,T) = \theta_r + \theta_s \cdot e^{-\frac{Z^2}{4T}} \cdot \int_0^T \left\{ \frac{f(\tau)}{\sqrt{\pi(T-\tau)}} \cdot \exp\left(-\frac{Z^2}{4(T-\tau)}\right) \right\} d\tau \quad (3-8)$$

上式中 T 及 Z 為無因次參數，定義為 $Z = \frac{k^* z}{D}$ 及 $T = \frac{(k^*)^2 t}{D}$ 。定義流速 $V(z,t)$ 如下所示：

$$V(z,t) = -k \frac{d\psi}{dz} \quad (3-9)$$

求得地表污染源入滲非飽和層的流速分佈如下所示：

$$V(z,t) = -k_s \frac{1}{\theta_s - \theta_r} \frac{1}{\alpha} \frac{d\theta(z,t)}{dz} \quad (3-10)$$

3-2、一維對流擴散方程式解析解

考慮一維地表污染源濃度 C_0 藉由地表降雨入滲污染非飽和含水層，一維對流擴散問題的控制方程式、起始條件以及邊界條件如下所示：

$$\frac{\partial C(z,t)}{\partial t} = D \frac{\partial^2 C(z,t)}{\partial z^2} - V \frac{\partial C(z,t)}{\partial z} \tag{3-11}$$

$$C(z,t)|_{t=0} = 0 \quad z = 0 \tag{3-12}$$

$$C(z,t)|_{z=0} = C_0 \quad t \geq 0 \tag{3-13}$$

$$C(z,t)|_{z=\infty} = 0 \quad t \geq 0 \tag{3-14}$$

上列(3-10) ~ (3-13)式可利用 Ogata et. al.'s [1961] 推導之結果解得：

$$C(z,t) = \frac{C_0}{2} \left[\operatorname{Erfc} \left(\frac{z-Vt}{2\sqrt{Dt}} \right) + e^{\frac{Vz}{D}} \cdot \operatorname{Erfc} \left(\frac{z+Vt}{2\sqrt{Dt}} \right) \right] \tag{3-15}$$

