

AN INVESTIGATION AND VISUALIZATION DESIGN OF HYGIENIC PUBLIC SPACE: CASE STUDY OF LU-YANG-JU COMMUNITY, GUANGDONG PROVINCE, CHINA



A Thesis Submitted in Partial Fulfillment of the Requirements for Doctor of Philosophy DESIGN ARTS (INTERNATIONAL PROGRAM)

> Silpakorn University Academic Year 2023 Copyright of Silpakorn University



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปรัชญาดุษฎีบัณฑิต ศิลปะการออกแบบ แบบ 1.1 ปรัชญาดุษฎีบัณฑิต(หลักสูตรนานาชาติ) มหาวิทยาลัยศิลปากร ปีการศึกษา 2566 ลิขสิทธิ์ของมหาวิทยาลัยศิลปากร

# AN INVESTIGATION AND VISUALIZATION DESIGN OF HYGIENIC PUBLIC SPACE: CASE STUDY OF LU-YANG-JU COMMUNITY, GUANGDONG PROVINCE,CHINA



A Thesis Submitted in Partial Fulfillment of the Requirements for Doctor of Philosophy DESIGN ARTS (INTERNATIONAL PROGRAM) Academic Year 2023 Copyright of Silpakorn University

Title An Investigation and Visualization Design of Hygien	
	Space: Case study of Lu-Yang-Ju Community, Guangdong
	Province, China
Ву	Miss Jie DENG
Field of Study	DESIGN ARTS (INTERNATIONAL PROGRAM)
Advisor	Assistant Professor Jirawat Vongphantuset, Ph.D.
Co advisor	Assistant Professor Veerawat Sirivesmas, Ph.D.

Faculty of Decorative Arts, Silpakorn University in Partial Fulfillment of the Requirements for the Doctor of Philosophy

	3
	Dean of Faculty of
( Thanatorn Jiarakun, Ph.D.)	Decorative Arts
Approved by	5)
	Chair person
(Professor Dr. Nicole Wragg)	53
1933	Advisor
(Assistant Professor Jirawat Vongphantuset, Ph.D.)	
	Co advisor
(Assistant Professor Veerawat Sirivesmas, Ph.D.)	
	Committee
(Associate Professor Sone Simatrang)	committee
	Committee
(Professor Eakachat Joneurairatana, Ph.D.)	

#### 640430028 : Major DESIGN ARTS (INTERNATIONAL PROGRAM)

Keyword : Community, Transformation Design, Natural ventilation, CFD analysis, ACH, Automatic vibrative furniture, Eccentric-and-pitman, Sedentariness, Vegetable market, Library, Window, Public health crisis, Hygiene, Simulation design

Miss Jie DENG : An Investigation and Visualization Design of Hygienic Public Space: Case study of Lu-Yang-Ju Community, Guangdong Province, China Thesis advisor : Assistant Professor Jirawat Vongphantuset, Ph.D.

In the history of past public health crises, the prevailing view is that a virus is constantly evolving that has caused a number of health problems in people's lives through airborne transmission.

In this paper, a public community in Zhong-Shan city, a typical ancient community in China, was studied to explore the problems in the community and gathering the transformational needs of local habitats. An online questionnaire was randomly carried out on 260 samples (45% men and 55% women) of different ages to analyze their satisfaction with the community. Field research was conducted using satellite maps and photographs to study the community's surroundings. In parallel, design solutions were sought for the transformation of the community, consisting of the general layout, the functional design of the entire community, and the design of the vegetable market and library, which were specifically selected as examples of detailed designs with public health in mind. The transformation and design update activities include literature review, interdisciplinary research, field research, case studies and evaluation. A visualization design of community studied and integrated with the art discipline, mechanical engineering, and psychological principles.

By carrying out the visualization design for community transformation, the work of this thesis can be concluded by the methodology of "Macro-Meso-Micro" as follows.

(1) The transformation design of the whole community was carried out; (2) The transformation design of the vegetable market was conducted for both the external market environment and the internal market space. (3) The transformational

design of the library was carried out with regard to the room layout, the ventilation system, the indoor furniture and windows design. Finally, after the transformation, the community is characterized by both the beauty of modern art and the function of public health prevention, which makes people's lives more humane and enjoyable. The work in this paper can be a practical and valuable reference for the upgrading of other urban communities with public health in mind.



#### ACKNOWLEDGEMENTS

This thesis was written with the support of the doctoral supervisors Asst. Prof. Jirawat Vongphantuset and Asst. Prof. Veerawat Sirivesma. First of all, I would like to thank the supervisor, Assistant Professor Jirawat Vongphantuset, for his careful guidance and leadership in all aspects of the research, from determining the research activities to writing the final dissertation. It is not easy to complete all the research tasks in a PhD and there were times when I was slowed down by difficulties. The encouragement and guidance from the supervisor have always given me hope and motivation to move forward. Secondly, I would like to thank her co-supervisor. Assistant Professor Veerawat Sirivesmas' rigorous academic attitude, profound knowledge and unpretentious and approachable personality have a great impact on me. I would like to express my deepest gratitude to both supervisors.

I would also like to thank the Design Arts doctoral program (international program) in the Faculty of Decorative Arts at Silpakorn University (SU) for giving me the opportunity to have access to a platform for my doctoral study and providing me with the appropriate facilities so that I could focus on my PhD research. I would especially like to thank Professor Eakachat Joneurairatana, the chairperson of the program during my studies, who always helped me in a timely manner whenever I asked him for advice on academic research. I would also like to thank the other faculty advisors for their help, such as Asst. Prof. Song Simatrang, Asst. Prof. Pairoj Jamuni, Dr. Rueanglada Punyalikhit, Dr. Fon Supawinee, and Dr. Tong Vivasadej. Also, I would like to thank the SU assistants, such as Maleene and Jidapha Yoongenwadee.

I would like to sincerely thank the family for the years of suffering together. My family has been very supportive of my study path. My parents have always supported me with spiritual values and encouraged with their silent love. My husband who constantly helped me with his monthly financial support, also carefully reviewed my article drafts with his logical thinking and limited knowledge of English. I sincerely thank him for his dedication and continued support and encouragement.

I sincerely thanks the deans of the Faculty of Creative Arts, Changzhou

Vocational Institute of Industry Technology, Jiangsu, China, for example, Asst. Prof. Xin-Hua Xiao, Asst. Prof. Xin-Zhong Qu, and Asst. Prof. Jun Sun. They are very supportive and offered sufficient time for my doctoral studies. Therefore, I can concentrate on my studies without having to worry too much about work. The institute has also paid me a basic salary so that I can continue my education. I am happy to work for this institute. I would like to thank the college once again.

I would like to thank my fellow students and friends such as Dr. Ding Zhou, Dr. Xue-Zhen Qian, Cai Feng Mai, Dr. Erwin Ardianto Halim, Dr. Ye Zhou, Dr. Lulu Liu, Post-Dr. Ran-Ran Wang, Dr. Gang Qing, Dr. Yan Wan, Dr. Tao Tian and Dr. Jun-Yun Lu for their support in all aspects throughout the research process. The researcher is also grateful to all individuals whose names are not listed here.

Finally, I would like to thank my countries, the People's Republic of China, and the Kingdom of Thailand. Long live the Sino-Thai friendship. The researcher would like to thank all those who have encouraged, mentored and helped her.



Jie DENG

## TABLE OF CONTENTS

Pa	age
ABSTRACTI	D
ACKNOWLEDGEMENTS	F
TABLE OF CONTENTS	Н
LIST OF TABLES	Ν
LIST OF FIGURES	С
CHAPTER 01 INTRODUCTION	1
1.1 Background of the Research	1
1.2 Statement of the Problems	4
1.2.1 Problem of the External Environment	4
1.2.2 Problem of the Internal Demands of Community Dwellers	7
1.2.3 Problem of Prolonged Sedentary Activity Infected the Healthy	7
1.3 Objectives of the Research	
1.4 Overview of the Dissertation	9
1.5 Significance of the Research	0
1.6 Research Methodology	1
1.6.1 Interdisciplinary Research1	2
1.6.2 Investigation Research1	2
1.6.3 Case Study1	2
1.6.4 Evaluation1	3
1.7 Research Outcomes1	3
CHAPTER 02 LITERATURE REVIEWS	5

2.1 Introduction	15
2.2 Public Health	15
2.3 Typical old community	15
2.3.1 Definition of Community	15
2.3.2 Community Research	16
2.3.2.1 Neighborhood Unit	16
2.3.2.2 Traditional Neighborhood Concept (TND)	17
2.3.2.3 Transit-Oriented Development (TOD)	18
2.3.2.4 Old community research	
2.4 Critical Public Spaces	24
2.4.1 Community fitness space	24
2.4.2 The street park	25
2.4.3 Vegetable market	27
2.4.3.1 Current situation of vegetable market	28
2.4.3.2 Consumption habits and psychology of community residents	28
2.4.4 Community library	
2.5 Transformation design.	31
2.5.1 Traditional Ling-Nan Culture	32
2.5.1.1 The Ling-Nan Architecture	32
2.5.1.2 The Ling-Nan Windows	33
2.5.1.3 Ling-Nan Paper-cut	37
2.5.1.4 The "wedding-on-water" ceremony	38
2.5.2 Chinese ancient philosophy	39
2.5.2.1 Feng-Shui	39

I

2.5.3 Mental health - Spiritual space	41
2.5.3.1 Design approach of spiritual space	
2.5.4 Space safety requirements	43
2.5.4.1 Spatial distance	43
2.5.4.2 Ventilation	45
2.5.4.3 Sedentary problem prevention	
2.6 Summary	52
CHAPTER 03 INVESTIGATION AND DESIGN METHODOLOGY	54
3.1 Introduction	54
3.2 Interdisciplinary research	54
3.3 Field research	54
3.3.1 Research on community circumstance	55
3.3.2 Research on community history	57
3.3.3 Research on community characteristic resource	58
3.3.4 Research on community people crowd	59
3.3.5 Research on local field activity	60
3.4 Questionnaires and Data Analysis	60
3.5 One by one Interview	65
3.5.1 Experts feedback of some designs in community	65
3.5.2 Stakeholders questionnaire and feedback	66
3.5.3 The result score of evaluation	69
3.6 Simulation-based evaluation	72
3.7 Experiments	73
3.7.1 Experiment one: Safety space distance	73

3.7.2 Experiment two: Cross-ventilation	74
3.7.3 Experiment three: fatigue relief	
3.7.4 Experimenter feedback	77
3.8 Actions to Feedbacks	
3.9 Summary	
CHAPTER 04 Design development	
4.1 Introduction	
4.2 Design of the general layout of the community	
4.3 Design of Community Facilities	
4.3.1 Application of Ling-nan architecture element	
4.3.2 The planning of traffic streams	
4.3.3 Plant disposition	
4.3.4 The community fitness space	92
4.3.5 Expanding boundary space	
4.4 Case study - Vegetable Market	
4.4.1 Transformation strategy application	97
4.4.2 Space Design of the Vegetable Market	
4.4.2.1 The position of space design of the vegetable market	
4.4.3 The Design Outcome of Community Vegetable Market	
4.4.3.1 Design of external market environment	
4.4.3.2 Internal space designs of the vegetable market	102
4.5 Case study - Community Library	105
4.5.1 Library investigation method	106
4.5.2 General Design of Community Library	106

		4.5.2.1 Design of spatial layout10	)6
		4.5.2.2 Two-dimensional construction drawing	)7
		4.5.2.3 Three-dimensional design sketch10	)9
	4.5.3	Library furniture	)9
		4.5.3.1 Different furniture	)9
		4.5.3.2 Vibrative chair	11
	4.5.4	Ventilation Design	20
		4.5.4.1 The problem of ventilation	20
		4.5.4.2 The method of ventilation	20
		4.5.4.3 Ventilation location description	22
		4.5.4.4 Natural Ventilation Recommendation Based on ACH Calculation	
			23
		4.5.4.5 CFD Simulation	23
		4.5.4.6 Physical Model	23
		4.5.4.7 Calculation Zone and Meshing12	24
		4.5.4.8 Boundary Condition	25
		4.5.4.9 The outcome of Community Ventilation design	26
	4.5.5	Windows design	27
		4.5.5.1 The design process of windows	27
		4.5.5.2 The outcome of windows design	31
4.6	Mode	el-making	39
	4.6.1	The scaled model of community library14	10
	4.6.2	3D printing model	12
	4.6.3	The real model of windows	14

4.6.4 The factory customization	144
4.7 Summary	147
CHAPTER 5 Conclusions and contributions	149
5.1 Conclusions	149
5.1.1 Community planning and design	149
5.1.2 Community Vegetable Market	149
5.1.3 Community Library	150
5.1.3.1 Community Ventilation	151
5.1.3.2 Community Library Furniture	151
5.1.3.3 Community Windows	153
5.2 Contribution	154
5.2.1 Solving the problems	154
5.2.2 A knowledge gap	155
5.2.3 The confirmation of the findings	155
5.3 Recommendations	
5.3.1 Professional field	156
5.3.2 Education field	157
REFERENCES	162
VITA	169

## LIST OF TABLES

	Page
Table 1 Chinese traditional philosophy	40
Table 2 Current status statistics	56
Table 3 The survey of satisfaction of community	60
Table 4 Result of satisfaction survey of community public space (N=260)	62
Table 5 The Stakeholder feedback	68
Table 6 Feedback of FCIC professors	70
Table 7 Description of the cost of total experimental	73
Table 8 The feedback of spatial distance experiment	77
Table 9 The feedback of ventilation experiment	78
Table 10 The feedback of vibrating chair experiment.	79
Table 11 Aquatic plants	88
Table 12 Shrub plants	89
Table 13 Fern plants	90
Table 14 Four season Plants	91
Table 15 Results of ACH Calculation in five types of windows	127
Table 16 The construction drawing of new windows.	136
Table 17 Airflow simulation results of new windows corresponding to Table 16	136
Table 18 Analysis of air flow of new windows on elevation	137
Table 19 the Jalousie with different shutters	138
Table 20 Materials list and cost	139

## LIST OF FIGURES

	Page
Figure 1 Virus image	2
Figure 2 History of public health crisis	3
Figure 3 The main problems	4
Figure 4 Photos of Lu-yang Ju community	5
Figure 5 Photos of Tan-Zhou market	6
Figure 6 The process of three experiments	9
Figure 7 The framework of thesis	10
Figure 8 Research methodology	11
Figure 9 Case study	13
Figure 10 A concept of traditional Neighborhood	
Figure 11 Case One	20
Figure 12 Case Two	21
Figure 13 Case Three	21
Figure 14 Case Four	23
Figure 15 Turn old communities into healthy communities through urban agriculture	24
Figure 16 Communities fitness spaces	25
Figure 17 General strategic plan of New Borg Al Arab City	
Figure 18 Silicon Waha master plan	
Figure 19 Phases of landscape design modelling	
Figure 20 The types of activities participants could imagine performing in the small urban parks	27
Figure 21 Vegetable market	29
Figure 22 The structure of transformation and updating design	
Figure 23 "wok yi uk "wall in the Ling-nan architecture	
Figure 24 The Ling-nan windows	
Figure 25 The data framework of Ling-nan windows	
Figure 26 Traditional window shape grammars	
Figure 27 Different opening forms of ling-nan windows	
Figure 28 A "Xiao-Lan" paper-cut	

Figure 29 The history of a water-wedding ceremony	
Figure 30 The water-wedding ceremony	
Figure 31 Feng-shui, philosophy numbers and five elements	
Figure 32 Ancient Feng-Shui samples	41
Figure 33 Outdoor restaurant scheme	43
Figure 34 Comparison of classroom	44
Figure 35 Safety spatial distances	45
Figure 36 Effect of opening types on wind flow	47
Figure 37 Analysis of Air flow on layout of space.	48
Figure 38 Analysis of Air flow on elevation	48
Figure 39 Prolonged sitting	50
Figure 40 Types of mechanical design of vibration of fitness machine	52
Figure 41 The location of Tan Zhou area in Zhong-shan City	55
Figure 42 Interview of local stakeholders	55
Figure 43 Location analysis of Lu-yang Ju Community	57
Figure 44 The history of Lu-yang Ju community from the year 1954 to 2023	58
Figure 45 The list of municipal intangible cultural heritage	58
Figure 46 Population analysis of Lu-yang Ju Community	59
Figure 47 Local activity areas	60
Figure 48 One by one interview	66
Figure 49 The lu-yang Ju community questionnaire	68
Figure 50 The evaluation score of stakeholders (N=46)	70
Figure 51 The experiment one	74
Figure 52 The experiment Two	76
Figure 53 The experiment Three	77
Figure 54 Modification after feedback	81
Figure 55 The design modification after feedback	82
Figure 56 The general layout plan of Lu-Yang Ju Community	85
Figure 57 The aerial view of community in SketchUp software	85
Figure 58 The sketch of community planning and design	86
Figure 59 The application of Ling-nan architecture element	87
Figure 60 The road planning of community	88

Figure 61 Plant disposition of Lu-Yang Ju community	92
Figure 62 Community fitness space	93
Figure 63 Expanded boundary of Lu-Yang Ju community	93
Figure 64 Renderings of different functional space	96
Figure 65 A community vegetable market	96
Figure 66 Floor plan of the vegetable market	100
Figure 67 Building drawing of vegetable market	102
Figure 68 Floor plan of the vegetable market	102
Figure 69 Stall and store renovation design	105
Figure 70 Community library	105
Figure 71 Feng-shui number in library spatial layout	107
Figure 72 Floor plan of community library	108
Figure 73 Community library elevations	108
Figure 74 A yoga room in Library	109
Figure 75 Library furnitures with different behaviors	110
Figure 76 Library study room	111
Figure 77 The overall structure of double diamond design thinking method	111
Figure 78 Vibrative chair	113
Figure 79 Automatic vibrative chair and construction	
Figure 80 An eccentric-and-pitman drive	115
Figure 81 Schematic diagram of link gearing mechanism	116
Figure 82 A semicircular eccentric wheel mechanism	117
Figure 83 SOLIDWORKS Simulation calculations	119
Figure 84 Motion Curve Results of Simulation	120
Figure 85 Sketch analysis of ventilation design in community library	121
Figure 86 Community library	122
Figure 87 Meteorological analysis of zhong-shan city	123
Figure 88 Physical models of yoga rooms with different window types	124
Figure 89 Physical models of yoga rooms with different window types	125
Figure 90 Velocity contours of yoga room with different window	127
Figure 91 Three optimal prototypes of windows after ventilation test	128
Figure 92 The structure of Municipal intangible cultural heritage	129

Figure 93 Design Process of windows	129
Figure 94 Windows design thinking	130
Figure 95 New patterns design	
Figure 96 The color of new windows	
Figure 97 The glass pattern of window	
Figure 98 The new pattern in CAD	
Figure 99 The construction drawing of three windows	
Figure 100 Windows materials	
Figure 101 Parts of Automatic Jalousie	
Figure 102 The Renderings of new windows	135
Figure 103 The air flow layout of library floor plan	
Figure 104 The process and results of handmade mode	
Figure 105 3D Printer	
Figure 106 3D Printing models.	
Figure 107 The process of producing a real size of window	
Figure 108 The real picture of Jalousie	145
Figure 109 The poster of windows	
Figure 110 Application of flow chart	155
Figure 111 Application of experiments framework	156
Figure 112 Application of framework of design data collection	156
Figure 113 FCIC 6 Conference	159
Figure 114 The Certificates of presentation in Conference	159
Figure 115 Four Acceptance Letters	160
Figure 116 The certificate of policy mission scholarship	
Figure 117 Six Design Patents	

## CHAPTER 01

## INTRODUCTION

#### 1.1 Background of the Research

#### (1) History of public health crisis

Airborne virus transmission is a severe reason for health problems (Shown in Fig.2).

Throughout the public health crisis, viral evolution has constantly existed in our lives and has afflicted humanity for thousands of years (Kelly, 2006). Epidemiologic studies mentioned that the Antonine Plague had caused the death of over 5 million in AD165-169, and the plague had spread to Gaul and the legions along the Rhine (D.-B. Liu, 2020). The fourth-century historian Eutropius noted that a large proportion of the empire's population died from this outbreak (Fears, 2004). This was followed by the Great Plague of Athens in ancient Greece, which killed almost half of the people in Athens in 430-426 BC (D.-B. Liu, 2020). And then the Plague of Justinian destroyed Byzantine ambitions as the Byzantines pursued a grand strategy to build up their own lands. The Plague of Justinian reunited the Roman Empire and killed twenty-five to fifty million people; Europe was in the Dark Ages in 541-542 AD (Peterson, 2020). In the past, people were weak and hopeless in the face of a public health crisis until we overcame the technical problem of vaccination. In one successful case, smallpox, which is thought to be transmitted by airborne droplets more than any other disease, had killed a hundred million people before it was eradicated by a global vaccination campaign in 1980 (Berche, 2022). Amidst the joy of a better life after the vaccination campaign, it saved our lives. The Black Death, the most significant public health crisis, was a devastating global public health crisis caused by the bubonic plague that killed about a quarter of the European and Asian population in the mid-13th century (D.-B. Liu, 2020). The Black Death killed about 50 million people in Europe during the five years of the outbreak (Wagner & Reifegerste, 2022).



Figure 1 Virus image Source: Google picture, 2021

There are many reasons why a hundred million people have died from the public health crisis. One of the most important reasons for the severe public health crisis is the airborne transmission of respiratory viruses. During the SARS pandemic (1993–2007), there were 2,500 cases of hantavirus with an overall mortality rate of 30% (Clement, Maes, Ducoffre, Van Loock, & Van Ranst, 2008). This viral pathogen was airborne and could spread widely, which was generally accepted. In addition, previous experience with public health crises suggested that H5N1 was airborne after modification, and H5N1 had killed up to 150 million people worldwide (Petsko, 2005). Tuberculosis transmission was thought to occur indoors and had occurred almost every year prior to the decline of tuberculosis in the UK from the mid-19th century (Hobday & Dancer, 2013). The literature also indicates that tuberculosis is mainly transmitted by airborne droplets (Hobday & Dancer, 2013), which kills approximately 2 million people annually (Fattorini, Piccaro, Mustazzolu, & Giannoni, 2013). The WHO (2003) reported that the SARS epidemic was not only a public health problem. On July 11, 2003, there were only 8437 SARS cases worldwide, resulting in 813 deaths. By early 2019, a novel coronavirus had infected the world with rapid speed and wide reach, leading to an unstoppable global public health crisis. According to global coronavirus data, the coronavirus pandemic led to an estimated 6.63 million deaths worldwide and infected 643 million people in December 2022 (Data, 2022). The main reason for the spread of the coronavirus is airborne droplets. Nevertheless, the public health crisis is linked to deaths and economic losses.

From another perspective, the spread of the virus has caused enormous economic damage as people have spent huge amounts of money on medical care. Some statistics from the US in 2002 put the healthcare costs of building-borne respiratory infections at 10 billion US dollars (Mendell et al., 2002). With no way to eliminate virus transmission, poor performance in public health risk detection and community prevention (Wu, Chen, & Chen, 2021) has led to a historic epidemic crisis. However, the public health crisis has also created opportunities to rethink critical issues related to public space design (Campioli & Peraboni, 2022). Dilara Begum (2022) collected online data from 71 public libraries and conducted semi-structured interviews with eight librarians. He proposed guidelines for developing library infrastructure and showed that it is necessary to redesign public spaces (Begum, Roknuzzaman, & Shobhanee, 2022). The redesigned space increases public safety. There are some previous studies on redesigning spaces after a public health crisis. Based on standard epidemic prevention and control, Tao (2023) conducted a design study on the improvement of public space in old communities (M.-Q. Tao, 2023). It pays attention to the health of residents at the three levels of physiology, psychology and society, and creates a vibrant community public space. Peng (2023) proposed three strategies for renovating old communities based on preventing and controlling infectious diseases, controlling the source of infection, interrupting the channel of infection, and protecting the end of infection. Integrate the critical points of landscape transformation into the design of healthy landscape transformation of old urban communities (Peng, 2023). Similar cases are based on the prevention and control of infectious diseases (Lu Zhou, 2023; Ying-ying Song, 2023).

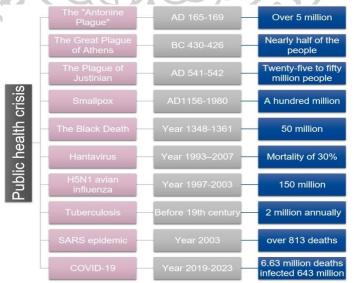
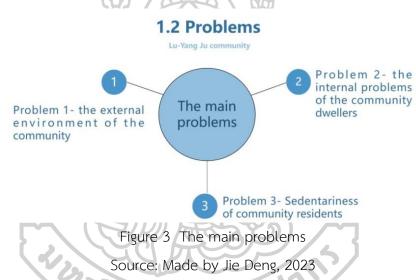


Figure 2 History of public health crisis Source: Made by Jie Deng, 2023

## 1.2 Statement of the Problems

This article is about Lu-yang Ju in the city of Zhong-Shan in Guangdong Province, China. This old community is one of the typical examples of many secondand third-tier cities in China. Many old communities have similar situations and problems.

The main problems of Lu-yang Ju community related to the public health crisis can be divided into three parts (Fig.3). The first part is the external environment of the community, the second is the internal problems of community residents, and the third is the sedentariness of community residents after sitting in public spaces for a long time.



## 1.2.1 Problem of the External Environment

(1) The external public spaces of the community include a passageway, the gym, the central park, the street and the vegetable market, which form the external environment of the community. The function of public space in Lu-yang Ju community is old-fashioned and barely keeps up with the demand of residents, especially for outdoor fitness areas. The central park is the only public activity area and the central pond is a stagnant water for mosquitoes. The streets of the outer community are dirty, disorganized, broken and full of dirty objects that can promote the growth of bacteria. Therefore, the current space of the old community cannot meet the requirements of long-term public health prevention (Fig. 4).



a. Community centre park

b. Outdoor fitness space





c. The street of external community

Figure 4 Photos of Lu-yang Ju community Source: Made by Jie Deng, 2022

The community's external environmental problems are mainly represented by an outdated infrastructure and disorganized arrangements. The community market is a critical public space among all external public spaces because it is the most significant space of disorder. The community market faces significant health and safety risks and lacks an environment where people can meet and relax (Fig. 5).

First of all, the infrastructure of the vegetable market is weak. Since the products in the vegetable market are diverse, including vegetables, fruits, meat, aquatic products, etc. The environment in the market is dirty and chaotic. For example, vegetables and fruits are easily perishable, frozen aquatic products may lead to a wet floor after melting, and the smell of seafood and meat is heavy. Like many traditional vegetable markets, this market has several cramped infrastructures, with old lighting and drainage installed two or three decades ago. These market facilities pose a risk of fire accidents. Meanwhile, hygiene and disinfection in the market cannot be carried out in a timely manner. Once a health crisis has occurred, it can spread quickly in such an environment and become a high risk to public health.

Secondly, the spatial layout of the vegetable market is not right. The market area could be of better quality and more complex in appearance. The preliminary planning of the market area is relatively superficial, with a low utilization of space. The preliminary planning of the market area shows that the planned business zone is very blurred. For instance, internal traffic flows are constantly disrupted, including traffic flows for freight and shoppers. At the peak of a busy period, infectious diseases can easily occur due to the flow of people.

On the other hand, the public space of the market is long and narrow, while the internal functional area is small and limited. The narrowness of the square leads to the problem that vehicles on the periphery are more prone to traffic congestion. Following the outbreak of the health crisis, most vegetable markets have taken temporary measures, such as closing entrances and exits. The advantage of these measures is that they keep the area tidy, but the disadvantage is that they have seriously affected regular traffic at the market.

Finally, the internet has had a major impact on the functioning of the vegetable market. Apart from the disadvantages of the lack of a unified management and standard system, the lack of a rational public health prevention plan, and the immaturity of the commodity circulation infrastructure system, the current mode of operation needs more room for development. The increasing e-commerce and the intelligent mode of trading are having a rapid impact, which puts forward new requirements for the innovation and development of the vegetable market.



a. Public access between market blocks b. Internal space between stands Figure 5 Photos of Tan-Zhou market

#### 1.2.2 Problem of the Internal Demands of Community Dwellers

The main internal problem of the community is the inadequate consideration of the needs of the residents. The survey found that the area surrounding the Luyang Ju community is full of restaurants, food wholesalers, hotels and condominiums, hospitals, salons, and expressways. All the surrounding areas are used for commercial purposes. Cultural facilities such as libraries, museums, galleries and other facilities related to spiritual pursuits are far from the community. This situation has become common in many cities, especially second and third tier cities. The literature states that Baoding in Hebei Province has studied the range of 15minute living circles of more than 1,000 communities by calculating the proportion of public service facilities in each district. The allocation of medical and commercial facilities in urban community life circles was relatively perfect, but the allocation of public cultural facilities was inadequate (Z. Li, Zheng, & Zhang, 2019).

On the other hand, when the public health crisis occurred, people suffered from fear, anxiety, stress, and depression, while the related kinds of literature facilities can alleviate these matters (Alnazly, Khraisat, Al-Bashaireh, & Bryant, 2021; Fitzpatrick, Harris, & Drawve, 2020). Public cultural institutions, such as churches, sometimes influence the mood and purify the mind. Therefore, the transformation strategy of the redesigned community should consider the needs of residents, including mental health and surrounding environmental amenities. Moreover, a community library, an important public space within the community, is a good choice.

#### 1.2.3 Problem of Prolonged Sedentary Activity Infected the Healthy

Sitting is one of the most common activities of the human body (Harrison, Harrison, Croft, Harrison, & Troyanovich, 1999). Many occupations involve prolonged or even hours of sitting, such as students, factory workers, and office workers. The public health crisis is undoubtedly linked to prolonged sedentary behavior. Reduced mobility leads to less activity, which increases the risk of prolonged sitting.

The related health problems have rapidly increased since the public health crisis happened. The reason is that the public crisis would force people to restrict their movement and social contacts, therefore having a higher risk of inactivity (Gallè et al., 2020). There is an evident relationship between lack of physical activity (sedentary behavior) and health problems such as obesity, metabolic syndrome, aging with diminished immune and viral defenses (Lim & Pranata, 2020), hypertension (Pardee, Norman, Lustig, Preud'homme, & Schwimmer, 2007), adverse metabolic markers (Ekelund et al., 2006), and poorer mental health (Primack, Swanier, Georgiopoulos, Land, & Fine, 2009). Sedentary behavior is associated with adverse health outcomes, which differ from the degree of lacking physical activity (Tremblay, Colley, Saunders, Healy, & Owen, 2010). Furthermore, some researchers believe that sedentary behavior can worsen human diseases (Owen, Healy, Matthews, & Dunstan, 2010).

As a result, sedentary behavior is widespread and unavoidable, and the development of facilities such as outdoor gyms that can alleviate the negative effects of sedentary sitting is significant.

### 1.3 Objectives of the Research

The objectives of this thesis are the following:

(1) To research the problem in a typical old community, and propose transformational strategies ideas on community property considering public health.

(2) To utilize some design factors to achieve healthy, peacefulness and contemplation in community space.

Design factors used in this thesis include the local temperature, meteorological conditions, local environmental condition, Chinese ancient philosophy "Feng-shui" and five elements, traditional "Ling-nan" architecture elements and municipal intangible cultural heritage, etc.

(3) To propose a method of visualization design on the transformation of community space (Fig.6)

Experiment 1-Spatial distance

Experiment 2-Cross-ventilation

Experiment 3- Facilitation of

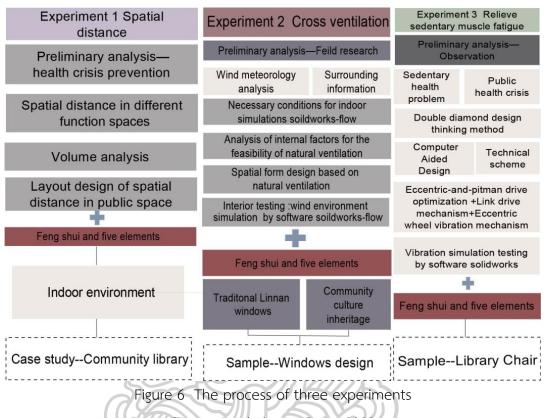
Community Planning and Design

Community Landscape

Community vegetable market

sedentary muscle fatigue.

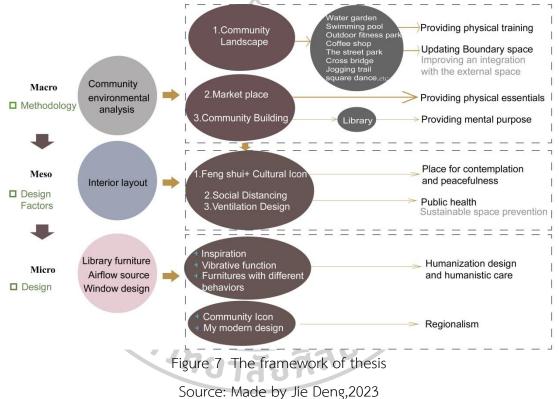
## Community library



Source: Made by Jie Deng, 2023

## 1.4 Overview of the Dissertation

This thesis consists of five chapters. Chapter One introduces the background information, the problem under investigation, the research objective, the significance, the methodology and the results. Chapter Two presents the a literature review on public health, typical legacy communities, critical public spaces, and transformational design. Chapter Three illustrates the study and research methods of this thesis, including interdisciplinary research, field research, questionnaires and data analysis, individual interviews, simulation-based assessments, and experiments. Chapter Four presents the general plan for the transformation of the old community, which is the main content of the visualization design of this thesis. The general transformation plan includes the design of the general layout of the community, the design of the community facilities and two case studies as examples of the detailed design. The design of the communities mainly includes the application of elements of Ling-nan architecture, traffic flow planning, plant layout, boundary spacing and expansion. The two case studies of the community's vegetable market and library were studied in detail and selected as examples for the design of the transformation. Additionally, several models including handmade models, 3D printed models, accurate models and factory fabrications were created to illustrate the design of the community library. The design methods starts from macro, meso to maicro (Shown in Fig.7). Finally, Chapter Five discusses the entire research, draws conclusions, analyzes contributions and makes recommendations.



,

## 1.5 Significance of the Research

The airborne transmission of viruses has caused several public health crises that have lasted at times for several thousand years around the world, affecting our daily lives. It is an unavoidable public environmental problem that people face the recurrence and mutation of the health crisis in hygienic public spaces. According to the current state of medical technology, quarantine is usually imposed in the event of a public health crisis caused by airborne transmission of viruses. However, it is impossible to isolate a person from the outside world for too long, as this can lead to physical and psychological problems. A normal life is always important, and the community public space is the closest environment in which people to keep life normal. In order to prevent new public epidemics from affecting our lives in the future, the design of hygienic public spaces such as the community should consider the prevention of public epidemic events. This thesis focuses on the prevention of health and safety problems in public spaces. A general design for the transformation of an old community at the whole scale was proposed, a modernized vegetable market was designed as a representative for the transformation of the exterior space of the community, and a detailed design for a community library was carried out as a representative design for the interior space of the community including innovatively designed furniture and windows inside. The transformation design of the community is based on the prevention of epidemics in the public. Thus, the purpose of transforming and updating the public space of the community to a health crisis and granting the community the essential functions of emotional and behavioral needs of the community space was realized in this paper. The work in this paper can be a practical and valuable reference for upgrading other urban communities with public health in mind.

## 1.6 Research Methodology

Methodologies of interdisciplinary research, investigation research, case studies, and effect evaluation are mainly used in this thesis (Fig.8).

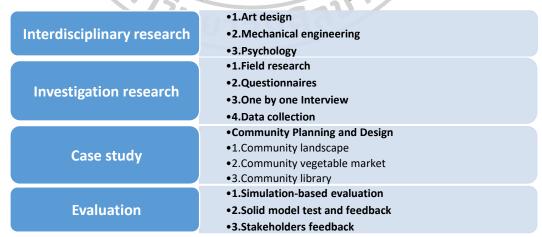


Figure 8 Research methodology

Source: Made by Jie Deng, 2023

#### 1.6.1 Interdisciplinary Research

The integration of interdisciplinary research in this work mainly involves the disciplines of art design, mechanical engineering and psychology. In the design of indoor furniture, art design is integrated into the mechanical construction of a vibrating chair designed for prolonged sitting. This work also incorporated psychological theory in the redesign of critical public spaces such as the vegetable market and library. By integrating psychological theory into the redesign of community spaces, people who have experienced psychological stress due to public health safety issues can benefit from spatial psychological therapy and relief in the community space.

#### 1.6.2 Investigation Research

The Lu-yang Ju Community in Zhongshan City, China, is the community studied in this paper of which the purpose is to examine the community's environment to develop a renovation plan. This is done by collecting circumstance data through direct observation of photographs and the satellite map. To understand the needs of the community residents in designing the remodeling, online questionnaires were distributed to collect data using "Wen Juan Xin" software. In addition, feedback was provided through face-to-face interviews, which helped to modify and refine the design. In this work, the literature of the community was also reviewed to research the local historical culture. Finally, based on the above research, the design for the community redesign was aligned with the geographic character, the needs of the residents and the local people.

#### 1.6.3 Case Study

Facilities that have been remodeled in the old community include landscaping, such as the main entrance, side entrance, parking lot, water pavilion, swimming pool, outdoor fitness park, café, community library, cross bridge, vegetable market, jogging path around the lake park and square dance, etc. (Fig. 9). Among these facilities, the vegetable market and the community library were selected as case study objects. In the case study of the vegetable market, the entrance and exit, the streamlines of the venue, the green design, the internal function arrangement, the internal streamline and the design of the stalls and stores were redesigned. In the community library case study, the internal layout, library furniture, ventilation system and windows were designed.

Three experiments were conducted in the community library case study. Experiment 1 is an experiment on physical distancing in the library reading room. Experiment 2 is an experiment on cross ventilation in the community library. Experiment 3 is an experiment on relieving sedentary muscle fatigue based on the vibrating chair in the community library.



#### 1.6.4 Evaluation

In this thesis, three evaluation methods were used to assess the results of experiments and the effects of some unique functional designs. The first method is experimenter evaluation, which is used to obtain the experimenter's direct feedback on the three experiments. The second method is third-party evaluation, including industry experts, designers, community leaders, and community residents. The third method is evaluation by simulation, which is used to assess the effects of the unique functional design, such as the movement of vibration and ventilation.

#### 1.7 Research Outcomes

The knowledge obtained through this thesis can effectively improve public health in China. The findings primarily focused on the planning and design concept of the entire community, which remodeled and updated the community space. The community boundaries were expanded, and the community and vegetable market were merged into a community living circle to improve the living conditions of residents. Critical public spaces, including the community library and vegetable market, are presented in detail as case studies.

The vibrating chair designed for sedentary people can effectively relieve fatigue caused by prolonged sitting. The design of the Ling-nan windows takes into account the esthetic knowledge of the city's intangible cultural heritage, the ancient philosophy of feng-shui and the five elements, and the character of Ling-nan architecture.



## CHAPTER 02

## LITERATURE REVIEWS

## 2.1 Introduction

This chapter focuses on the investigation and visualization design of hygienic public spaces: public health, typical old community, critical public spaces, and transformation design.

### 2.2 Public Health

From the perspective of environmental public health, the elements of natural ecology are strongly interconnected and influence each other. Humans are also part of the natural environment, and if an epidemic virus enters a human body, the epidemic can quickly spread to nearby human bodies. If not well controlled, public health crises would become an ever-spreading infectious event in human society, dramatically affecting human health and leading to severe hazard (Chong-Sheng, 2006).

A community is a dense population in which people have a greater chance of coming into contact with each other. As a result, there is a higher risk of infectious diseases in the community, which can even cause the outbreak of a public health crisis. High population densities catalyze the spread of the pandemic (Rocklöv & Sjödin, 2020). Aw (2021) mentioned that higher population density increases epidemic virulence in the community (Aw et al., 2021). A number of opinions are similar to previous scholars (Chandra, Kassens-Noor, Kuljanin, & Vertalka, 2013) (R. Li, Richmond, & Roehner, 2018). Therefore, community transformation design considering public health crisis prevention is of great importance in this work. The work in this thesis can be a practical and valuable reference for visualization design of typical old urban communities and other hygienic public spaces.

#### 2.3 Typical old community

#### 2.3.1 Definition of Community

There are many interpretations of community. The idea of community as a dialectic between the individual and society, when linked to the physical space in a city, has a long history in urban planning and design practice. The term 'community'

comes from the Latin for a shared possession or close relationship. In 1881, the sociologist Tennes wrote the term "community" into his book. The concept of community has constantly renewed its meaning over time. Communality is one of the perspectives in the study of public space (Lynch, 1995). The word "public" implies "equal" and "accessible to all"," so that the facilities and services in public space should be available to all members of the community without restriction (Hsia, 1998). —Community space is considered as public space in the long flow of history. The community is the actor that plays a fundamental role in public space. It refers to most people with a common background who share urban places, ethnic values and projects (Campioli & Peraboni, 2022). In traditional sociology, a community is a group of people living in a common area, and this word denotes a community of people with shared values. As a social unit, a community consists of a certain number of families. Community is also a biological concept; it represents groups of connected organisms with the same environment (Wikipedia, 2009).