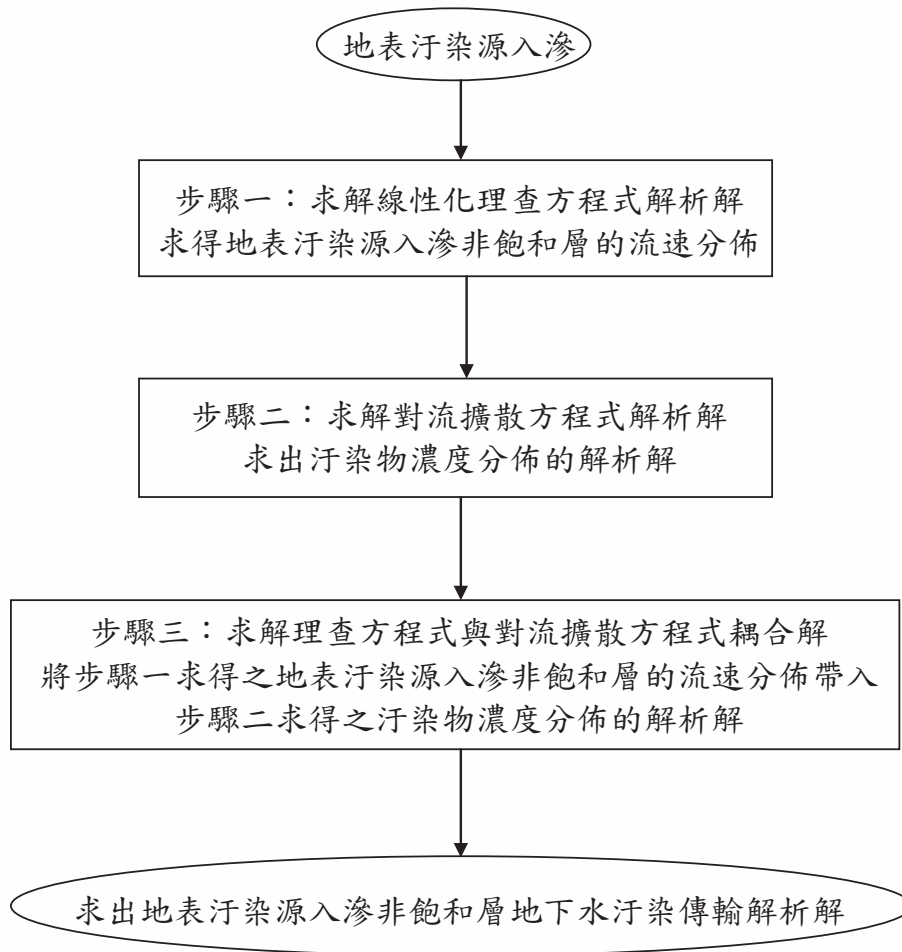


圖 3-1 求解流程圖

3-3、理查方程式與對流擴散方程式耦合解

考慮(3-7)式中 $f(T) = \gamma \cdot T^n$ ，其中 γ 式常數且 $n = -0.5, 0, 0.5, 1, 1.5, 2 \dots$ ，可求得地表污染源入滲非飽和層的流速分佈如下所示：

$$V(Z, T) = k_s \frac{\theta_r}{\theta_s - \theta_r} \cdot \gamma \cdot \Gamma(n+1) \cdot (4T)^{n+0.5} \cdot (-1)^n \cdot e^{\frac{Z \cdot T}{4}} \left[\frac{(2+Z)}{2\sqrt{\pi}} \cdot \text{Erfc}\left(\frac{Z}{2\sqrt{T}}\right) - \frac{1}{4\sqrt{T}} e^{-\frac{Z^2}{4T}} \right] \quad (3-16)$$

將 $Z = \frac{k^* z}{D}$ 及 $T = \frac{(k^*)^2 t}{D}$ 帶入(3-16)式地表污染源入滲非飽和層的流速分佈如下所示：

$$V(z, t) = k_s \frac{\theta_r}{\theta_s - \theta_r} \cdot \gamma \cdot \Gamma(n+1) \cdot \left[\frac{4(k^*)^2 t}{D} \right]^{n+0.5} \cdot (-1)^n \cdot e^{\frac{k^* z}{2D} \cdot \frac{(k^*)^2 t}{4D}} \left[\frac{\left(2 + \frac{k^* z}{D}\right)}{2\sqrt{\pi}} \cdot \text{Erfc}\left(\frac{z}{2\sqrt{Dt}}\right) - \frac{\sqrt{D}}{4k^* \sqrt{t}} e^{-\frac{z^2}{4Dt}} \right] \quad (3-17)$$

將(3-17)式帶入(3-15)式可求得理查方程式與對流擴散方程式耦合解如下：

$$C(z, t) = \frac{C_0}{2} + e^{\frac{z}{2\sqrt{Dt}} - \frac{\sqrt{t}}{2\sqrt{D}}} \left[\left. \begin{aligned} & \left[k_s \frac{\theta_r}{\theta_s - \theta_r} \cdot \gamma \cdot \Gamma(n+1) \cdot \left[\frac{4(k^*)^2 t}{D} \right]^{n+0.5} \cdot (-1)^n \right. \\ & \left. \cdot e^{\frac{k^* z}{2D} \cdot \frac{(k^*)^2 t}{4D}} \left[\frac{\left(2 + \frac{k^* z}{D}\right)}{2\sqrt{\pi}} \cdot \text{Erfc}\left(\frac{z}{2\sqrt{Dt}}\right) - \frac{\sqrt{D}}{4k^* \sqrt{t}} e^{-\frac{z^2}{4Dt}} \right] \right] \right\} \\ & \left[k_s \frac{\theta_r}{\theta_s - \theta_r} \cdot \gamma \cdot \Gamma(n+1) \cdot \left[\frac{4(k^*)^2 t}{D} \right]^{n+0.5} \cdot (-1)^n \cdot e^{\frac{k^* z}{2D} \cdot \frac{(k^*)^2 t}{4D}} \left[\frac{\left(2 + \frac{k^* z}{D}\right)}{2\sqrt{\pi}} \cdot \text{Erfc}\left(\frac{z}{2\sqrt{Dt}}\right) - \frac{\sqrt{D}}{4k^* \sqrt{t}} e^{-\frac{z^2}{4Dt}} \right] \right] \cdot z \end{aligned} \right] \\ + e^{\frac{z}{2\sqrt{Dt}} + \frac{\sqrt{t}}{2\sqrt{D}}} \left[\left. \begin{aligned} & \left[k_s \frac{\theta_r}{\theta_s - \theta_r} \cdot \gamma \cdot \Gamma(n+1) \cdot \left[\frac{4(k^*)^2 t}{D} \right]^{n+0.5} \cdot (-1)^n \right. \\ & \left. \cdot e^{\frac{k^* z}{2D} \cdot \frac{(k^*)^2 t}{4D}} \left[\frac{\left(2 + \frac{k^* z}{D}\right)}{2\sqrt{\pi}} \cdot \text{Erfc}\left(\frac{z}{2\sqrt{Dt}}\right) - \frac{\sqrt{D}}{4k^* \sqrt{t}} e^{-\frac{z^2}{4Dt}} \right] \right] \right\} \end{aligned} \right] \quad (3-18)$$