The concept of the old community is topical. A "typical" community means that many similar communities have the same situation. According to preliminary statistics, there are nearly 160,000 old communities in China, with more than 42 million households and a construction area of about 4 billion square meters(Cai, Yang, & Li, 2017). The transformation design of the old community has enormous potential value.

### 2.3.2 Community Research

The community has garnered several significant theories, such as the neighborhood unit theory.

#### 2.3.2.1 Neighborhood Unit

The American planner and sociologist Clarence Perry coined the term of the "Neighborhood unit" in 1929 (Brody, 2009). The idea of the "neighborhood unit" has extensively promoted the evolution of community planning worldwide. Neighborhood unit theory includes six principles that define the basic components of a community. The six principles of neighborhood unit are as follows (R.-r. Zhang, 2018):

a. Size: Population is the main element to measure the size of a neighborhood, and the subdivision of the neighborhood has been related to population density.

b. Boundaries: The establishment of a sufficient trunk road in residential units should ensure the safety of the trunk road that does not encroach into the interior of residential units.

c. Open spaces: Residential neighborhoods need open spaces that are equipped with parks and recreational spaces.

d. Public facilities: Schools and other public facilities should be concentrated in a central location, and residential units could make the best use of the surrounding public area.

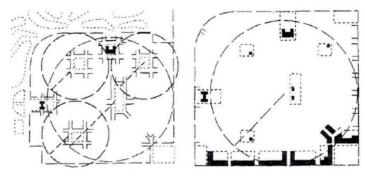
e. Local stores: To meet the living needs of residents, at least one store should be located in the housing unit. It is better to plan the intersection of streets and stores in the adjacent residential area.

f. Internal road network: The design of the internal road system should meet the needs of residents for communal traffic and realize the necessary separation between different areas.

## 2.3.2.2 Traditional Neighborhood Concept (TND)

The Charter of a New Urbanism, published in 1993, focused on this idea that corresponded with the Traditional Neighborhood Concept (TND) and the Transport-Oriented Concept (TOD) (Fu, 2020) (Fig.10).

The core idea of TND was to replace the traditional car-dominated development model with forms such as street grids, compound functions, dense building, public facilities and sidewalks. The following drawings illustrate the TND community (Yu, 2005).



a. The daily life circle within 5 minutes' walk b. The park within 3 minutes' walk

## Figure 10 A concept of traditional Neighborhood

Source: Made by W. B. Yu, 2005

#### 2.3.2.3 Transit-Oriented Development (TOD)

Transit-oriented Development (TOD) was defined by Peter Calthorpe to mitigate the effects of urban sprawl. In the 1970s, the New Urbanist Movement saw TOD as a model for curbing sprawl and placeless neighborhoods. TOD establishes a transit station around which planning develops to provide mixed-use services within walking distance of communities. TOD has established a direct relationship between public transportation and land development modes. The advantages of TOD lie in the following four aspects (R.-r. Zhang, 2018):

a. The size of the road is suitable for residents to walk along with pleasant scenery along the road is beautiful.

b. The centers and boundaries of the regions are recognizable, and the growing boundaries of the cities and communities are limited.

c. Different compositions of population and land use functions.

d. The limited enclosure of public space means that the functions of public space and private space complement each other and form interconnected cultural center systems and residential service systems.

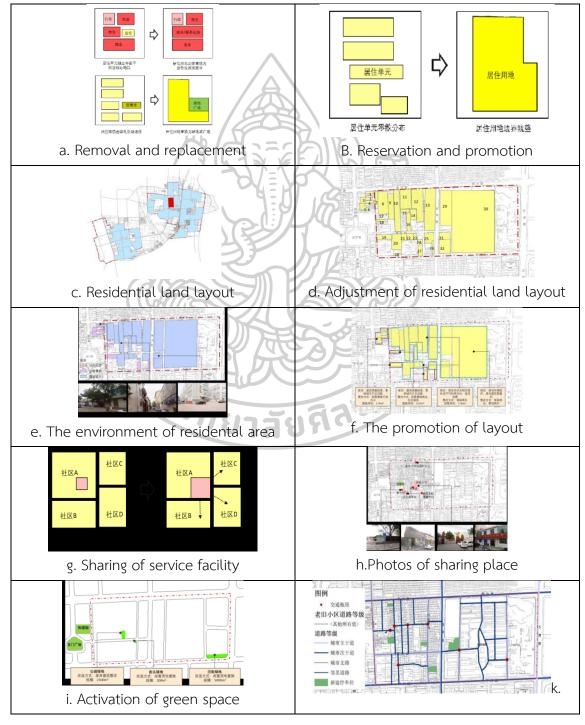
In the contemporary community, public space specifically includes community squares, gardens, libraries, gymnasiums, restaurants, supermarkets, and various formal and informal organizations formed by members of the community, such as a city choir, volunteer groups, etc. (H. Xu, 2021) It is important to define the contemporary function of the public space that prompted the designer to create the space.

#### 2.3.2.4 Old community research

(1) Case One: Study on the spatial layout of a residential community in the central urban area of He-Jin Central Community (Fig.11)

The community system in He-Jin Central Community is chaotic. The internal space and construction level of the community are of low quality, which does not meet the needs of residents (Yang, 2021) Based on the urban development, community and spatial distribution of the population in He-Jin Central Community,

Yang (2021) explored the spatial layout of a residential community in order to alleviate the realistic dilemma of growing disorder and poor quality in the community. Therefore, the space of the residential community was integrated and the layout of the internal spatial community was adjusted, which is an active demand to realize the sustainable and healthy development of the residential community space.

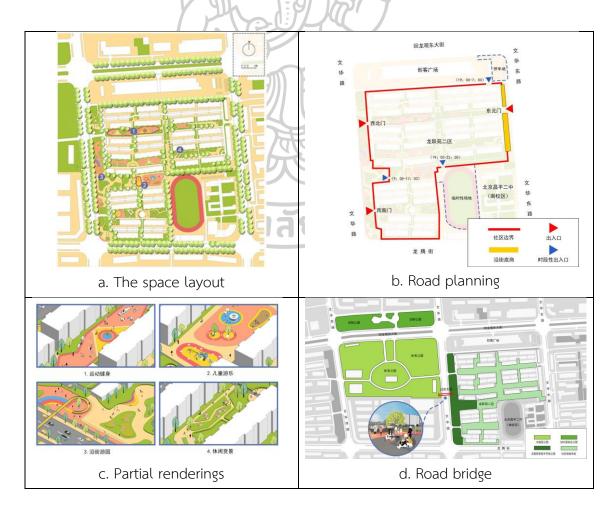


	Traffic reconciliation
Figure 11	Case One

Source: photos by Yang, 2021

(2) Case Two: Research on Renewal Design of Beijing Old Community Public Space Based on Resident Demand (Fig.12)

The problems of the old community include homogenization and superficial construction (Fu, 2020). However, focusing too much on the format of beautification and ignoring the actual demand of residents has led to a series of problems in the community, such as lack of function, vacancy, disorderly traffic and impersonality. Based on residents' needs, Fu (2020) proposed five aspects of regeneration strategies, namely quality, structure, atmosphere, management and culture. However, due to the insufficient samples and limited accuracy of field research in previous research, Fu's study could not accurately carry out the renewal design in reality.



## Figure 12 Case Two

### Source: photos by Fu, 2020

(3) Case Three: Research on the practical micro-transformation of Old Communities in the post-epidemic Era-- A Case Study of Nan-guan Community (Fig.13)

Zhou (2023) pointed out that the old community in the post-pandemic era has many problems in terms of both functional space and management style, such as backward sanitary conditions, misallocation of public resources, lack of disaster prevention and emergency plans, weak community management, and hysteresis of information and data sharing (Lu Zhou, 2023). Zhou suggested that the microtransformation of old communities in the post-epidemic period, such as the diversification of space security and flexible service, is healthy. In Nan-guan community in Bi-Shan District of Chongqing, he has carried out micro-transformation, such as establishing physical boundary control, regulating entry and exit checkpoints, optimizing emergency power lines for epidemic prevention, excavating and relocating flexible space, and establishing medical facilities in groups.

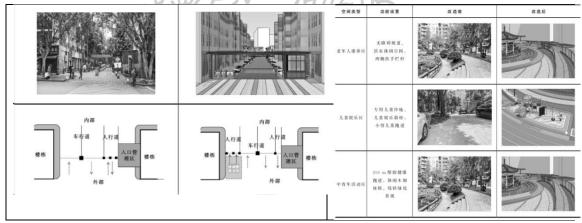
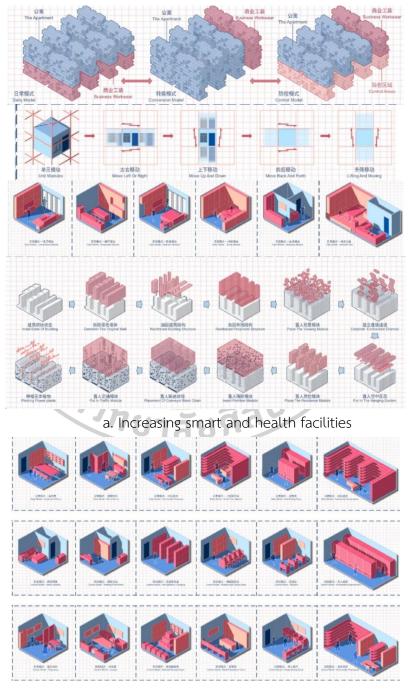


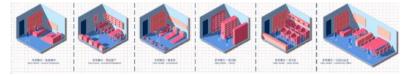
Figure 13 Case Three

Source: photos by Liu Zhou, 2023

(4) Case Four: Research on the Transformation of Community Space in the Post-Pandemic based on Metabolism Talks (Fig.14)

Yuan-Cheng Ma (2023) pointed out that constructing a traditional community cannot adequately cover the ability to face unknown risks. By studying the theory of metabolism and serving as a guide, he analyzed and summarized the current situation of the community in the post-pandemic period. Based on the metabolic theory, he summarized the corresponding design strategies aimed at realizing the transformation of the community in the post-epidemic era. He proposed modular design and intelligent layout, the integration of public space facilities, multifunctional and sustainable design and digital virtual construction. The design practice is the No. 27-39 courtyard of Zheng-tong Road in Guangzhou, where the community is located (Yuancheng, 2023).





b. Increasing the leisure space and entertainment place



c. Realizing and sharing the community resource by Digital APP

Figure 14 Case Four Source: Photos by Yuancheng, 2023

(5) Case Five: Towards the Healthy Community: Residents' Perceptions of Integrating Urban Agriculture into the Old Community Micro-Transformation in Guangzhou, China (Fig.15)

Chen (2018) pointed out that the public space in old communities lacks attention to the environmental problems in the area of modern cities, such as the destroyed spatial diversity and the discrepancy between the spatial function and the daily needs of users. Such problems occur frequently. Chen's study took microrenewal as the starting point; the daily activities of elderly users were observed as the perspective. The service design method and its disciplined thinking were considered as the direction of the study. The focus was on the environment of public space in the old community, considering the aspects of spatial function, landscape, sharing, and treatment (J. Chen, Wang, Xiao, & Zeng, 2018). However, the samples studied by Chen are insufficient, and not enough homogeneous communities are studied and designed. In addition, the actual practice is insufficient and the implementation phase of the system has not yet been carried out.

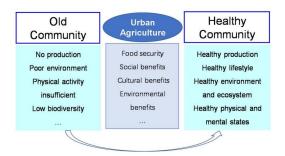


Figure 15 Turn old communities into healthy communities through urban agriculture Source: photos by J. Chen, Wang, Xiao, & Zeng, 2018

## 2.4 Critical Public Spaces

### 2.4.1 Community fitness space

Outdoor fitness has become a widespread community infrastructure in public open spaces to improve the health of residents. Building community fitness spaces can boost residents' immune systems, which is important for long-term public health.

Liu (2023) suggested that the National Fitness Program has promoted the rapid development of community fitness spaces, which are an indispensable part of China's outdoor fitness system (K. Liu, Zhang, & Xu, 2023). Six communities in Dongchang-fu County of Liao-cheng City, Shandong Province were selected for his study. The places equipped with community fitness spaces were taken as samples. Here are some photos of the fitness spaces in the six communities (Fig. 16).

*ระหาวิท*ยาลัยศิลปาก

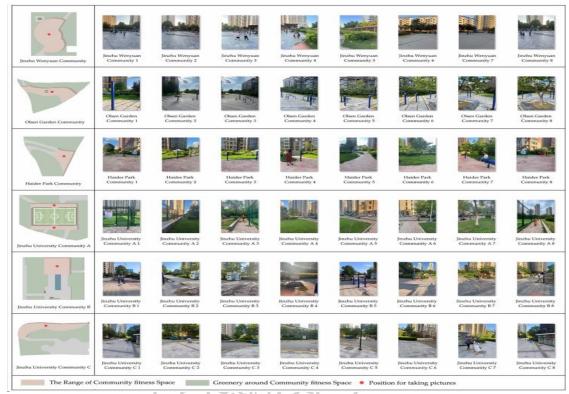


Figure 16 Communities fitness spaces Source: Photos made by K Liu, 2023

Xiang-yang Wu (2018) investigated that gender-specific differences played a significant role in determining the choice of sport. Men cycle, run individually or play ball games in a team. Women prefer to do yoga and eight-piece brocade individually or play square dance in a team.

Therefore, multifunctional spaces should be considered as a design model for community fitness spaces.

## 2.4.2 The street park

Parks have been an integral part of modern cities (Talen, 2010). Many developing countries have constructed many parks in recent years. The street park is a narrow range of landscapes. The street parks have similar design methods, for example, the general strategic plan of New Borg Al Arab City shown in Fig.17 and the Silicon Waha master plan, shown in Fig.18. Atwa (2019) developed a methodology for the GBPs' landscapes by using virtual reality with different landscape design models. She constructed 2D and 3D models using AutoCAD and SketchUp (Fig.19) (Atwa,

Ibrahim, Saleh, & Murata, 2019). This method of park design is also useful for the street park.

Nordh (2013) researched the idea of activities that people could participate in parks. The research concludes that small urban parks should be designed with natural components, screened from distracting environments and equipped with some seating to promote opportunities for recreational experiences and act as social meeting places (Nordh & Østby, 2013). This thesis of residents' activities will help to shape the park design to meet their needs (Fig.20).

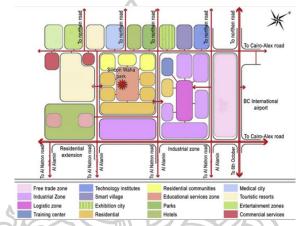


Figure 17 General strategic plan of New Borg Al Arab City Source: http://mmohsen.weebly.com/professional.html



Figure 18 Silicon Waha master plan

Source: http://siliconwaha.net/why-borg-alarab.html



Figure 19 Phases of landscape design modelling

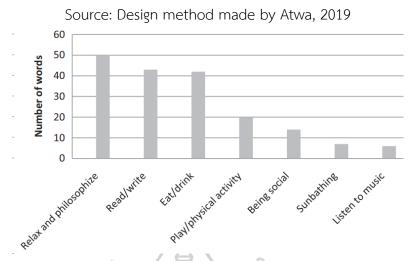


Figure 20 The types of activities participants could imagine performing in the small urban parks.

Source: Made by Nordh, 2013

Da-Peng Li (2012) has attempted to shape the vitality of the Renaissance in historic neighborhoods. The heritage of traditional culture in the neighborhood, the transformation of industrial landscape, the embodiment of regional characteristics, and the abstraction and integration of historical information are all done through park design. Its main strategies for transformation design in the park are the renovation design of park boundaries, the protection and regeneration of historical and cultural buildings, the renovation and restructuring of historical and cultural landmarks, the utilization of brownfields and the redesign of the natural landscape (Da-peng Li, 2012)

### 2.4.3 Vegetable market

A "market" is defined in the Modern Chinese Standard Dictionary as "the concentrated sale of vegetables, meat, eggs, by-products and others. It is called a vegetable market or vegetable farm"(X. Li, 2010).

The "Standardized Vegetable Market - Construction and Management" was issued by the Ministry of Commerce in 2011. The term "vegetable market" is defined as the trading areas with facilities for the sale of all kinds of agricultural products and by-products such as fruits and vegetables, meat, poultry and eggs, aquatic products, dairy products, soybean, spices, cooked brine, canned food, grains and oil. The vegetable market is part of food retailing, an essential consumption in people's lives. According to a survey and research, the Public Space Project of the United States suggests that the market has gathered a number of users in the community and promoted the economy of community life, which is conducive to the atmosphere in the community and the renewal of development. It plays a critical role as a catalyst for community life. "Integrating the market morphology into the neighborhood creates an active public space and promotes healthy living." (Leinberger, 2005) "Urban catalysts can also promote urban regeneration, Renaissance, and townscape near markets. Therefore, this property of urban catalysts has a long-lasting effect (Bohannon, 2004).

## 2.4.3.1 Current situation of vegetable market

Many surveys have observed the current situation on the vegetable market. Xiao Liu (2016) conducted a field survey of six vegetable markets in the old communities of Shanghai city. In urban development, the old community of Shanghai needs help in the coexistence and integration of new and old buildings. More attention needs to be paid to this vegetable market in Shanghai. Similar situations exist in many cities, and the following points have been summarized (X. Liu, 2016): such as the existing living conditions were still relatively chaotic, the area surrounding the traditional market was not landscaped in an appealing way, functional combination between vegetable market and other buildings made noise and foul odors, and etc.

## 2.4.3.2 Consumption habits and psychology of community residents

Vegetable markets, scattered greengrocers, fresh supermarkets and large stores with similar commercial functions were all located within the community. Various service systems were created to support different lifestyles. According to the research, Xiao Liu (2016) conducted a questionnaire that investigated the building and interior of the market and randomly asked residents about the market and supermarket. The most common answers to the question "Why do you prefer to buy food at the vegetable market?" were the cheap food, the familiar environment and

the more human businessperson. Furthermore, the survey also revealed that some residents have changed their consumption, psychology and needs.

Compared with traditional food markets, they were more inclined to supermarkets and stores that suit the fast pace of life. Since older people do not have to work and have a lot of free time, buying and selling at the vegetable market is a necessary shopping and entertainment activity. Young people have little free time due to study and work under great pressure and prefer targeted shopping. The active participants in the community are older people and children in the community's public spaces. Their needs should be taken into account when redesigning the vegetable market.



Figure 21 Vegetable market Source: Made by Jie deng, 2022

## 2.4.4 Community library

The community library is an essential part of the public cultural service system, providing information guidance services, social education and recreational activities (G. Li, 2016). There is no hierarchy level in a community library, only different sizes compared to other standard libraries. A community library collects books compiled by the community (Z. Liao, 1992) and serves all residents by selecting information, organizing, storing and sharing documents in a certain area (Huo & Guo, 1995). The relationship between the library and the community is remarkably close. Usherwood (2002) and Kerslake (1998) found that public libraries had a positive impact on communities through their social, educational and cultural roles and by developing trust in individuals and communities. As the service function of community libraries has expanded and the cultural needs of community residents

have been strengthened, the importance of community libraries has steadily increased. However, a common point regarding community libraries is based on the function of a community, which aims to enhance cultural exchange and community competitiveness through the information exchange. Kretzman and Rans (2005) found that public libraries have contributed to community development by providing free community space, technological resources, connections to the local economy, a sense of belonging to the community, and a high level of trust in the community (Aabø & Audunson, 2012) (Kretzman & Rans, 2005).

Moreover, Guo-Xin Li (2016) briefly summarized the six characteristics of these new public reading spaces and compared them with the traditional public reading spaces. First, based on the population density of residents and the flow of people as the primary information for local distribution, which was closer and more attractive than traditional libraries. Second, although the area could have been more significant and all small libraries with the primary service function, the categories of books depend on the preferences of local residents in the community library. Third, the interior design of the new library was original and the environment was elegant, which was more attractive than the traditional community library. Fourth, it integrated high-tech means such as wireless networks, automatic borrowing and returning, card processing, e-book scanning and downloading, automatic control of lighting and temperature, remote monitoring of cell phones, and comprehensive intelligent and digital services. Fifth, the main branch of the town library system was integrated and a standardized management and service system was introduced. Sixth, various forces were brought together, such as libraries, enterprises and institutions, grassroots communities and volunteers, which included high social participation and sustainability (Tiao, 2019).

In principle, people should live in a balance of three circles, including family, work and social circle. The American sociologist Ray Oldenburg (1989) wrote in his book that the best place to combine snack bars and coffee is in the heart of the community. In the book, he pointed out some places for restaurants, bookstores, bars, hairdressers and other meeting places that modern citizens need for a healthy life. He called these places the third place. According to his induction, the third

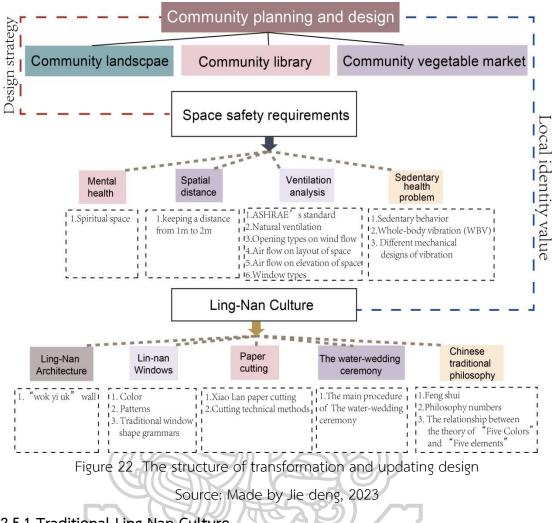
place must have iconic characteristics. Zi-liang Liao's (1992) community library mentioned that the library is located in the community. Guo-Qing Huo (1995) suggested that community libraries should consider the characteristics of the community and the library. Zi-Liang Liu (2002) pointed out that community libraries are cultural and educational institutions and that information exchange centers are established in communities and used by community residents.

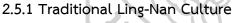
As for the internal function of the community library, Chang Song Chen stated that the reading space includes a public space, a group space, and a personal space (C. s. Chen, 2009; Tiao, 2019). The theory of social space by American sociologists Erving Goffman and John Lofland analyzed and summarized that the personal reading space is private and not subject to outside control or interference, and that everyone has their own personal space. Therefore, the community library should consider the three parts of space design.

#### 2.5 Transformation design

The airborne transmission of the virus has led to a public health crisis that provides an opportunity to rethink some critical issues related to the public space design (Campioli & Peraboni, 2022). There are some defense requirements and lessons learned from previous infectious diseases that can be used in the design of public space. Studies related to prevention measures can improve public health by providing effective transformation strategies. Transformation strategies include content on mental health, physical distancing, ventilation design and prevention of physical inactivity.

Moreover, local culture will enhance the value of local identity. The local culture discussed in this paper includes Ling-nan architecture, Ling-nan windows, paper-cutting and water wedding ceremony. Furthermore, the traditional Chinese philosophy is widely used in architectural design and can also be used for the transformation design in this thesis. The transformation design of Lu-yang Ju community becomes more recognizable (Fig.22).





## 2.5.1.1 The Ling-Nan Architecture

The architecture of Ling-nan is in the traditional Cantonese style. There are many historical buildings in a community, such as temples, shrines, ancestral halls and listed houses, which display the colorful and intricate decorations of Ling-nan's architecture.

There are some typical designs in the architecture of Ling-nan. There is a lot of wisdom and esthetics of ancient China in the designs. For example, they use perforated brick walls and screens for cross ventilation. Stones and bricks for walls and structures were used instead of wood to avoid mold and moisture in the hot and humid climate. The "wok yi uk" architecture with a vertical roof was designed to protect the walls from direct sunlight, reducing heat build-up in the room.

Moreover, the high wall of the mountain can prevent the wind from entering the alley, so that the wind flows into the house through the door and window, making the house cool. The main function of the "wok yi uk" wall is to protect against fire. The "wok yi uk" wall is not only a decoration, but also a cultural icon (Fig.23). The abstract element of the "wok yi uk" can be used to transform the community.



Figure 23 "wok yi uk "wall in the Ling-nan architecture Source: https://architectureontheroad.com/shawan-ancient-town-lingnan, 2023

## 2.5.1.2 The Ling-Nan Windows

Traditional Ling-nan windows are usually built with window pediments. Different patterns and colors are used for both the windows and the pediments. Window pediments are mainly divided into round arches, triangular arches, double round arches, square arches and linear arches (H.-g. Tao, 2020), as shown in Fig.24. The main function of the window pediment is to prevent too much rainwater from flowing into the window and to enhance the display value of the window. The decoration patterns are vivid and show the Chinese art of gray carving to the utmost. The traditional Ling-nan window patterns consist of animal and plant patterns, geometric patterns, handwritten patterns and composite patterns (Huang, 2013). The main colors of the windows are blue, red, yellow, white, black, and mixed colors. Thus, the traditional Ling-nan windows also reflect the local traditional culture (Fig.25).



Figure 24 The Ling-nan windows

Source: Photos by Tao Hong Guo, 2022

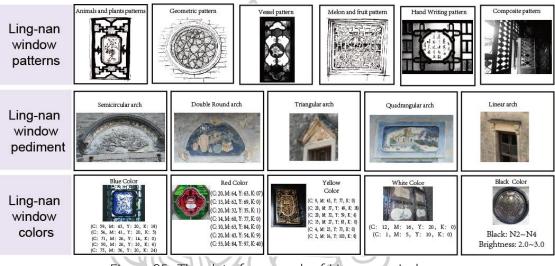


Figure 25 The data framework of Ling-nan windows

Source: Made by Jie Deng, 2022

## (1) The design method of traditional Ling-nan windows

According to Tao's study, the design methods of the Ling Nan window mainly consist of addition, subtraction, multiplication and division (Fig. 26). The four methods are each analyzed as follows (H.-g. Tao, 2020):

## Addition

The design methods of the Ling Nan window utilize the design methods of buildings in western countries and absorb part of the culture of northern immigrants into the local culture. In this way, the design process of refining, assembling and merging and the addition method emerge.

In the field of design, refinement means that one original ecological element is grafted onto another to create a complete design. When Ling-nan people invaded Western culture, they successfully absorbed a part of Western culture and grafted it into Ling-nan's design method.

A collage is a design form in which several elements are combined together without these elements being integrated. In the modern design period, this form has become a mixture of art and can give people visual impressions through variety, composition, overlapping and juxtaposition.

From the perspective of design, fusion integrates elements of different types or levels into a combined integrity, which has different characteristics through specific morphological reorganization and stylistic reproduction.

Subtraction

Subtraction includes simplification and tracing. The traditional Ling-Nan windows are good at using various natural objects in their design. However, these objects are usually abstractly simplified. Tracing uses an empty window to cut out scenery without reducing the scenery of a traditional garden, creating a moving scenery.

### Multiplication

Traditional Ling Nan windows subtly apply the method of multiplication with time, which uses the light rays of sunrise and sunset to make the wall with the window and the ground become an organic whole. This design method has realized the transformation of a four-dimensional space through shadow, color and shape.

Division

The design method of division in the Ling Nan window is based on proportion and gradation. Studies of traditional windows have shown that ancient people were sensitive to numbers. The surface proportions of the windows to the walls were subtly predetermined and followed the rules of the time.

17519

Graduality is often used in the division of space in architecture, such as small and oversized windows. The number of windows is usually 3, 6 and 9, and the number of small windows divided by the large windows is usually equal to the number of doors.



Figure 26 Traditional window shape grammars

Source: Architectureontheroad.com/shawan-ancient-town-lingnan-guangzhou/,2013

# (2) The opening form of ling-nan windows

The Ling-nan windows have various species judging by forms such as double casement window, sliding window, top-hinged swinging window, vertical pivot window, permanent sash, folding, etc. as shown in Fig.27.

a. Double casement				
b. Sliding				

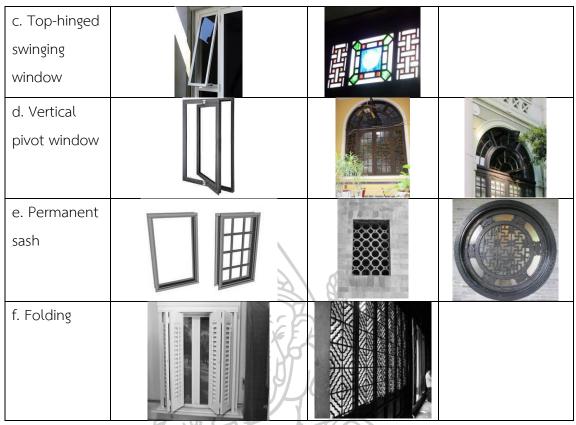


Figure 27 Different opening forms of ling-nan windows Source: Photos by Xiang-Han Huang, 2013

## 2.5.1.3 Ling-Nan Paper-cut

The paper-cut called Xiao-Lan in Zhong-shan City is unique in the world and has been declared a national cultural heritage site. The "Xiao-Lan" paper-cut features a variety of patterns, which can be roughly divided into plants such as flowers, animals such as fish and walking beasts, human figures, landscapes such as mountains and rivers, traditional ornaments, etc. Paper-cutting silhouettes, such as window and lath cuts, are often used to decorate families. In terms of artistic value, "Xiao Lan" paper-cut is well suited to absorb the artistic nourishment of different schools of thought for its use. It has the characteristics of a delicate and beautiful southern paper-cut and a rough and straightforward northern paper-cut. In terms of social value, the Ling-nan "Xiao-Lan" paper-cut closely follows the development of society. It not only records the history of the Xiao Lan area, but also constantly updates itself. By beautifying people's lives, the Xiao Lan paper-cut has played an imperceptible role in edifying people's feelings and building a harmonious society (Fig.28).

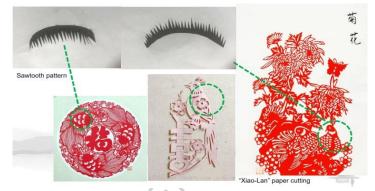


Figure 28 A "Xiao-Lan" paper-cut Source: http://k.sina.com.cn/article\_5787187353\_158f1789902001lb9e.html, 2023

## 2.5.1.4 The "wedding-on-water" ceremony

The custom of "marriage on the "water" has its origins in the etiquette of the Tanka people. It originated in the early Qing Dynasty and matured in the late Qing Dynasty. It has a hundred-year history and has been combined with Guangfu and Hakka cultural elements. Tourist Administration (2023) published the result of the declaration of the tenth urban cultural heritage. Tan Zhou Water Wedding Ceremony was successfully designated as an urban cultural heritage (Fig.29).

```
History in Tan Zhou area of Zhongshan City
(The water-wedding ceremony)
```



Figure 29 The history of a water-wedding ceremony

Source: Made by Jie Deng, 2022

This ceremony consists of a total of 13 procedures. The entire sequence of the wedding ceremony is unique (Fig. 30). The etiquette includes, above all, sitting in the Main Hall (the groom and his relatives sit in the main hall where two large candles are lit), Tying up the Hair (in the past, women wore their hair in plaits when they were not married and then tied their hair into a bun, Antiphonal Singing (before the "weeping wedding"," mother and daughter, sisters and bridesmaids sing in antiphonal style), Fetching the Flower Boat (the bride is fetched by the flower boat), Return of the Bride (the bride's return to her mother's house on the third day of the wedding) (Z. Liu, 2021), etc. The "wedding on the water" ceremony will be a pattern element of the windows, which enhances the cultural symbol of the community in the transformation design of the community.



Figure 30 The water-wedding ceremony

Source: http://www.zs.gov.cn/tzz/zjtz/lsyg/content/post\_1315053.html, 2023

## 2.5.2 Chinese ancient philosophy

## 2.5.2.1 Feng-Shui

The term feng shui is made up of the Chinese words "feng"," meaning wind, and "shui"," meaning water. Feng shui is the arrangement of objects in living spaces to create a balance with the natural world. In this work, the Ying-Yang and the "Five Elements Theory" are used to realize a part of transformational design in a community: harnessing the energy forces and creating harmony between an individual and their environment. (Fig.31)

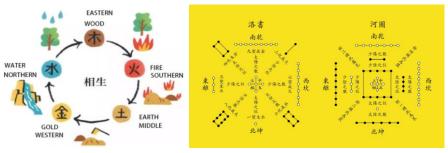


Figure 31 Feng-shui, philosophy numbers and five elements

#### Source: Internet picture, and made by Jie deng, 2023

### (1) Ying-Yang and five elements

The five colors have their origin in the theory of the five elements in ancient Chinese philosophy. This superficial materialism believes that all things are made up of the five essential elements: Gold, Wood, Water, Fire and Earth. The original theory of the "five elements" dates back to the Shang Dynasty. At that time, people believed that the sky was round and flat, the earth had five directions and China was at the center. In the book called Zhou-Li-the chapter Kao-gong-Ji describes that each direction of the earth represents a pure color. The universe contains "five elements"," and each element is represented by a certain pure color: gold represents white, wood represents blue, water represents black, fire represents red and earth represents yellow. The colors blue, red, white, black and yellow correspond to the elements wood, fire, gold, water and earth and the directions east, south, west, north and center (Lian-fu Guo, 1992)

Table 1 Chinese traditional philosophy Source: Made by Jie deng, 2023

Five colors	Blue		Red		Yellov	V	White		Black	
Five elements	Wood Fire		Earth		Gold		Water			
Wind direction	Eastern Southern		ern	Middle		Western		Northern		
Number	1	2	3	4	5	6	7	8	9	10
Yi Yang	Yang	Yi	Yang	Yi	Yang	Yi	Yang	Yi	Yang	Yi

#### (2) Relationship between Ying-Yang and architecture

Based on the principle that the octant operation utilizes yang as the lifeblood, the "yang" number became a fundamental design principle of ancient Chinese architecture. From modeling to construction, from the whole to the details, the arithmetic sequence of "yang" numbers is generally considered, such as the layout of beams and frames, the setting of doors and windows, etc. Ancient Chinese architecture emerges as a feminine and delicate esthetic style of ancient architecture through the masculine technique of designing with "yang" numbers. This was the "yang" method and "ying" style (C.-g. Li, 2017).

The philosophy of numbers permeated the planning, construction, decoration and other design processes that originated from the convention of ying-yang and the five elements. In the book "Carpenter House of Ru-ben", it is said that one means misfortune, two means feeling at home, three means fortune, four means misfortune, five means fortune, six means misfortune, seven means fortune, eight means misfortune and nine means fortune (Luo & Luo, 2008) (Fig.32 a). There are some examples, for example, the philosophy numbers used in residential buildings to symbolize good or bad luck. In the capital Beijing in the Ming Dynasty, the outer city had seven city gates, a "Ying" number. The number of city gates in the inner city is nine, also a "Ying" number. The Temple of Heaven is a typical allegorical design that uses the numbers of philosophy (Luo & Luo, 2008). According to Ba Gua theory, the inner space of the temple has 4 long pillars symbolizing the four seasons: Spring, Summer, Autumn and Winter. The outer room has 12 golden pillars representing the 12 months of the year; 4 and 12 are Yang numbers (Fig.32 b).





a. Illustration of the Ru-ban wood b. Layout map of Prayer of the Year

workshop

Temple

Figure 32 Ancient Feng-Shui samples Source: https://mp.weixin.qq.com/,2023

### 2.5.3 Mental health - Spiritual space

The history of epidemiology shows that people have experienced various public health crises. Faced with a huge public health crisis, quarantine became one of the fastest measures to restrain virus transmission in national health departments. The national office of the NHC pointed out that home quarantine is the best measure to protect against a public health crisis (Authority, 2022). Prolonged isolation

creates negative emotions that affect mental health, apart from psychological learning.

#### 2.5.3.1 Design approach of spiritual space

The essence of the design of spiritual spaces depends on the overall atmosphere. The design elements include form, color, texture, light and shadow. The goal is to achieve a highly functional and esthetic design of the space so that people can naturally surrender to the artistic conception.

### (1) Color

Color is the first option for realizing the effect of visions in the spatial environment. People will feel comfortable and satisfied if the interior color matches people's lifestyle and esthetic taste. A harmonious color is the most important prerequisite for designing an emotional space. For example, the designer should choose one color as the main color at the beginning and then coordinate it with other colors.

#### (2) Shadow

Light is the soul of space. The American architect Louis I. Kahn (1990) explained the relationship between light and space. In his opinion, the design of space meant the design of light. For emotional space, designers often use light and shadow to create a certain atmosphere through the design of light, such as amplification, attenuation, blurring, realization, etc. The Church of Light on the outskirts of Osaka, designed by Japanese architect Tadao Ando (1999), is an excellent example of the use of light to create a spatial atmosphere. The reflection of soft sunlight penetrated the interior of the church, darkened the existing rectory in the courtyard, isolated the noise from outside, formed a poetic sense of the East, and reflected the concept of emotional space.

## (3) Material

People perceive the details of shape in space primarily through touch and sight. To create a human, emotional space, the texture of the space is important. Materials can emanate from people's psychological feelings and enhance the atmosphere of the environment. Materials take into account nature, organicism, purity and simplicity. The use of natural materials can create fantastic landscapes.

### 2.5.4 Space safety requirements

## 2.5.4.1 Spatial distance

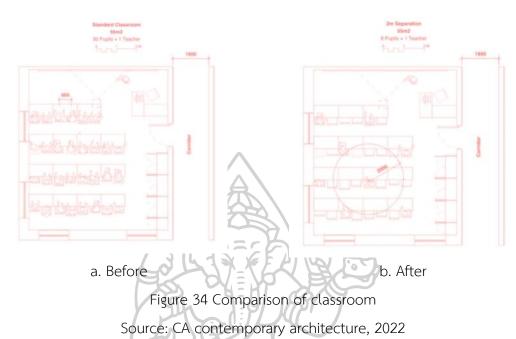
## (1) Case studies of spatial distance

The safety distance is closely related to the transmission of droplet viruses. In order to avoid the transmission of viruses, we should design physical distancing in public areas. There are some cases related to the physical distance in public space, for example, the outdoor restaurant in New York City designed by David Rockwell (2020), which transformed the streets of New York City into outdoor restaurants, thus creating social distance from the dining place, as shown in Fig.33. The expansion area of the restaurant was located near the sidewalk and streets. The design included the restaurant, sanitation station, sidewalk and landscape, complemented by lighting, umbrellas, fans, flowers and other amenities. The aim was to create a module that would adapt to the different parts of the city and provide potential revenue for the restaurant operators. At the same time, people had a sense of security as the restaurant met the requirements for social distancing in the space.



Figure 33 Outdoor restaurant scheme Source: https://www.dezeen.com,2020

Another case is the studio in Great Britain. The head of architecture firm Curl la Tourelle (2017) conceptualized the classroom to keep students safe when they returned to school. They envisioned a creative temporary classroom in schools that increased social distancing for students to learn and reduced reliance on transportation. After the redesign, the detailed spacing was changed from 600mm to 2m to create safe social distancing. The design can effectively protect students' health during a health crisis (Fig.34).



According to the relevant literature, the safety distance criterion is different in

many countries.

The Department of Public Services reports that the normalization of prevention should focus on venue control to create a healthy environment (Department of Public Services, 2011). Controlling venues is important to ensure safety in the space. Physical distance is an effective measure of safety control in the design of public spaces. In related studies, Saeed Ullah Jan (2020) stated that these practices would avoid the risk of contact contamination, including limiting the number of people in the library, sanitizing floors/surfaces, keeping doors open, social distancing, digital services for library users, and a dedicated quarantine area for the incoming documents (Jan, 2020). Dilara Begum (2022) mentioned that physical distancing is a practical non-pharmaceutical approach to stop disease transmission (Fraser, Riley, Anderson, & Ferguson, 2004) (Gray et al., 2021). Bar-On YM (2020) suggested that the virus has a diameter of about 0.1 mm (100 nm). To characterize droplet transmission from someone within 1 m or in "close contact" with someone with respiratory symptoms (Organization, 2020). In Hong Kong, Singapore and Norway,

a distance of 1 m is recommended. In England, the recommended distance is now at least 1 m. In New Zealand, 1 m is recommended in schools and workplaces with a high alert level (Han et al., 2020). Nevertheless, the assessment criteria are different in many countries. In Germany and Spain, for example, it is 1.5 m, in Japan and South Korea 2 m. In New Zealand, a distance of 2 m between people is recommended in public spaces (Gray et al., 2021) (Han et al., 2020). The guideline in the United States as of November 2020 is six feet, or 1.8 m (Schneider et al., 2023). Overall, the limited physical distancing became the preventive measure that the required distance is better than maintaining a distance of 1m to 2m, at least 1m, to reduce the risk of droplet transmission (Fig.35).