3-4、一維地表污染源入滲地下水污染傳輸結果分析

本研究以壤土(Silt loam)為例，說明一維無地下水位之半無窮區間地表污染源入滲地下水污染傳輸問題，以均佈起始條件舉例，計算一維地表污染源入滲地下水污染傳輸結果，今將計算結果分別說明及討論如下。壤土之相關參數 [Van, 1980] 詳見表 3-1。

表 3-1 壤土參數值

參數	參數值	單位
k_s	316	mm/day
α	0.002	mm ⁻¹
θ_s	0.434	mm ³ /mm ³
θ_i	0.218	mm ³ /mm ³

資料來源: Van Genuchten, 1980

令 $100 = \gamma$ ， $2 = n$ ， $0q = 0.005$ mm/s， $3000 = C$ ppm 且將表 3-1 之土壤參數代入 (3-7) 式，同時繪出降雨強度隨時間變化如圖 3-2 所示。將相關參數代入 (3-18) 式，可繪出地表污染源入滲非飽和層地下水污染傳輸隨時間變化剖面圖則如圖 3-3 所示，由圖中發現本例之降雨強度變化趨勢為隨時間增加降雨強度隨增加，因此當經過 100 秒時污染物已經向下傳輸到地表下 10 公分；當經過 300 秒時污染物已經向下傳輸到地表下 20 公分；當經過 500 秒時污染物已經向下傳輸到地表下 30 公分；當經過 700 秒時污染物已經向下傳輸到地表下 35 公分；當經過 900 秒時污染物已經向下傳輸到地表下 40 公分；當經過 1100 秒時污染物已經向下傳輸到地表下 45 公分，由此可見污染物向下傳輸速度相當快速。