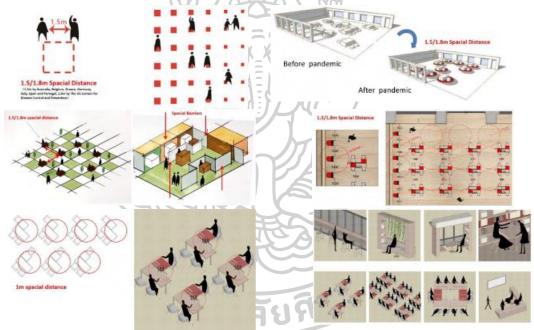


Figure 35 Safety spatial distances Source: Made by Jie Deng 2022

### 2.5.4.2 Ventilation

Sustainable and long-term prevention of epidemics in public spaces is essential nowadays. Natural ventilation is one of the most effective ways to sustainably reduce airborne transmission. A 2009 World Health Organization (WHO) guideline for infection control mentions that natural ventilation is widely used and accepted as an effective environmental measure to reduce the risk of the spread of healthcare-associated infections (Jayaweera, Perera, Gunawardana, & Manatunge, 2020). The World Health Organization (WHO) guidelines indicate that a combination of environmental control and ventilation mechanisms can effectively prevent the spread of viruses in healthy environments (Organization, 2008).

The healthcare environment design needs to consider indoor environmental factors such as temperature, humidity, light, and airflow speed (Ramos, Dedesko, Siegel, Gilbert, & Stephens, 2015). In designing a natural ventilation system to prevent the spread of the virus in public, there are some practical cases to use as references, such as the American prevention of airborne transmission in 2009 (Hendrawati, 2021) and similar case in China in 2021 (Alrebi, Obeidat, Abdallah, Darwish, & Amhamed, 2022). R.A. Hobday (2013) studied the effects of infections caught in buildings, a major global cause of sickness and mortality. However, current knowledge of infections spreading indoors is limited (Hobday & Dancer, 2013). Morawska and Milton (2020) emphasize the importance of sufficient and adequate Ventilation for supplying clean air outdoors in public spaces to slow the spread of the virus. Park (2021) focused on the natural ventilation performance according to the window opening conditions in a school building, which is related to infection probability. All these studies conjectured that there are potential safety hazards in public indoor spaces, and adequate ventilation can decrease the spread of the virus in those spaces.

Ventilation cools the temperature and refreshes the internal air flow. Nembhard (2022) also pointed out that ventilation can be a component of reducing the risk of health crisis transmission and ongoing risk mitigation measures. His team continued to look for best practices for ventilation systems in non-medical buildings.

Natural ventilation can reduce acquisition and operating costs for some commercial buildings while maintaining ventilation rates consistent with acceptable indoor air quality (Emmerich, Dols, & Axley, 2001). Natural ventilation can improve the indoor environment, and such improvements can also increase occupant productivity by reducing absenteeism, health care costs, and worker productivity (Nicol & Raja, 1997). In addition, some previous studies have used ventilation design to address public health issues (Metnitz et al., 2009; Wunsch, 2020; Wunsch et al., 2010). They categorized ventilation into four principles used to control air quality: direct convection cooling, direct personal cooling, and indirect night cooling

(Emmerich et al., 2001). Air quality control improves indoor prevention and reduces the infection rate of public health crises. For example, the use of airflow and ventilation systems reduces the rate of pathogen transmission in public places (Memarzadeh & Xu, 2012).

The provision of heat, wind or diffusion effects through doors, windows, fans and blowers has been defined as natural ventilation (Nembhard, Burton, & Cohen, 2020). Each type of window allows a flow of air through and transports it into the interior; the difference is the percentage transfer volume of fresh air, as shown in Fig. 36.

Û				
45%	75%Awning	45%	90% 75%	45% Single
Hopper	, Fu	Sliding	Casement Jalousie	Window
45%	45% Single	7 55%	65% Folding Window	100% Double
Double	Hung	Folding		Casement
Hung		Window		

Figure 36 Effect of opening types on wind flow

Source: Bangunan Tropis, Lippsmeier and Made by Jie Deng, 2023

Natural aeration systems have three basic approaches: wind-driven crossventilation, buoyancy-driven stack ventilation, and single-sided ventilation (Ghiaus & Roulet, 2012), as shown in Fig.37. Emmerich (2001) explains that wind-driven cross ventilation takes place via vents on opposite sides of an enclosed space. Buoyancydriven stack ventilation is based on density, which draws cool outside air into low vents and discharges warm inside air at higher vents. Single-sided ventilation typically serves individual rooms and provides a localized ventilation solution. Therefore, wind-driven cross ventilation is the primary design for public spaces in this thesis.

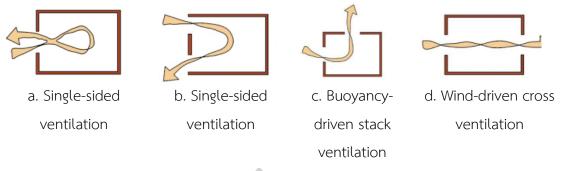
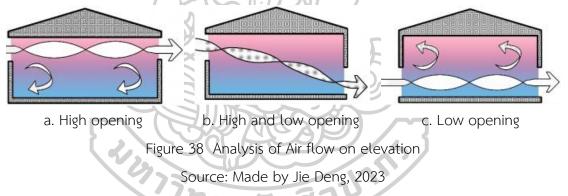


Figure 37 Analysis of Air flow on layout of space.

Source: Made by Jie Deng, 2023

Wind-driven cross ventilation includes many types of convection, such as the high opening, the high and low opening and the low opening, as shown in Fig.38. The types of cross ventilation affect the air quality in the room, so high and low opening is the most suitable type in this work.



### (1) ASHRAE's standard

Ventilation is important for the room, but the criterion helps us to evaluate the internal air quality. The ASHRAE standard is a practical criterion for evaluating indoor air quality. ASHRAE (2020) reports that higher ventilation rates can reduce the risk of virus transmission (ASHRAE, 2020). The ASHRAE standard states that the Air Changes per Hour (ACH) rate should determine the air quality standard (Drees, Wenger, & Janu, 1992) in public spaces. ACH uses the amount of air change per hour compared to the volume of a room to measure the air quality in indoor public spaces, where the ventilation rate can be measured indoors. As a result, AHC can have different values depending on the ventilation rate. For example, in summer in Korea, the ventilation rates at a window opening ratio of 15, 30 and 100% under cross ventilation were measured at 6.51, 11.20 and 22.43 ACH, respectively (Park, Choi, Song, & Kim, 2021). Dyah Hendrawati (2021) studied the relationship between AHC values based on different ventilation rates and virus transmission in a classroom and a dormitory. It can effectively restrain virus transmission when the ACH value is above 8 (Hendrawati, 2021). In Dyah Hendrawati's work, the independent variables of the ACH value are window size and window type and the fixed variables are space area, window position and wind speed.

According to the ASHRAE seven-point scale, the thermal comfort of the human body indoors is 20.3 °c in winter and 23.3 °c in summer (Djongyang, Tchinda, & Njomo, 2010). When the indoor temperature is too high or falls below the ASHRAE seven-point scale, the natural ventilation system considers switching to the mechanical ventilation system. Therefore, a proper space arrangement in the community library should consider a natural ventilation system and a mechanical ventilation system so that both the control of virus transmission and the sense of thermal comfort can be met.

### 2.5.4.3 Sedentary problem prevention

#### (1) Sedentary behavior

Sitting is one of the most common actions of the human body (Harrison et al., 1999). Many people around the world lead a sedentary lifestyle. Work and study take up most of our time, forcing people to limit their movement and replace outdoor activities with long periods of sitting. Many careers require long periods of sitting or overtime, such as students, factory and office workers. However, sedentary lifestyles continue to have a significant impact on the overall health of the world's population. Sedentary lifestyle-related health problems have increased rapidly in recent years (Underwood & Sims, 2019). There is an obvious link between lack of physical activity (sedentary behavior) and health problems such as obesity, metabolic syndrome, aging with reduced immune and viral defenses (Lim & Pranata, 2020), hypertension (Pardee et al., 2007), unfavorable metabolic markers (Ekelund et al., 2006), poorer mental health (Primack et al., 2009), physical discomfort, pain and even injuries,

especially in the neck, shoulders and lower back (Y.-L. Chen, Chan, & Zhang, 2021). Sedentary behavior is associated with adverse health outcomes that differ from those due to a lack of moderate or vigorous physical activity (Tremblay et al., 2010).

Furthermore, some researchers have noted the health problem that sedentary behavior can exacerbate human diseases (Owen et al., 2010). Ricci (2022) also reports that insufficient physical activity and prolonged sedentary behavior are detrimental to health. Physical inactivity is the fourth leading risk factor for global mortality and is responsible for 6% of global mortality (Ricci et al., 2020). The scientific report concludes that the energy expenditure of sitting is  $\leq 1.5$  metabolic equivalents (Diamond & Byrd, 2020). Consequently, sedentary sitting is extensive and unavoidable. The development of a chair that can alleviate the negative effects of sedentary sitting is therefore of great importance.



Figure 39 Prolonged sitting Source: internet, 2022

## (2) Whole-body vibration (WBV)

Whole body vibration (WBV) was introduced in the late 1990s and has been conducted over the past decade (Milanese et al., 2018). Such vibration experiments depend on the vibration intensity, as human sensation to different vibrations may depend on the vibration intensity. Vibration intensity varies depending on the frequency or number of vibrations per second—usually vibration intensity is measured in Hertz (Hz). In the literature, Salimath. S.M. (2023) (Salimath & Tuljapure, 2023) clearly stated that a vibrating chair with a frequency of 5 Hz and an amplitude of 7.5 mm can help people reduce insomnia and fatigue and improve the health of sleepers. Bronson (2018) (Du et al., 2018) clarified that reducing whole-body vibration helps to reduce discomfort and maintain alertness, thereby improving drivers' health and reducing the risk of truck collisions. N. Zhang (2018) (N. Zhang et al., 2018)

investigated the effects of whole-body vibration of 4-7 Hz for 60 minutes administered through the car seat, which helped drivers to increase sympathetic activation and avoid drowsiness. S. H. Kim (2013) (Kim, Kang, & Moon, 2013) focused on the design of a specific chair, namely the vibration transmission properties of a foam seat. Christopher G. (2009) (Goetz, 2009) investigated the effects of a vibration chair on patients with Parkinson's disease (P.D.), which is a vibration therapy. Patients with daily 30-minute sessions on the automated vibration chair felt more comfortable and slept better after train. The result was only achieved with a vibration frequency below 10 Hz to avoid drowsiness, and it is not nearly enough if the vibration chair increases additional functional requirements such as the requirement for weight loss. In order to experience a better feeling, such as relaxing body muscles, relieving physical discomfort and reducing body weight, some studies have investigated whole-body vibration through experimental tests and developed common vibration standards. In WBV, the subject stands or exercises on a platform that vibrates at set frequencies (typically between 15 and 70 Hz) and amplitudes (typically between 1 and 10 mm) (Milanese et al., 2018). Vella Gonzaga (2022) pointed out that most vibration sneakers operate within a limited range of 15 Hz to 30 Hz, while some are within 30 Hz to 50 Hz. The vibration frequency must also be maintained at a low intensity, with an increase in vibration intensity only possible for a limited time (Gonzaga, 2022). The recommended time for using a vibration facility for exercise is 15 to 30 minutes per session, with 2 to 4 sessions per week (Gonzaga, 2022). Furthermore, a similar experiment involves the vibration of human subjects designed by Mohajer (2017) (Mohajer, Abdi, Nahavandi, & Nelson, 2017), on the seat cushion for 65 kg human subjects. The results suggest that the design of the vibration chair should have a variable vibration function setting with a limited range of 15-30 Hertz and a weight of 65 kg.

### (3) Different mechanical designs of vibration

The vibration regulations are based on the design of the mechanical device. Therefore, the design of vibration by mechanical devices such as Pivotal Oscillation, Lateral Oscillation, Linear Vibration, Complex Motion, and Solenoid Oscillation is crucial (see Fig.40). All five types of vibration devices can generate specific vibrations. Originally, however, they were used as fitness equipment. When they are combined directly with chairs, a new problem arises. The chair must utilize the limited hertz of the motor to adjust the device and generate the vibration. Considering the stability of the vibrating chair, the design of the vibrating chair can be inspired by the operation of the previous motor. Complex motion can be considered in this work, and it greatly depends on the actual situation and the redesign of the suitable machine for the chair.

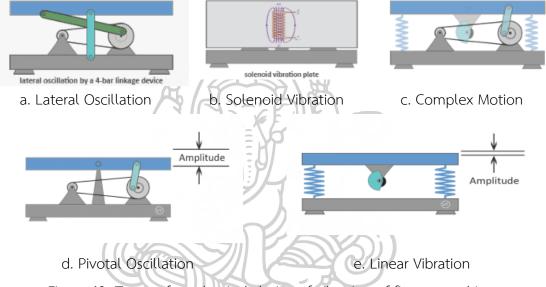


Figure 40 Types of mechanical design of vibration of fitness machine Source: www.vibrationtherapeutic.com/vibration-plate-buying-guide.html, 2021

### 2.6 Summary

In this chapter, a literature review was conducted on the study and visualization of hygienic public spaces, including public health, typical old communities, critical public spaces, and transformational design.

First, this chapter examines the literature on public health. Public health is undoubtedly one of the most important issues for hygienic public space. In this section, the relationship between the people affected by the epidemic virus and the public health crisis is introduced. When an epidemic virus invades a human body, the epidemic can quickly spread to neighboring human bodies. In terms of public health, this chapter also analyzed the literature that supports the idea that a community is at higher risk for infectious diseases and that designing community transformation with public health in mind is of great importance.

Second, this chapter reviewed the literature on typical old communities, including theories about communities, and some actual cases of old communities. This section has highlighted the problems of old communities and the social significance of the transformation of old communities. Typical old communities are numerous, and the public space of old community facilities cannot meet the growing needs of residents, especially the function of preventing airborne transmission of viruses.

Third, the literature review on critical public spaces examined public spaces such as community fitness spaces, street parks, vegetable markets, and community libraries. These critical spaces are fundamental to the health of community residents and are therefore also the subject of investigation in this thesis.

Finally, the literature on the design factors and theories for community transformation design was presented in this thesis. These include Ling-nan culture such as Ling-nan architecture and windows, ancient Chinese philosophy such as fengshui and the five elements, mental health including the design approach of spiritual design, space safety requirements such as physical distancing and ventilation requirements, and prevention of sedentary behavior. These design factors and theories are used in the following remodeling of the old community.

กยาลัยศิล

#### CHAPTER 03

### INVESTIGATION AND DESIGN METHODOLOGY

#### 3.1 Introduction

This chapter focuses on the methods of investigation and design. Following on from the preliminary study in Chapter Two, the research and design methods in this chapter include interdisciplinary research, field research, questionnaires, data analysis, individual interviews, simulation-based assessments and experiments.

#### 3.2 Interdisciplinary research

Interdisciplinary research in this chapter mainly was to conduct the disciplines of art design, mechanical engineering and psychology theories.

In terms of the design of the ventilation system, the principle of natural ventilation with different types of windows was mainly used to conduct a ventilation simulation test and select the optimal window model for the design of the ventilation system. Different types of windows in the same internal environment were evaluated as part of the simulation.

As for the design of the vibrating chair, the internal structure of the chair is a semi-automatic design integrated with the principles of mechanical engineering design. The esthetic principle was used for the appearance of the chair. Simulation can evaluate the feasibility of machinery and estimate the vibration effect under a certain pressure.

Basically, the simulation can carry out the design test more scientifically, so that the design is not only esthetic but also rational. According to the interdisciplinary research, design is more of rational thinking.

In addition, this thesis also considers psychology and creates a portfolio for spatial planning that focuses on people's psychological needs. This thesis aims to provide an emotional value, the space is both esthetic and spiritual.

#### 3.3 Field research

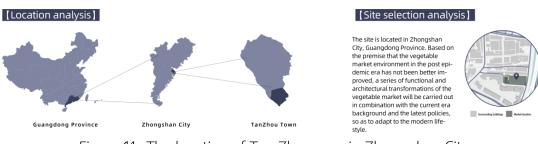


Figure 41 The location of Tan Zhou area in Zhong-shan City Source: Google map, 2023

Lu-yang Ju community is located in Zhong-Shan City, Guangdong Province, China. This community belongs to the city of Tan-Zhou (Fig. 41). It is surrounded by functional buildings. The population density is intense. The poor environment in which the residents live include chaotic markets, dirty streets, old service facilities, mixed traffic and disorganized space arrangements.

In order to observe this community directly, the field research method was used. Data on public health, were collected through direct observation and recorded through photographs. The spatial distances of the local environment were summarized using a satellite map, and the characteristics of spatial function were observed by analyzing the relationships between the community and its associated spaces. The ideas of local stakeholders were documented through direct interviews or questionnaires, as shown in Fig.42.



Figure 42 Interview of local stakeholders Source: photos by Lin, 2022

#### 3.3.1 Research on community circumstance

The current status statistics of the Lu-yang Ju community are summarized in Table 2. Other data come from the nearest spaces around the Lu-yang Ju community, where we have thoroughly scrutinized the commercial establishments in the living circle. The place has a mixed pedestrian and vehicular access system and a poor and unsafe environment. The preliminary collection of the life circles in the satellite map revealed that there are about 30 restaurants and food wholesalers around the Lu-yang Ju community, the number of hotels and condominiums is about 4. The number of hospitals, salons and express services is about 6, as shown in Fig.43b. The nearest library is about 2.2 kilometers or 22 minutes away by car, which is inconvenient for residents, as shown in Fig. 43a.

Table 2 Current status statistics

Source: Made by Jie Deng, 2021
--------------------------------

Space-level	Space design	Current circumstances problems of Lu-yang Ju
	element	community
	Water of	Poor water quality, stagnant pool
Space quality	Landscape	
	Plants of	Single color, single sort, homogenization
	Landscape	
	Exercise yard	Single format, negative space, fraction
	Environmental	Undersupply, facilities decrepit
	facilities	
Space safety	Organization of	Poor connectedness, dendritic structure,
Г	public road	dead-end road
5	Space boundary	Stiff format, lack of connection, negative
	973	space
Space vitality	Community	Single recreational facility, lack of activities
	facilities	
Space	Community	Resident lower participation, indefinite rights
management	management	
Space culture	Community	No local culture construction, lack of
	culture	awareness, no unfolding model
Space	Community	Messy surrounding environment, mixed
environment	perimeter	pedestrian and vehicular road system

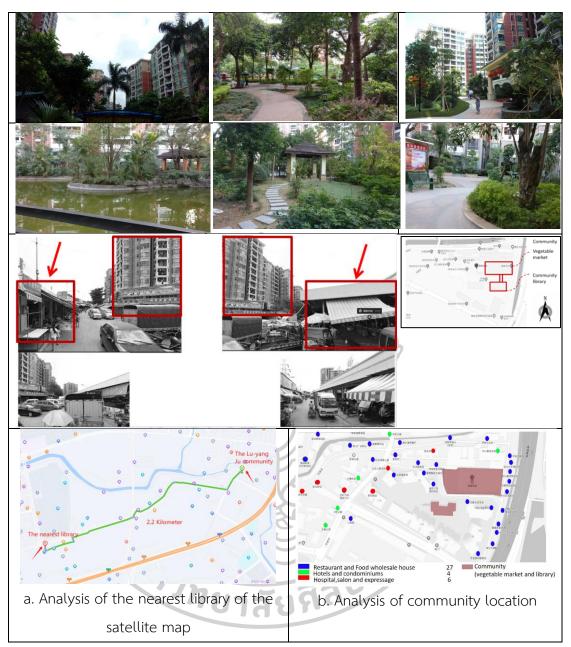


Figure 43 Location analysis of Lu-yang Ju Community Source: Made by Jie Deng, 2021

#### 3.3.2 Research on community history

Lu-Yang Ju community is located in Tan Zhou town, which belongs to Zhongshan City but is closer to the vastness of Zhuhai City. Before 2023, this town will be a special region because neither city cares about it. As a result, the city has become a "triple" zone, labeled "dirty, messy and bad" Due to its unique location, social security is poor, the environment is bad and traffic is chaotic. In 2023, a new policy was enacted in Zhong-shan City, and Tan Zhou City has started to clean up the streets and create a healthy environment, as shown in Fig.44.







Before Year 2023



Figure 44 The history of Lu-yang Ju community from the year 1954 to 2023 Source: https://mp.weixin.qq.com, 2023

#### 3.3.3 Research on community characteristic resource



Figure 45 The list of municipal intangible cultural heritage Source: http://www.zssfeiyi.com/, 2023

Zhong-Shan city has numerous urban cultural assets in various fields, such as heraldic tiles, "Xiao-Lan" paper cutting, redwood carving, embroidery, lanterns and the water wedding. However, the "Wedding on the Water" of Tan Zhou Town is the most prominent cultural heritage.

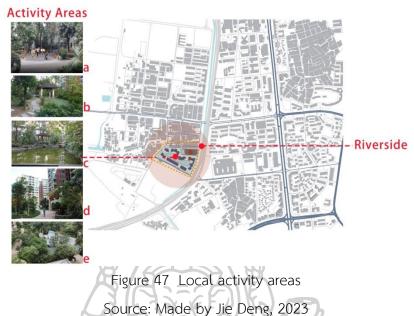


#### 3.3.4 Research on community people crowd

Figure 46 Population analysis of Lu-yang Ju Community Source: Made by Jie Deng, 2022

The area where the crowd is investigated is about a 5-minute walk from the Lu-yang Ju community. There are mainly three types of people living in this community: Migrant workers, residents from Zhuhai and locals. People who visit Tan Zhou market, who are mainly distributed in three communities. They often visit the vegetable market every day, and the market makes the community the center of the area. The local residents like to go to this vegetable market mainly because the produce is fresh and the walking distance is short. The majority of residents live on the periphery of the market. The shortest distance between the nearest neighborhood and the market. The last neighborhood is 400 meters away from the market. The last neighborhood is 400 meters away from the market. The main artery, several side streets and a few streets (Fig.46).

#### 3.3.5 Research on local field activity



Activity options at the Lu-yang Ju community include an outdoor fitness space, a lake, a park, and a swimming pool. The riverside is located near the community, as shown in Fig.47.

# 3.4 Questionnaires and Data Analysis

Several community satisfaction questionnaires were distributed in this thesis. The questionnaires asked for some personal information. When asked about gender, you could choose between male and female. The age option included four age groups: under the 18 years, between 18 and 35 years, between 36 and 50 years and over 50 years. Some questionnaires included different choices, including rating, single or multiple choices. The highest score was 5 points and the lowest was 1 point for the rating answers. The multiple-choice questions contained at least two answers to accurately understand the requirements.

Table 3 The survey of satisfaction of community

Questionnaire Setting:
1. Your sex? A. Male B. Female
2. Your age? A. Under 18 years old B. Between 18 and 35 years old C. Between 36
and 50 years old D. Above 50 years old

3. Are you satisfied with the public space in your community? (Maximum score is 5)
1 2 3 4 5
4. Do you agree that the environment of your community is poor and public health
is weak? (Maximum score is 5)
1 2 3 4 5
5. Do you agree that the traffic in your neighborhood is chaos and mixed people
with vehicles? (Maximum score is 5)
1 2 3 4 5
6. Do you agree that your community's public space lacks vitality, indifference
between people? (Maximum score is 5)
1 2 3 4 5
7. Which space function you would like to add into your community?
A. Community library B. Coffee shop C. Fitness center D. Children
entertainment area E. Shopping mall F. Elder activity center G.
Restaurant H. Art gallery I. Others
8. What kind of outdoor activities do you prefer?
A. Walk and chat B. Enjoying the scenery and rest C. Chess and card game
D. Purchasing daily necessities E. Exerciser F. Group activities (hexagram
boxing /dancing, etc.) G. Others
9. Which public space do you prefer to go?
A. Close to home B. Good environment C. Vigorous popularity D.
Recreational Facilities E. Abundant Multiple activities F. Others
10. What is your acceptable walking distance to participate in public space
activities?
A. 200 meter B. 500 meter C. 1000 meter D. Above 1000 meter
11. Which type of activity space do you prefer?

A. Fully open space	B. Semi-open space	C. Closed space	D. Outdoor
environment E. Half-C	Dutdoor environment	F. Interior space	

The collection of circumstantial data of the Lu-yang Ju community was done through direct observation of photos/Google Maps and data statistics. At the same time, online questionnaires were also conducted on a Chinese online survey website called "Wen-Juan-Xing" (www.wjx.cn) (Jiang et al., 2020) to collect data. In order to understand people's needs, the questionnaires (n = 260) were mainly to collect data on community satisfaction. The participants included 173 young people between the ages of 18 and 35.

The online survey found that of the 260 responses, 67.31% of respondents wanted to include a community library in the community, 86.54% preferred an excellent environment, 80% preferred walking and talking, and 32.69% wanted a completely open space. Further information can be found in Table 4.

Table 4 Result of satisfaction survey of community public space (N=260)

1. Your sex?	alex									
Option	Number	Ra	ate	42	)					
Male	117		45%							
Female	143		55%							
2. Your age?	(9)									
Option	1	רנ	Number	Rate						
A Below 18 yea	ars old		2	6	0.77%					
B Between 18 and 35 years old			173		66.54%					
C Between 36 a	and 50 years old		45		17.31%					
D Above 50 yea	ars old		40		15.38%					
3. Are you satisf	ed with the publ	lic spa	ice in your	community	? (maximum score is 5)					
Result: the avera	age score is 3.55									
Option		Num	ber	Rate						
1		20			7.69%					
2		16	j		6.15%					

3	85		32.69%
4	80		30.77%
5	59		22.69%
	at the surrounding environm eak? (maximum score is 5) e score is 2.89	nent of the com	munity is poor and
Option	Number	Rate	
1	61		23.46%
2	36		13.85%
3	69		26.54%
4	58		22.31%
5	36		13.85%
1 2 3	56 38 48		21.54% 14.62% 18.46%
4	C 769		26.54%
5	49		18.85%
5. Do you agree th	at your community's public	space is lack of	vitality, indifference
between people?	Result: the average score is	3.17	
Option	Number	Rate	
1	61		
-			23.46%
2	29		23.46% 11.15%
	29 69		
2			11.15%
2 3	69		11.15% 26.54%
2 3 4 5	69           53	dd into your con	11.15% 26.54% 20.38% 18.46%

Community library	17	5			67.31%		
Coffee shop	12				48.85%		
Fitness center	13	0			50%		
Children entertainment area	11	8			45.38%		
Shopping mall	90	1	6		36.15%		
Elder activity center	12	24	G		47.69%		
Restaurant	80	5			33.08%		
Art gallery	12	.9			49.62%		
Others	59	9			22.69%		
8. What kind of outbound activities d	o you pre	efer?	5				
Option A		Num	nber	Rate			
A Walk and chat		20	)8	C	80%		
B Enjoy the scenery and rest	A E BT	_18	32		70%		
C Chess and card game			2	23.85%			
D Purchasing daily necessities		10	)2	39.23%			
E Exerciser		113		43.46%			
F Group activities (hexagram boxing /dancing, etc.)	R	9	2)	37.31%			
G Others		4	1	15.77%			
9. What kind of public space do you	prefer to	go?					
Option	Numbe	r F	Rate				
A Close to home	184				70.77%		
B Good environment	225				86.54%		
C Vigorous Popularity	73				28.08%		
D Recreational Facilities	147				56.54%		
E Abundant Multiple activities	157				60.38%		
F Others	35				13.46%		
10. What is your acceptable walking c	distance t	io pa	rticip	ate in publi	ic space activities?		

Option	Number	Rate
A 200 meter	20	7.69%
B 500 meter	89	34.23%
C 1000 meter	93	35.77%
D Above 1000 meter	58	22.31%
11. Which type of activity s	space do you pre	fer?
Option	Number	Rate
A Fully open space	85	32.69%
B Semi-open space	72	27.69%
C Closed freedom space	9	3.46%
D Outdoor environment	57	21.92%
E Half-Outdoor environment	33	12.69%
F Interior space		1.54%

# 3.5 One by one Interview

#### 3.5.1 Experts feedback of some designs in community

#### (1) General

**Feedback One:** You should provide innovative design ideas that are different from other community libraries.

**Feedback Two:** You should add more design factors in your community, for instance, furniture.

Feedback Three: The philosophy should be considered in your design and theories.

**Feedback Four:** You should add some culture icons into your community, which could be considered your design.

#### (2) Ventilation

**Feedback One:** This thesis proposed a study on natural ventilation with epidemiological insights in community libraries based on the CFD simulation method.

It simulated natural ventilation considering the prevention of health crises caused by airborne transmission of viruses in public spaces of community libraries.

**Feedback Two:** The work is well illustrated in theory and experimental analysis. In addition, this thesis has a clear writing framework and high research relevance (Fig.48).

#### (3) Furniture feedback

**Feedback One:** The experiment is complete with excellent data analysis and conclusion.

**Feedback Two:** The research is of excellent significance and significantly contributes to the discipline's development. (Fig.48)



#### 3.5.2 Stakeholders questionnaire and feedback

The feedback includes the opinions of experts from conferences and other professional sources, including local stakeholders, the sponsor, identified users, art experts, developers, librarians, designers, professors, local authority staff and undergraduate design students (Fig.49).

This questionnaire is from the doctoral research project of Silpakorn University and aims to change the design of Lu-yang Ju community. The questions aim to evaluate the design in terms of material, color, shape, esthetics, release, value, safety, human engineering, ventilation, functional layout, emotion, culture, community landscape, outdoor fitness space, street park plus cross bridge, community market, community library, and furniture, with the highest score being 5. "Please fill in the questionnaire objectively on the online survey website "Wen-juanxing" (www.wjx.cn). The statistical results of the samples will be of great value to my research work. Thank you very much for your participation!"

Sex: Male Female

Age: 20-30 30-50

Total amounts: N=46

Educational status: University and above

Evaluation score: Very good (5), Good (4), General (3), Not good (2), Very bad (1)

The			ack)			(Stak ← Designer(4) ← Professor(3) ← Local people(15) ↓ Developer(1) ← → ↓	eholders)	→ rment(1)	
0		◆ 日本 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓				2	L B	 4	Satisfaction(5)
The data	又仅用于科研论文,作为原		Iback)		*4. Aestheti	CS UnSatisfaction(1)	- 3	4	Satisfaction(5)
• 1. Materi	al Unatisfaction(1) 1 1 2	3	Satisfact 4	ion(6)	*5. Release	UnSatisfaction(1)	3	4	Satisfaction(5)
*2. Color	Unsatisfaction(1)	1	Satisfact 4	ion(5)	• 6. Value	UnSatisfaction(1)	1 3	4	Satisfaction(5)
*7. Safty	UnSatisfaction(1)	3	   	Satisfaction(5)		UnSatistaction(1)		4	Satisfaction(5)
* 8. Human	Engineering UnSatisfaction(1)	3		Satisfaction(5)	• 12. Culture		1 1	ļ	l <sub>b</sub>
*9. Ventilat	ion UnSatisfaction(1)	- 10		Satisfaction(5)	1	ommunity landscape			5
*10. Functi	onal layout UnSatisfaction(1)	3	-4	5 Satisfaction(5)		(2) utdoor fitness space in con	3 nmunity	(4)	6
	1 l	3	4	15	1	) (2)	3	٩	5

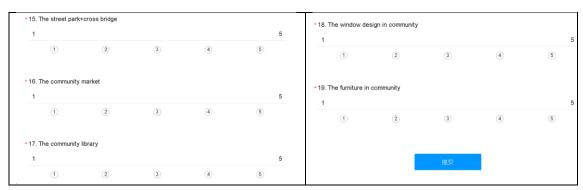


Figure 49 The lu-yang Ju community questionnaire

Source: Made by Jie deng, 2023

Table 5 The Stakeholder feedback

(Community vegetable market)

Source: Made by FCIC 6, 2022

	A) Please rate the manuscript using the following criteria:								
	Please color BLUE your score (1= Weak; 5 = Excellent)								
No.	Description	Score (Circle)				e)	Strengths or reservations		
1	Topic (Weightage: 3 %)	2		$\langle \langle $	次	$\sim$			
а	Relevance to theme?	1	2	3	4	5			
2	Introduction (Weightage: 2 %)	5	de la	5					
а	Research background explained?	1	2	3	4	5			
b	Research purpose explained?	1	2	3	4	5			
3	Literature Review (Weightage: 20 %)	5	G						
	The use of previous theories and								
а	their	1	2	3	4	5			
	evaluation demonstrated?								
b	Knowledge as the basis of research	1	2	3	4	5			
0	demonstrated?	1	~		-	5			
	Proficiency in the presentation of								
С	information and bibliography	1	2	3	4	5			
	demonstrated?								
d	Critical thinking and compact	1	2	3	4	5			

	explanations of						
	literature reviews demonstrated?						
	Critical understanding of theories						
е	used demonstrated?	1	2	3	4	5	
4							
4	Research Methodology (Weightage: 15%)						
а	Research Design (plans, structures	1	2	3	4	5	
	and strategies)?						
b	Data Collecting	1	2	3	4	5	
С	Data Analysis	1	2	3	4	5	
5	Findings (Weightage: 15%)		8				
а	Study results objectively reviewed?	1	2	3	4	5	
6	Discussion & Analysis (Weightage: 20%)	Z		g.	0	3	
	Interpretation or significance of	1		X			
а	study results referred?	1	2	3	4	5	
b	Identified issues processed?	1	2	3	4	5	
	Relation of study results to theories				么		
С	demonstrated?	1	2	3	4	5	
7	Conclusions & Recommendations	2	P.	5			7
	(Weightage: 10 %)	S	Ģ			4	)
а	Summary of the study findings.	1	2	3	4	5	
	Relation of study findings to the	9	5				
b	purposes and study issues	1	2	3	4	5	
	explained?						
C	Relation of findings to literature	1	2	3	4	5	
С	reviews explained?	T		5	4	С	
8	Overall (Weightage: 15%)		•		•		
а	Illustrations	1	2	3	4	5	
J							

## 3.5.3 The result score of evaluation

Figure 50 shows the research score of the stakeholders who are experts and belong to the FCIC 6 conference, and the score shows the value of the research in this thesis. Moreover, the rating (N=46) of the stakeholder feedback through the

Chinese online survey website "Wen-Juan-Xing"," which is composed of different areas of people whose ratings are above 3 (the total rating is five), means that the research of the dissertation is significant and meaningful.

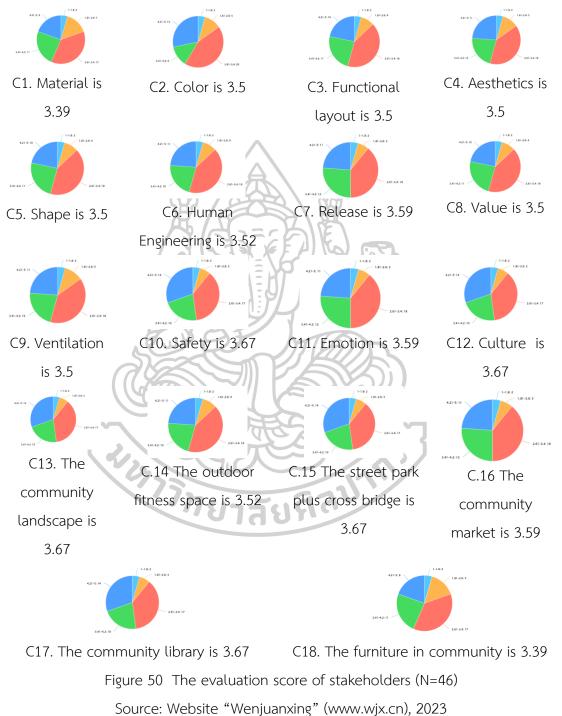


Table 6 Feedback of FCIC professors

# Source: Made by FCIC 6, 2022.

# Please color **BLUE** your score (1= Weak; 5 = Excellent)

Ν	Description		Score(Circ			с
ο			le)			
1	Topic (Weightage: 3 %)					
а	Innovation?	1	2	3	4	5
2	Introduction (Weightage: 2 %)					
а	Research background explained?	1	2	3	4	5
b	Research purpose explained?	1	2	3	4	5
3	Literature Review (Weightage: 20 %)					
а	The use of previous theories and their evaluation demonstrated?	1	2	3	4	5
b	Knowledge as the basis of research demonstrated?	1	2	3	4	5
с	Proficiency in the presentation of information and bibliography demonstrated?	1	2	3	4	5
d	Critical thinking and compact explanations of literature reviews demonstrated?	1	2	3	4	5
е	Critical understanding of theories used demonstrated?	1	2	3	4	5
4	Research Methodology (Weightage: 15%)					
а	Research Design (plans, structures and strategies)?	1	2	3	4	
b	Data Collecting	1	2	3	4	5
С	Data Analysis	1	2	3	4	5
5	Findings (Weightage: 15%)					
а	Study results objectively reviewed?	1	2	3	4	5
6	Discussion & Analysis (Weightage: 20%)					
а	Interpretation or significance of study results referred?	1	2	3	4	5
b	Identified issues processed?	1	2	3	4	5
С	Relation of study results to theories demonstrated?	trated? 1 2 3 4		5		
7	Conclusions & Recommendations ( <i>Weightage: 10 %</i> )		<u> </u>			
а	Summary of the study findings.	1	2	3	4	5

h	Relation of study findings to the purposes and study	1	2	2	4	5
b	issues explained?			4	J	
С	c Relation of findings to literature reviews explained		2	3	4	5
8	Overall (Weightage: 15%)					
а	Illustrations		2	3	4	5

Additionally, the feedback helps the researcher understand the value of her work in the professional realm. It improves the quality of the thesis to go further through international conferences.

#### 3.6 Simulation-based evaluation

Haddad mentioned that the design evaluation ranges from sophisticated methodologies to simulations that provide feedback on the design process and implementations (Haddad, 2014). Simulation-based evaluation helps the designer to improve their design products. SOLIDWORKS software simulation and analysis of designed products can provide real- time feedback (Popa & Popa, 2017). Models will behave differently when design changes occur (Planchard, 2017).

SOLIDWORKS Flow Simulation is an intuitive and powerful Computational Fluid Dynamics (CFD) solution (JUST, 2014). Based on the CFD simulation, the SOLIDWORKS Flow Simulation embedded within SOLIDWORKS 3D and CAD can quickly and effectively assess the simulated airflows. There are some previous studies investigating the products through experimental tests and simulation by using advanced programs (Aganovic, 2019; Bhattacharyya, Dey, Paul, & Biswas, 2020; Cho, 2019; Drees et al., 1992; Kudo et al., 2018; Rizi, 2015)

This thesis simplified the internal vibrative structure of an automatic vibrative chair to simulate vibration by SOLIDWORKS. Firstly, it created simplified models of different structural components of the chair and assembled the whole threedimensional model in a SOLIDWORKS environment. Secondly, the COSMOS Motion Module of SOLIDWORKS was used for simulation analysis, and the output results showed the characteristic motion curve of displacement, the speed of the vibrative plate, and the energy consumption curve of the motor. These results could show the performance and capabilities of the vibrative chairs This thesis utilized the SOLIDWORKS Flow Simulation to evaluate the opening performance of five types of windows. The airflow passed through five types of windows in the yoga room of the community library, and the SOLIDWORKS Flow Simulation calculated the different airflow velocity fields in a simulation environment. The calculation result would be evaluated, and the optimal window in the community library would be known.

#### 3.7 Experiments

Three experiments will help to evaluate the effectiveness of design hypothesis in terms of safety social distance, cross-ventilation, and fatigue relief.

Table 7 Description of the cost of total experimental

Source: Made by Jie Deng, 2025				
Foamed PVC plates	320 (RMB)			
Feather	15 (RMB)			
Glue gun	35 (RMB)			
multi-use mucilage	8 (RMB)			
Таре	12 (RMB)			
Electric fan	320 (RMB)			
Simplified vibrating cushion	300 (RMB)			
Lab chair	120 (RMB)			
Total amounts	1130(RMB)			

Source: Made by Jie Deng, 2023

#### 3.7.1 Experiment one: Safety space distance

(1) Material Type

Organic polymer material (plastic baffle), metal material (measuring tape), school

table and school chair. Further information can be found in Table 7.

(2) Description of the test model

Table: 1300 mm x 750 mm x 750 mm, Chair: 420 mm x 500 mm x 900 mm.

Baffle: 600 x450 mm.

The distance between the front and rear table is 1000 mm and 1500 mm respectively.

(3) The experimental group

Number: six people (undergraduate).

Experimenters 1, 2: Shan-Shan Teng, Yan-ting Luo

Experimenters 3, 4: Ying-Zhang Li, Shanni Li

Experimenters 5, 6: Xi Diao, Yong-Yi Liang

The table was set up at a distance of 1000 mm and the baffle was placed in the middle of the table. Experimenters 1 and 2 performed the experiment with the spatial distance, and the researcher took photos and recorded the course of the experiment. After the recordings of subjects 1 and 2 were made, the same procedure was repeated with the other experimenters.

The spatial distance was set to 1500 mm between the front and back desks, and the experimental procedure and recordings were repeated.

All experimenters described their feelings and drew their conclusions from the two experiments. At the end of the experiment, the researcher summarized the results.



Figure 51 The experiment one Source: Photography by Jie Deng, 2023

#### 3.7.2 Experiment two: Cross-ventilation

(1) Material Type

PVC, Electric fan, tape-measure, hot melt adhesive, more information is shown in Table 7.