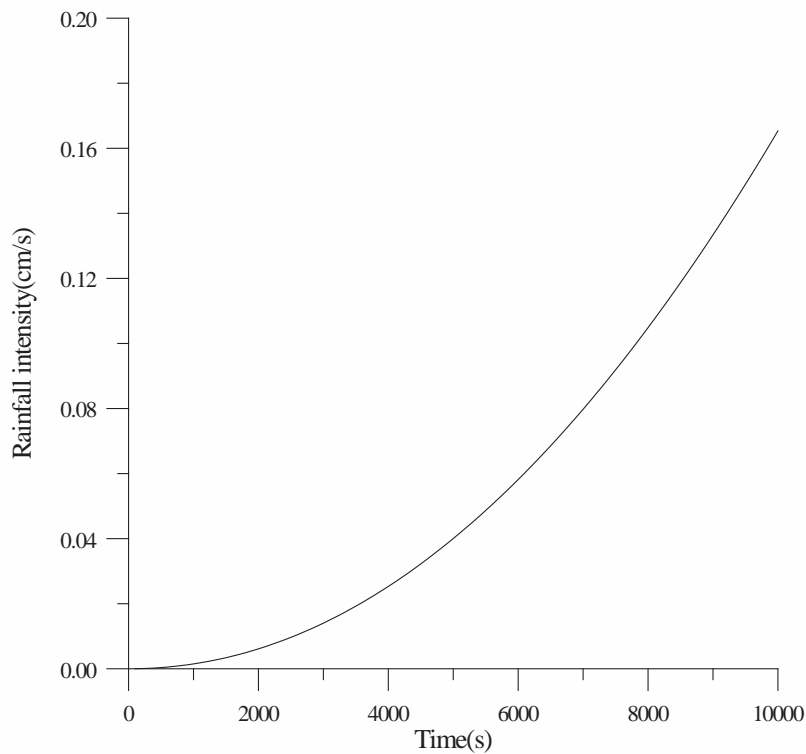


圖 3-2 降雨強度隨時間變化圖

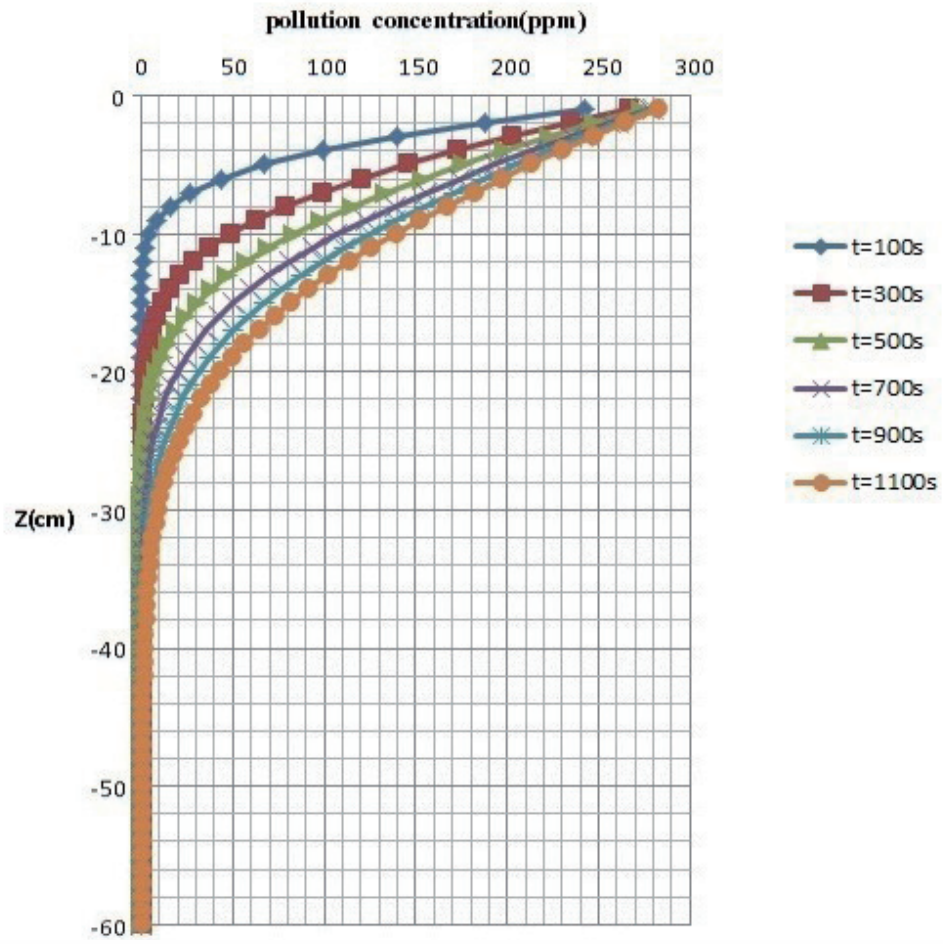


圖 3-3 地表污染源入滲非飽和層地下水污染傳輸隨時間變化剖面圖

四、結論與建議

4-1 結論

本研究經由文獻探討、運用理查方程式與對流擴散方程式耦合解求得非飽和層地下水污染傳出之解析解，得到以下結論：

(一) 地下水污染是國際上共同面臨的難題，本研究探討地表污染源入滲導致不飽和含水層地下水污染之解析解，以線性理查方程式以及對流擴散方程式為控制方程式進行耦合方程式求解，求解任意降雨量及任意地表污染源濃度之條件下的染物傳輸之解析解。透過理論解析模式探討地下水污染傳輸的影響範圍，提供政府部門作為針對重點地下水污染區治理對策研擬以及佈設電子監測儀器範圍之參考，同時也可以提供數值解校正參考。