(2) Description of experimental model

Size details: room is 1200 x 1200 x 2000 mm. Window openings are 1000mm x 700mm and 500mm x 500mm, respectively.

(3) The experimental group

Eight people (undergraduate)

- Experimenters 1, 2: Shan-Shan Teng, Yan-ting Luo
- Experimenters 3, 4: Yu Zhong, Lu-Lu Xiao
- Experimenters 5, 6: Yong-Yi Liang, Shan-Ni Li
- Experimenters 7, 8: Xi Diao, Ying-Zhang Li
- (4) Description of experimental procedure (Fig.52)

The 1200mm x 1200mm room was constructed with a window opening of 1000mm x 700mm on one side directly in front of the ventilator. The experimenters, with feathers, entered the room. Then the fan of a ventilator was switched on. The researcher took photos and recorded the entire experimental procedure as well as the feelings of experimenters in the experimental room with the one-sided window.

Secondly, the 1200mm x 1200mm test room was opened with the opposite opening hole of the 500mm x 500mm window. After turning on the fan, the experimenters entered the room with feathers and felt the wind. The researcher took photos, recorded the entire test procedure and noted the experimenters about the double-sided window at the end of the experiment.





a. Room with single window

b. Room with double windows

Figure 52 The experiment Two Source: Made by Jie Deng, 2023

### 3.7.3 Experiment three: fatigue relief

Using the simplified vibration cushion was to test whether the vibration would relieve

the fatigue.

(1) Material Type

Materials: Metal, tap, office metal chair, woven vibrative cushion.

#### (2) Description of experimental model

Chair: 420mm\*500mm\*900mm (length, width, and height)

Cushion: 350\*380mm

# (3) The experimental group

Experimenters 3, 4: Yi, Yue Xu Experimenters 5, 6: Su Li, Ying-Yin Let

Experimenters 7, 8: Hui-Ning Chen, Xin-Yue Zhu

#### (4) Experimental process of vibrative chair

In this thesis, the mechanical function of a vibrating chair was tested with SolidWorks. The researcher used the simplified vibrating cushion, which has the same function as the actual vibrating chair (Fig.53). After the test, the researcher received feedback from the experimenters. The experimenters sat on the vibrating cushion of the office chair and felt the vibration of the seat cushion after charging. The researcher took photos and recorded the entire experiment process.



Figure 53 The experiment Three Source: Made by Jie Deng, 2023

# 3.7.4 Experimenter feedback

# (1) Summarizing the feedback and keywords (spatial distance).

**Feedback Summary:** If the distance is 1000 mm, the room is small, narrow and uncomfortable and the air circulation is poor. After the distance was adjusted to 1500 mm, the room was spacious, the seating position was more comfortable and the air circulation was adequate (Table 8).

Keywords: comfortable, spacious, air circulation, pleasant mood

Table 8 The feedback of spatial distance experiment

Experimenters	Summary of opinions
1	The larger room was less crowded than the smaller room when it

	was overcrowded.		
2	The distance of 1500 mm would be more comfortable.		
3	Experimenters felt less pressured at the 1500mm distance than at		
	the 1000 mm distance.		
4	The distance between the seat and the table has been extended		
	and will be even more spacious once the distance has been		
	increased.		
5	People got more ventilation when they had more distance.		
6	The 1500m space would not be depressing and became more		
	comfortable		

(2) Summarizing the feedback and keywords (airflow experiment).

**Summary feedback:** The air flow was stuffier when the one-sided window was open. There was not enough fresh air in the room and the airflow was concentrated in the room. When the two-sided windows were opened, the movement of the air flow changed from a circle to a straight line, the circulation was more intense, the air spread faster and the temperature was significantly lowered. Experimenters felt more comfortable and less stuffy in the double-sided windows than in the single-sided windows (Table 9).

Keywords: comfortable and good airflow.

Table 9 The feedback of ventilation experiment

Experimenters	Summary of opinions			
1	The experimenters felt that the air was trapped and could not			
	circulate in the case of a one-sided window. On the other hand, it			
	was perceived as very pleasant with two-sided windows.			
2	When they changed from a single-sided window to a two-sided			
	window, they felt that the house was less hot and the wind speed			
	was stronger and greater.			
3	The airflow of the one-sided window was a confined space and the			
	internal temperature was high. When two-sided windows were used,			

	the air flow was less concentrated and air convection lowered the			
	internal temperature.			
4	When the one-sided window was used, the air flow was more			
	intense, not enough fresh air entered the room and the room was			
	hot. The air flow with two-sided windows was convective and the air			
	flow was dispersed, which drastically reduced the temperature.			
5	In the case of the one-sided window, the air flow was more			
	concentrated and the air flow moved backwards and outwards in			
	the room. With the two-sided windows, the air was less stuffy and			
	the air flow no longer moved in a circle but in a straight line.			
6	The wind from a side window was less strong. It is perceived as			
	cooler with two-sided windows than with one-sided windows.			
7	With single-sided windows, the air circulation was perceived as fast.			
	With the double-sided windows, the air flow was felt to be faster			
	than with the single-sided windows and it was much cooler with the			
	two-sided windows.			
8	The one-sided window ventilated sufficiently. The two-sided			
Г	windows made people feel a little cooler.			

(3) Summarizing the feedback and keywords (vibrating chair)

**Summary feedback:** Compared to an ordinary chair, the vibrating chair was more comfortable and relaxed for people. For most experimenters, it was able to eliminate the discomfort and fatigue caused by prolonged sitting. The ergonomic design solved the problem of sitting, which was more humane (Table 10).

Keywords: comfortable, relaxed, convenient, pleasant, humanity, permeability, relieving fatigue

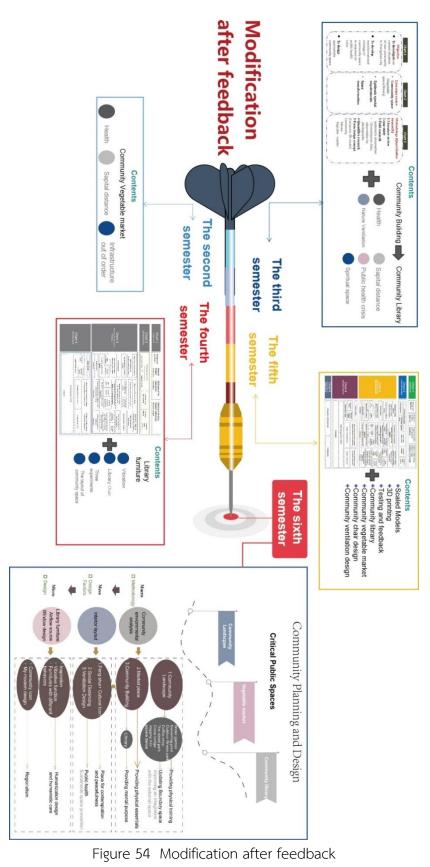
Table 10 The feedback of vibrating chair experiment

Experimenters	Summary of opinions				
1	The vibrating chair sat more comfortably, which could relax the				
	muscles and reduce the discomfort caused by sitting for too long.				

2	The vibrating chair relieved the experimenter's fatigue caused by				
	prolonged sitting.				
3	The vibrating chair has been equipped with a soft, vibrating cushion				
	for ultimate comfort.				
4	It was more convenient that the vibrating chair allowed the				
	experimenter to adjust the intensity with different modes according				
	to experimenter preferences and needs.				
5	The vibrating chair helped the experimenter to adjust the sitting				
	posture to a human one.				
6	The vibrating chair enabled the experimenter to naturally maintain a				
	good posture when experimenter down without tiring.				
7	The vibrating chair enabled the experimenter to feel comfortable.				
8	The vibrating chair enabled the experimenter to adjust his sitting				
	position posture and relieve the physical discomfort of prolonged				
	sitting.				

#### 3.8 Actions to Feedbacks

Based on feedback from the experts, stakeholders and experimenters, the transformation design was modified and refined in response. As shown in Fig. 54 and Fig. 55, the design for the transformation of the old community included the following works: Community Library Design, Vegetable Market Design, Community Room Streamline Design, Community Gym Design, Street Park Design and Cross Bridge Design. Feng Shui philosophy, element theory, "Ling-nan" culture and architecture were also considered as design strategies during the remodeling. Technologies such as software simulation methods and 3D printing are also used to make the design more realistic.



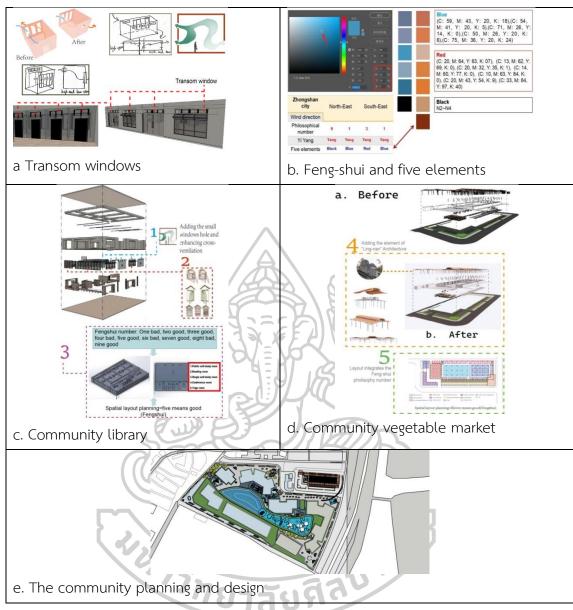


Figure 55 The design modification after feedback Source: Made by Jie deng, 2023

#### 3.9 Summary

The research and design methodology of this chapter includes interdisciplinary research, field research, questionnaires and data analysis, one-on-one interviews, simulation-based evaluations, and experiments.

The interdisciplinary research helped the researcher to consider design decisions more rational and reasonable. This thesis mainly integrates the disciplines of art design, mechanical engineering and psychology to conduct interdisciplinary research. The use of the disciplines of art design and mechanical engineering is particularly emphasized in the development of the ventilation and the vibrating chair, which will be detailed in the next chapter. The discipline of psychology is characterized by the creation of a portfolio for spatial planning that focuses on the psychological needs of people.

The field research collected basic information about the Lu-Yang Ju community, which helped the researcher to determine the research direction. Data on circumstances, including public health, were collected through direct observation and recorded through photographs. The spatial distances of the local environment were summarized using the satellite map, and the characteristics of spatial function were observed by analyzing the relationship between the community and its associated spaces. The field research includes the investigation of the circumstances in the community, the history, the characteristic resources of the community, the gatherings of people in the community, and the activities in the community.

The questionnaires were distributed to determine the level of satisfaction and aspirations of the inhabitants of the municipality. The data analysis was based on the statistics of the questionnaires. The individual interviews and questionnaires formed the stakeholder feedback, which provided many good suggestions for the community design and modified and refined the transformation design.

The simulation-based evaluation of the models helped the researcher to improve the design products, which is massively utilized in the detailed design of the case study in this thesis. Three experiments on spatial distance, cross ventilation and fatigue relief reflected the effectiveness of the associated transformational design strategies.

#### CHAPTER 04

#### Design development

#### 4.1 Introduction

This chapter presents the general transformation plan of the old community, which forms the main content of the visualization design of the thesis. The general transformation plan includes the design of the general layout of the community, the design of the community facilities and two case studies as examples of the detailed design.

The design of the community facilities mainly includes the application of elements of Ling-nan architecture, the planning of traffic flows, the disposition of plants, the limitation of spatial distances and the expansion of boundary areas.

The two case studies of the community's vegetable market and library were studied in detail and selected as examples for the detailed redesign. Several models were also made, including handmade models, 3D printed models, accurate models and factory-made models to illustrate the design of the community library.

#### 4.2 Design of the general layout of the community

A healthy community comprises four aspects of health: healthy production, a healthy lifestyle, a healthy environment, and ecosystem, and a healthy physical and mental state of residents in the community. In this work, the design for the remodeling of a typical old community was developed, which should be healthy and peaceful.

The general layout plan of Lu-Yang Ju community includes a series of functional facilities, such as a main entrance, a side entrance, a parking lot, a water pavilion, a swimming pool, a fitness park, a café, a community library, a bridge, a vegetable market, a jogging path around the lake park, and a square dance, etc. (Fig. 56). Two detailed case studies of the vegetable market and the library were carried out as part of this work and were selected as examples of the transformation. Figure 57 shows the aerial view of the Lu-Yang Ju community.

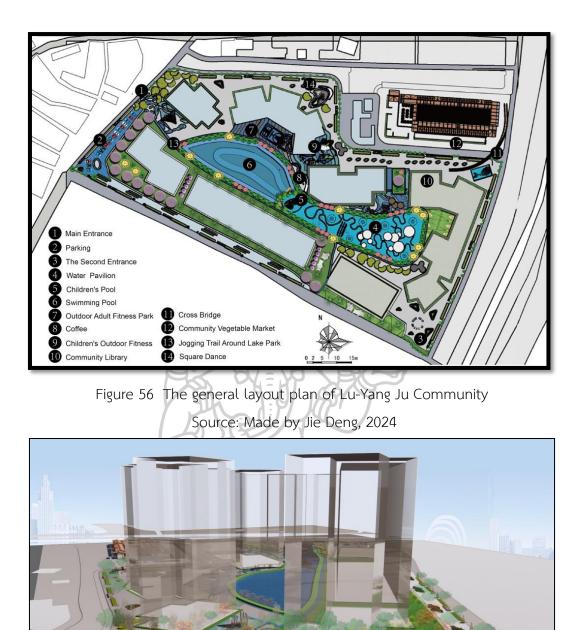


Figure 57 The aerial view of community in SketchUp software Source: Made by Jie Deng, 2024

# 4.3 Design of Community Facilities

The two sketches were an analysis of the design thinking process, the design of the common space and the definition of the important design node (Fig. 58).

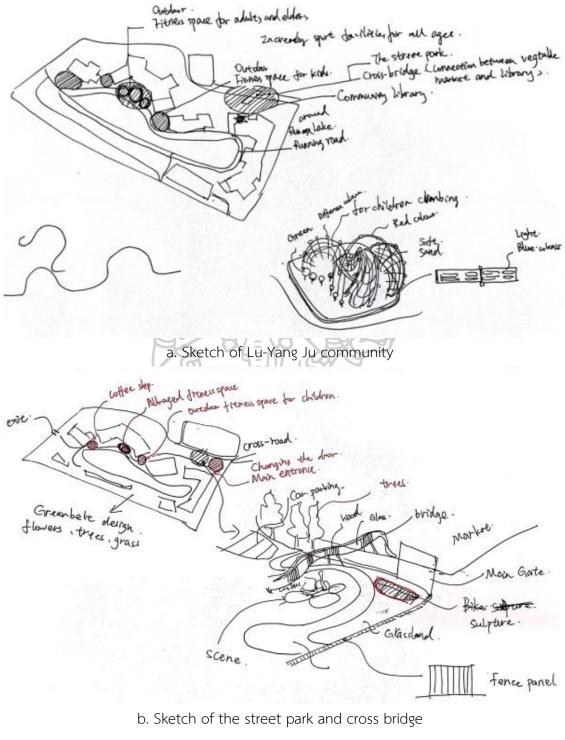


Figure 58 The sketch of community planning and design Source: Made by Jie Deng, 2023

The strategy of planning and design:

#### 4.3.1 Application of Ling-nan architecture element

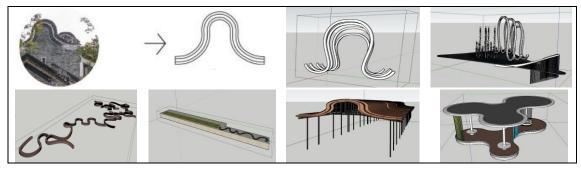


Figure 59 The application of Ling-nan architecture element Source: Made by Jie Deng, 2024

The typical design in the architecture of Ling-nan is the "wok yi uk" wall. In this work, this "wok yi uk" wall was adopted as a design element abstracted from architecture, which became a simple, abstract and geometric curve. This curve element was applied to the planning and design of the community and went through reconstructions such as a green belt, a landscape sculpture, a bridge with waterscape, a pavilion and a building roof (Fig. 59).

#### 4.3.2 The planning of traffic streams

Space traffic flows were the link that lined up the entire Lu-yang Ju community between the inside and the outside. Therefore, it was necessary to rationalize the traffic flow based on the relationships between spaces, which have the advantage of convenient transportation especially for the residents of the community (Fig.60).

The overall layout of Lu-yang Ju community was designed with three main entrances based on the existing traffic conditions to realize the divided flow of people and vehicles. The entrance for vehicles is located near the parking lot, where the front and back entrances of the community as well as the residential buildings are located. It was also convenient for residents to access the public areas.

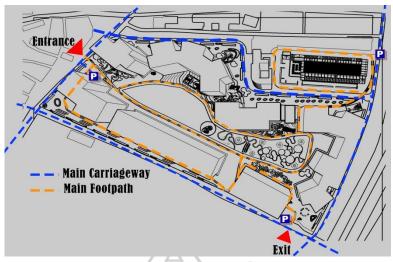


Figure 60 The road planning of community Source: Made by Jie Deng, 2023

## 4.3.3 Plant disposition

Plants with purifying functions for air and water were selected to prevent the public space crisis in the long term (Fig. 61). These plants helped the landscape to absorb toxic gasses and hazardous substances. The plant disposition strategy is as follows:

- Aquatic plants--Purification of water (Table 11)
- Floral zone of shrubs and ferns-- Improvement of air quality (Table 12)
- Propagation of plant species-- Rich and diverse landscape (Table 13)
- The four seasons of plants-- Plants were especially adaptable so that residents could enjoy the different natural landscapes of the four seasons (Table 14).

Table 11 Aquatic plants

ANDEA	Thalia dealbata is a perennial	A AND A AND AND A	Salvinia Natans (L.)
	aquatic plant that not only		All is a perennial
	has a high ornamental value		aquatic plant that
Thalia	as an aquatic plant, but also	Salvinia	can absorb heavy
dealbata	absorbs heavy metals and	Natans (L.) All.	metals and
UEalbala	pollutants in water.	Nataris (L.) Att.	metallic ions such
	Therefore, it has a good		as CuSO4,
	function in purifying water		

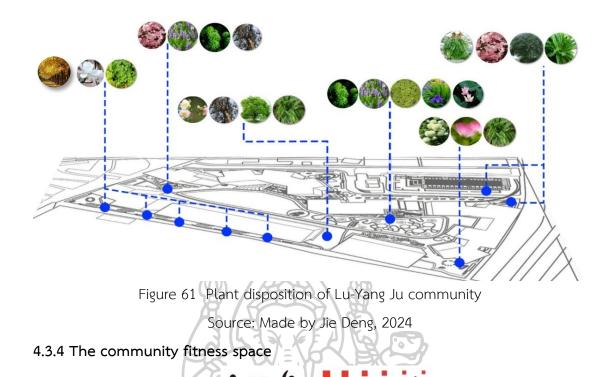
	quality.				
			Zn2S04, Hg2Cl2		
			and other harmful		
			substances in		
			water, so it has a		
			good function of		
			purifying water		
			quality.		
	Myriophyllum spicatum L. is a		Iris hybrids		
	perennial aquatic plant that	Iris hybrids 'Louisiana'	'Louisiana' is a		
	can purify the water quality		psychrophilous		
	and improve the ecological		plant. The aquatic		
Myriophyllu	system of the water.		plant Iris hybrids		
m spicatum	Myriophyllum spicatum L.		'Louisiana' plays		
L.	can remove eutrophying		an important role		
	elements such as nitrogen,		in the absorption		
	phosphorus, and potassium		of water pollutants		
	from the water, absorb heavy		all year round,		
E E	metals and release oxygen		even in winter.		
	through photosynthesis.	12/5			
	Table 12 Chruik				

Table 12 Shrub plants							
Source: Made by Jie Deng, 2024							
Cupressus funebris Endl.	Cupressus funebris Endl. is grown artificially throughout the country and can absorb toxic gasses in the atmosphere.	Broussonetia Papyrifera (L.) L'Hér. Ex Vent	Broussonetia Papyrifera (L.) L'Hér. Ex Vent is characterized by rapid growth, high adaptability, wide distribution, easy propagation and short growing seasons. It is widespread in tropical				

			China and is resistant		
			to sulfur dioxide,		
			hydrogen fluoride,		
			chlorine and other		
			toxic gasses.		
	The low ozone	Cinnamomum camphora (Linn) Presl	Cinnamomum camphor		
	concentration of Pinus		is very resistant to toxic		
	massoniana Lamb's		gasses such as chlorine,		
	emissions can clean the		carbon dioxide and		
Pinus	dust in the air. Its ability		fluorine. The broken		
massoniana	to absorb dust is so		twigs and leaves can		
Lamb	strong that a mature		give off a scent that		
	tree can absorb tons of		has a certain effect on		
	dust every year.	Qa'	mosquitoes and		
		LE	insects.		
Table 13 Fern plants					
Source: Made by lie Deng 2020					

	Source: Made by	Jie Deng, 2024	
	Nephrolepis exaltata	- Claren -	Adiantum capillus-
	Bostoniensis (L.)	CAR NO	veneris L has a high
	Darenport is a highly		ornamental value
	effective green plant	99	and absorbs
Nephrolepis	for air purification,	Adiantum	formaldehyde,
exaltata	which can remove	capillus-veneris L	toluene and other
Bostoniensis (L.)	pollutants in the air		pollutants. It
Darenport	such as		therefore has a
	formaldehyde,		strong ability to
	xylene, benzene and		purify the air.
	other harmful		
	gasses.		