(二) 本研究以壤土為例，發現當地表污染源入滲經過100秒時污染物已經向下傳輸到地表下10公分；當經過300秒時污染物已經向下傳輸到地表下20公分；當經過500秒時污染物已經向下傳輸到地表下30公分；當經過700秒時污染物已經向下傳輸到地表下35公分；當經過900秒時污染物已經向下傳輸到地表下40公分；當經過1100秒時污染物已經向下傳輸到地表下45公分，由此可見污染物向下傳輸速度相當快速。

4-2 建議

本研究目前探地表積水前之任意降雨量及任意地表污染源濃度之條件下的染物傳輸之解析解，建議後續研究可朝向求解地表積水後之任意降雨量及任意地表污染源濃度之條件下的染物傳輸之解析解。

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基於自組織理論的業主委員會能力建設模型研究



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摘要：隨著中國房地產行業的興起，業主委員會由沉寂走向覺醒，逐漸成為中國社區不可或缺的重要元素。業主委員會的運行效果直接關係中國社區的穩定，更是社會穩定的減壓器。然而，近年來業主委員會的運作效果差強人意，這裏面有法律地位確認的問題，有社區業主公民意識水平的問題，也有業主委員會自身能力建設的問題。對於業主委員會的研究，過往主要集中在業主委員會的法律地位和運行機制上，很少有站在業主委員會本身的角度去反思自身建設的問題。文章將從業主委員會自身能力的角度向內分析，建立「四大能力」模型進行定性和定量分析，得出業主委員會能力自組織管理下的關鍵影響因素，並進行針對性的改善。

關鍵詞：社區自組織，業主委員會，業主委員會能力

1. 引言

自組織理論是關於在沒有外部指令條件下，系統內部各子系統之間能自行按照某種規則形成一定的結構或功能的自組織現象的一種理論，社區自組織是自組織理論在社區管理中的應用。趙雪(2016)研究發現，社區自組織是通過社區成員和社區各類組織之間相互聯繫、相互協商、相互合作，充分調度各種資源從而實現社區的自我管理和自我服務的。陳征(2015)認為社區自組織並不是一種單純的定義，是通過社區內在的成員協商與交流的方式達成共識，消除分歧獲得共性彼此合作的過程，「共同體」是其主要的特徵。社區自組織能力，是指社區內共同體不需要外部力量的強制干預下完成自我整合、自我協調、自我維繫的能力(楊貴華，2009)。楊貴華還進一步強調社區自組織能力要與自組織機制區分開來，自組織機制是社區共同體自身固有的，而社區自組織能力是發展動態的。王瑞華(2007)也從上述六個方面對社區自組織能力建設遇到的問題進行了分析，並提出瞭解決建議。針對自組織理論在小區管理的應用研究，周潔(2018)認為業主委員會屬於小區業主自治組織，是為了管理和經營小區公共財產、維護小區的正常運轉而設立的。王豔麗(2012)認為，社區正式的自組織有社區居委會、小區業主委員會等，社區自組織應該是一個廣義的概念，小區業主委員會屬於社區自組織的一種形式。

2. 「四大能力」模型

本文針對業主委員會能力模型的建立，主要是從自我管理能力的自我約束能力、自我教育能力、自我服務能力四個方面來研究。四個能力的分類主要依據楊貴華(楊貴華, 2009)社區自組織能力六大能力體系來設計，但又與之不同的是，筆者

將楊貴華關於自組織資源整合能力歸入自我服務能力，把社區居民參與歸入自我教育能力，對於網絡結構與成熟度未納入本研究的範圍，並且還根據物業管理行業的既定的語義習慣進行了局部調整。為了進一步解釋業主委員會能力模型，本文根據行業專家、社區工作者的建議對四類能力進行了二級因子分解。具體情況如表 1 所示：

表 1 「四大能力」模型二級因子分解

分類	問題設置
自我管理能力的	a1 業主委員會權力清單的執行情況
	a2 業主委員會依規辦事情況
	a3 小區重大事件決策情況
	a4 業主委員會預算與計劃執行情況
自我約束能力的	b1 業主監督委員會的監督情況
	b2 審計制度執行情況
	b3 業主委員會回避制度執行情況
	b4 風險責任清單的履行情況
自我教育能力的	c1 小區遵守法律法規情況
	c2 業主委員會與外部機構溝通情況
	c3 業主委員會參與小區糾紛調解情況
	c4 業主參與小區公共事務的情況
自我服務能力的	d1 業主委員會整合資源服務業主的情況
	d2 業主委員會對物業服務的監督情況

為了更好的研究業主委員會能力模型，筆者選取了重慶市江北區、南岸區、九龍坡區、沙坪壩區的四個社區作為訪談地域範圍，針對業主委員會四個能力要素及其二級成分因子進行了調查。問卷設計分為兩個部分，一是針對受訪者的客觀資料調查，此部分主要是用於篩選自購房者和租住者兩種屬性的訪談對象，避免租住者數據混入。二是採用了五級李克特量表對四個能力影響因素及其二級成分影響因子進行調查。

通過調查分析，我們發現業主委員會自我管理能力的相關係數為 0.847， $P=0<0.05$ ，相關顯著，且為正相關。意味著業主委員會自我管理能力的自我約束能力越強，業主委員會的履職能力就越好。業主委員會自我約束能力與業主委員會履職能力的相關係數為 0.927， $P=0<0.05$ ，相關顯著，且為正相關，意味著業主委員會自我約束能力越強，業主委員會的履職能力就越好。業

主委員會自我教育能力與業主委員會履職能力的相關係數為 0.951， $P=0<0.05$ ，相關顯著，且為正相關，意味著業主委員會自我教育能力越強，業主委員會的履職能力就越好。業主委員會自我服務能力與業主委員會履職能力的相關係數為 0.908， $P=0<0.05$ ，相關顯著，且為正相關，意味著業主委員會自我服務能力越強，業主委員會的履職能力就越好。

為了進一步分析業主委員會能力模型，我們對相關變量進行了回歸分析，其結果呈現為，對於業主委員會能力建設影響最大的兩個變量是：自我管理能力和自我教育能力，其回歸係數分別達到 2.427 和 1.426。業主委員會自我管理能力的各變量對於業主委員會能力影響程度中，小區重大事項決策表現最為突出，其係數達到 0.413，其次是業主委員會的預算與規劃能力對業主委員會能力影響程度達到 0.330，這兩個因素是自我管理能

力中最为關鍵的變量。業主委員會自我約束能力的各變量對於業主委員會能力影響程度中，業主委員會成員回避制度表現最為突出，其係數達到0.486，其次是業主監督委員會對業主委員會能力影響程度達到0.423，這兩個因素是自我約束能力中最为關鍵的變量。業主委員會自我教育能力的各變量對於業主委員會能力影響程度中，業主委員會與外部機構溝通能力表現最為突出，其係數達到0.579，其次是業主參與小區公共事務對業主委員會能力影響程度達到0.362，這兩個因素是自我教育能力中最为關鍵的變量。業主委員會自我服務能力預設的兩個變量對於業主委員會能力影響程度中，業主委員會資源整合能力相對於物業服務的監督表現突出，其係數達到0.939，因此成為自我服務能力中較為重要的變量。通過研究發現自我管理能力和自我教育能力是業主委員會能力的關鍵能力，這與筆者先前經驗具有較大的差異。

3. 結論及展望

在自組織理論的框架下，筆者通過問卷調查方式對業主委員會能力進行了研究分析。結合筆者所掌握的重慶市住宅小區業主委員會的履職總體狀況，設計了本文的研究模型，提出了假設，並運用實證和分析，證明瞭假設成立。對業主委員會四個能力變量進行分析，通過訪談分析證明四個能力對業主委員會的履職影響都非常顯著，且都是正向影響，最終結論如下：

- (1) 自我管理能力和自我教育能力對業主委員會履職能力影響最大，自我管理能力和自我教育能力中小區重大決策和預算規劃能力是關鍵變量，自我教育能力中業主委員會與外部機構溝通能力為關鍵變量。
- (2) 自我約束能力中成員回避制度為關鍵變量，自我服務能力中資源整合能力為較重要變量。

- (3) 從自組織理論視角來研究業主委員會的履職能力問題，本次只設置了四個維度，在體系設計上難免存在不全面的情形，需要在今後進一步的研究中完善。一是在二級成分因子的設計上可以更加廣泛，以避免本研究的不足。二是在樣本體系上增加物業服務企業、政府機構的相關維度，多視角的完善業主委員會能力建設的不足。三是需要更加聚焦能力建設的某一方向研究，以獲得更加深入的研究成果。

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