Platycerium wallichii Hook	Platycerium wallichii Hook has a high ornamental value, which also has a good effect for purifying and refreshing the air. It can also regulate humidity.	Asplenium nidus	Asplenium nidus can absorb harmful gasses, including the familiar carbon dioxide.		
Table 14 Four season Plants					
Source: Made by Jie Deng, 2024					
Malus spectabilis -	Yulania denudata	Hydrangea	Ginkgo biloba L -		
Spring	(Desr.) D. L. Fu -	macrophylla	Autumn		
	Spring	(Thunb.) Ser -			
$\sum$		Summer			
	7.577 2000	auth			
Camellia japonica L	Nelumbo SP / Lotus Flower – Summer		Silktree Albizziae		
- Winter			Flower- Summer		



To maintain long-term prevention of health crises, public space has been incorporated into community planning and design with a safety distance of no less than 1 meter. The primary application of physical distancing by the municipality was seen in places such as outdoor fitness areas, vegetable markets and libraries for people of all ages.

A community fitness space was designed for people of all ages, as physical training will enhance the body (Fig.62). The fitness space was installed with many different types of facilities to meet human needs. For instance, part of the public space was designed as the jogging trail around a lake park, another part of the space was designed as two outdoor fitness spaces for adults and children (Fig.64b), a small square was designed as a square dancing location for the elders (Fig.64f), and a half of lake was divided into the swimming pool for adults and children (Fig.64e).

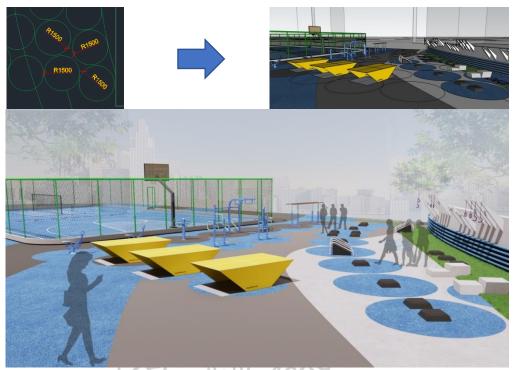


Figure 62 Community fitness space Source: Made by Jie Deng, 2024

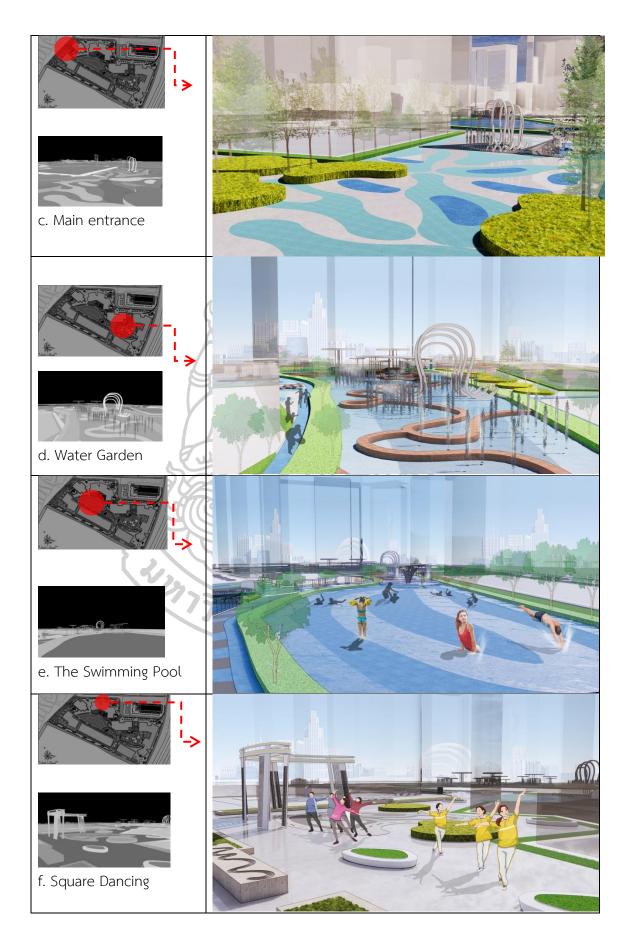
# 4.3.5 Expanding boundary space

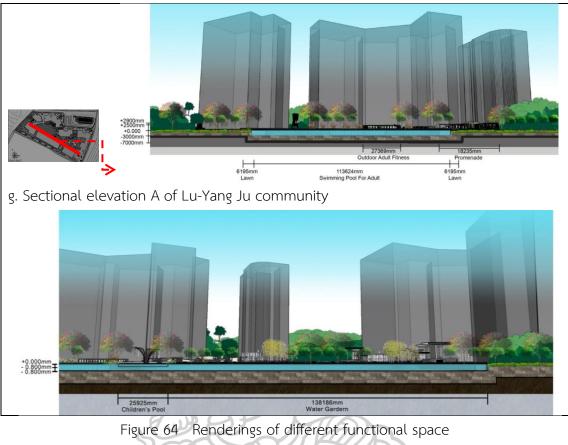
The optimum design of the road system improved the integration with the external space. The two areas were linked by a cross bridge, which has expanded the boundary space of the community. Expanding boundary space has improved the accessibility of external space (Fig.63). The street near the community before the transformation was chaotic and dirty. Improvement of the environment of the connected space between the vegetable market and the community was necessary. The transformation strategy was to design the street park with greenbelts and plants along the roads (Fig.64 a).



Figure 63 Expanded boundary of Lu-Yang Ju community Source: Made by Jie Deng, 2023







Source: Made by Jie Deng, 2024

4.4 Case study - Vegetable Market



Figure 65 A community vegetable market Source: Made by Jie Deng, 2024

The vegetable market plays an essential role in building the vitality of a community (Ying, 2018). The vegetable market utilizes the semi-open form as a designed form of transformation, judging from the characteristics of the market. Finally, the design theory about the market space and layout according to the standard "Upgrade Construction and Management Specification for Farmers Market"

was used in the design of both the exterior and interior space. The strategy proposed by Ahmed to prevent the health crisis was used as the basis for the design of Tan-Zhou Vegetable Market (Fig.65).

# 4.4.1 Transformation strategy application

It is a joint facet that the vegetable market is facing major challenges, including the modernization of companies, the expansion of functions and the optimization of management. To solve these problems, the transformation design of the vegetable market has adopted semi-closed management methods during the last health crisis, the COVID-19 epidemic. The entrances were controlled so that the main entrance was close to the one-way street, and some specific entrances were opened or closed by selection. As a result, the transportation of goods flows was under control. As for incoming and outgoing personnel, checks were carried out at the entrance, including taking body temperature, checking travel documents and registering market visits. Based on the findings on the public health crisis, the health care requirements at the vegetable market are divided into two areas.

The first part concerns entering and leaving the vegetable market. The staff entering the vegetable market must take the body temperature. When the goods enter the market, the relevant personnel, vehicles and transported goods must be quarantined, especially with regard to the cold chain (J. a. M. G. Pan, 2020). For example, seafood must be placed under strict quarantine, with sample storage, with classification partitions and with a special operating room (Kong et al., 2022).

The other part is related to the session, which ensures a safe distance between the booths and stands. As a result, social distancing in crowd control (Ahmed, Ahmad, & Jeon, 2021) has reduced the transmission scale. According to one study, consumers feel safe when the average open space per person is 4 square meters and crowded when the average open space per person is 1.5 square meters (Ahmed et al., 2021). In order to meet the requirements of health prevention, the infrastructure facilities in the vegetable market need to be updated.

### 4.4.2 Space Design of the Vegetable Market

#### 4.4.2.1 The position of space design of the vegetable market

Against the backdrop of the public health crisis, the transformation of the vegetable market is a demand for a humanized spatial design. The vegetable market was to be transformed from a mere place of sale into an important social space. In traditional vegetable markets, the large volume of buildings and the enclosed design make people feel oppressed, which will exacerbate the problems of traffic congestion.

Looking back at the history of the development of the vegetable market, we find that "semi-open" (Malaktou, Philokyprou, Michael, & Savvides, 2016) is the original form of the internal configuration of the vegetable market. Therefore, the market will be semi-open inside after the transformation. Considering the ventilation and the convenience of traffic, the exterior of the remodeled market is completely open. Meanwhile, the market can interact with various commercial areas by building through roads to the nearby commercial areas. As a result, the vegetable market can truly integrate into the entire city through the completely open design of the outdoor area and the well-developed roads.

The Japanese architect Ruhara Yoshiyoshi (Chang, 1995) suggested that the space coverage of the room has extended from the originally furnished interior to the exterior. Following the opinion of architect Ruhara Yoshiyoshi (Chang, 1995), the mode of "market+park" (T. Li, 2021) was developed for the vegetable market, creating a continuous and abundant activity at the interface with the street. Unlike the traditional vegetable market, the "park+" modern urban vegetable market will increase the unity of space, strengthen the supply of agricultural goods, and promote the development of new consumption. The "park+" modern vegetable market has adopted the element of a park and constructed a park to be close to nature and create a pleasant and friendly environment. At the same time, the design of the "park+" modern vegetable market attempts to form an architectural group with a series of streets and alleys connecting different parts of the city, so that the market can blend harmoniously into the city and develop an orderly business pattern.

### 4.4.3 The Design Outcome of Community Vegetable Market

## 4.4.3.1 Design of external market environment

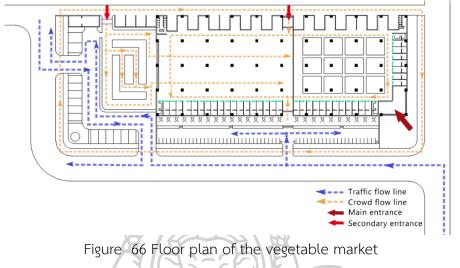
#### (1) Renovation design of entrance and exit

Tan-Zhou Vegetable Market is a fully open market with many streets inside. Judging from the aerial map of Tan-Zhou Vegetable Market, the streets inside the market are confusing and the main entrance is not clearly visible because there are so many entrances. As it is the only vegetable market nearby, the traffic flow is very heavy with people and various vehicles, which is a safety hazard.

The renovation of the entrances and exits was carried out to solve the problems. During the renovation, three entrances can also be used as exits. Of these three entrances, one was designed as the main entrance and the other two as secondary entrances. The main entrance is wider than the side entrances so that more people and larger vehicles can fit in. In addition, the side entrances have increased the circulation capacity of the market and provide more choices to enter the market, which is incredibly convenient for people coming from the north of the market. On special crisis days, the limited entrances are particularly effective in preventing health crises, as they make it easier to control people and goods entering the market, as well as the associated vehicles. The innovative design of the entrances and exits not only ensures the basic circulation of the market, but also helps to combat health crises.

## (2) Adjustment and reconstruction design in venue streamline

The entire flow within the market includes lines of traffic and people. To alleviate the congestion situation, the flow lines should be differentiated between crowds and vehicles. The market is surrounded by two main traffic flows. The flow lines for public traffic are numerous and fully distributed within the market so that vegetable transactions can be carried out at every stand in the market. The entrance for freight traffic has been designed so that the main entrance is far away from the market, so that parking and unloading of goods can take place while avoiding traffic peaks. This type of design can connect the weighing area with the quarantine area, which is beneficial for the access of goods to the market, especially for cold chains such as aquatic food (J. a. M. G. Pan, 2020) (Fig.66).



Source: Made by Jie Deng, 2021

# (3) Greening design of market transformation

The Tan-Zhou vegetable market lacks greenery as it is surrounded by apartment blocks, which makes it more difficult to design the greenery. Garden contributes to increasing air quality (H. Pan, 2018). During the public health crisis, fresh air was important and there were many people in the market. Therefore, greening design should be considered. The renovation measures to green the landscape include many steps. Firstly, the market square is designed with a green belt that divides the square into the entrance area and green landscape areas.

As for the square area, the greening has established the ground with a hard slab, three pools, corridors, rest areas and other landscape parks. Landscape parks such as corridors and rest areas not only help to create resilient terrace spaces, but also bring business benefits. The green spaces are planted with various trees, which can provide green spaces for people to rest and increase public activity. At the same time, the green landscape of the marketplace can be used as a natural isolation zone, which creates a safe marketplace and improves the resilience and adaptability of the market. During a particular health crisis, the greenery can produce fresh air and act as a natural isolation zone that can protect the safety and health of people in the market. The greening of the square is consistent with the positioning of the "Park + Market" The roof of the vegetable market has absorbed the element of Ling-nan architecture, and the building has local characteristics after it. By optimizing the spatial arrangement of the market building, the market is also well integrated with the city's streets and squares (Fig.67).



Figure 67 Building drawing of vegetable market

Source: Made by Jie Deng, 2023

# 4.4.3.2 Internal space designs of the vegetable market

## (1) Internal function layout renovation

There is a clear division of labor for the internal space of the vegetable market, and each unit has its items in service. The basis of the spatial sequence is the coordination of each unit. Core space includes a trading center, office, dining and leisure locations facilities, and parking lots (MA et al., 2008). Under these circumstances, the vegetable market has many problems, such as chaotic traffic and crowded environment. To solve the problem, the market should provide functional reorganization, convenient transportation, comfortable environment and public health safety. The functional reorganization of the market includes characteristic leisure areas, fruit and vegetable stalls, cooked food stalls, fresh aquatic product stalls, frozen fresh food stalls, meat stalls, etc. Convenient transportation includes well-planned vehicle access and parking and unloading areas. The convenient environment includes a restroom, storage and waste treatment center. Public health safety is ensured by the inspection and quarantine area (Fig.68).

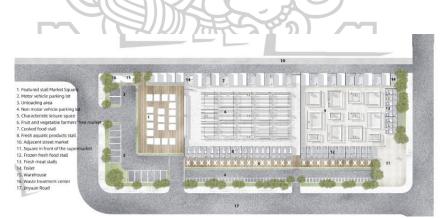


Figure 68 Floor plan of the vegetable market Source: Made by Jie Deng, 2021

# (2) Internal streamline transformation

The horizontal circulation lines inside the building are populated with consumers, freight personnel and administrative staff, bringing with them all kinds of human activity. The design of the primary and secondary channels is crucial to serve people with different functions. The streamlines were designed with special attention to the public health crisis or emergency so that people can be evacuated quickly and safely. The store's horizontal streamline has also been designed in the form of a circulation loop so that customers do not have to turn around within the store, which can avoid congestion.

### (3) Stall and store renovation design

The market area with its stalls and stores is the smallest unit, while it is the primary carrier of the sales behavior of vegetable stores. If the existing market stalls cannot meet the needs of the vendors, spontaneous rearrangement quickly occurs, creating disorder in the market. Therefore, a standardized mode of design should be implemented. With prefabricated construction, the various components of the stall configuration can meet the needs of the users. The main stalls in the vegetable market include cooked food, fresh meat, frozen food, aquatic products, etc. The store facilities include cleaning, storage, operating and other functional facilities. Different shops may require different types of design. Fruit and vegetable stalls need space to display different items. Meat stalls need hanging fixtures such as red lighting. Frozen food stalls need fresh water, tank systems and operational countertops. Due to the recurring phenomenon of public health crisis, the entrance of each stall is moved to the inner street to avoid connecting the indoor space with the outdoor area.

Furthermore, the market takes the column span as a unit of distance. Smaller stores make up about a third of the column width, and larger stores can occupy half a column or a full column width, which can be taken as the standard module. Additionally, independent commercial units can be rented and sold based on the module division (Fig.69).



b. Market outdoor design sketch

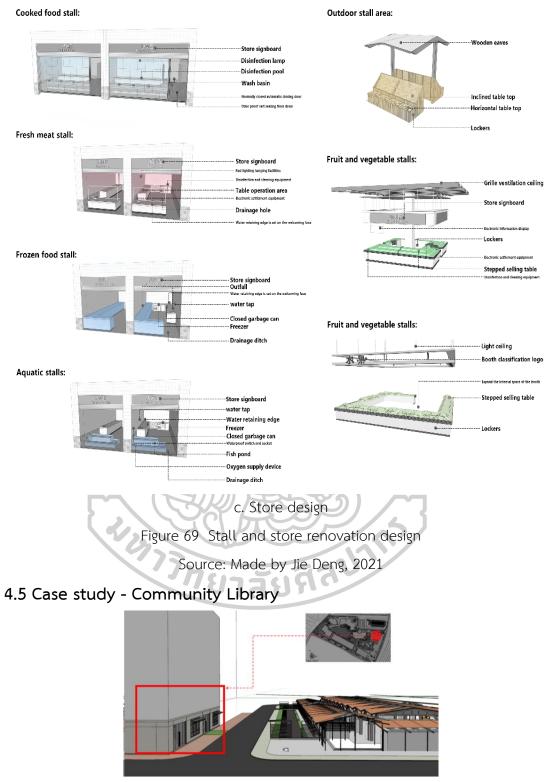


Figure 70 Community library Source: Made by Jie Deng, 2024

Community library plays an important role in the vitality of a community, and one part of the original building was transformed to library. The sustainable health prevention measurement was used in this case study.

#### 4.5.1 Library investigation method

From our observations, we concluded that community spaces faced many challenges in exploring new requirements.

(1) A literature review provided fundamental theories and references about the community library.

(2) Data about the community library were collected through field research and questionnaires.

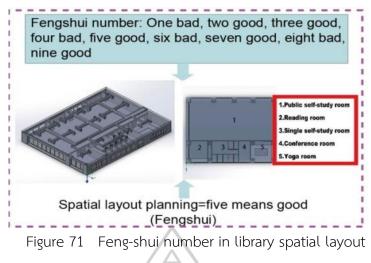
The online questionnaire was linked to the actual situation and was distributed in many cities, including Zhong-Shan in Guangdong Province, China. The questions of the questionnaire were related to residents' demands and the transformed strategies to improve Lu-yang Ju community.

4.5.2 General Design of Community Library

# 4.5.2.1 Design of spatial layout

One of the Lu-Yang Ju community's remodeling strategies was to convert part of the commercial space into a community library. The half-timbered structure of the original commercial building was to be retained. For example, concrete columns, beams, load-bearing walls and ceilings were to be retained. The shape of the original space is a rectangle with more pillars, sufficient lighting, no trivial construction and the entrance faces north.

The traditional philosophy of Feng Shui was also taken into account when designing this community library. According to the book Carpenter House, the Chinese famous carpenter Ru-ben wrote that five is a lucky number in ancient Feng - Shui. The spatial layout of the community library was divided into five small functional spaces, including a public self-study room, a reading room, an individual self-study room, an academic conference room and a yoga room, as shown in Fig.71.



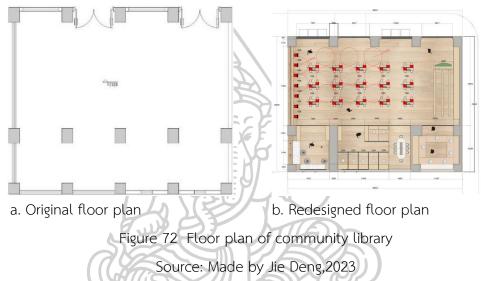
Source: Made by Jie deng, 2023

The "scroll" as a new element was extracted from the books and simplified. In the design, the thin gauze of a curtain was used to imitate the scroll hanging from the ceiling. The ceiling and interior were elegantly fitted with soft lighting. The whole design aims to create a vibrant cultural atmosphere.

People felt very vulnerable when they were suddenly confronted with a public health crisis. According to the literature, the public health crisis has led to a sharp increase in the number of depressed patients (Zhou et al., 2020). In order to alleviate these negative emotions, a self-healing yoga room was designed and added to the community library. The style of the yoga room was Chinoiserie. The interior was decorated with stillness and Zen. Warm light and colors were used to create a calm atmosphere in the yoga room of the community library. Buddha statues and Chinese-style plants adorned this yoga room, which provides a pure land for the human spirit, relieves anxiety and helps people escape from reality for a short time.

# 4.5.2.2 Two-dimensional construction drawing

Adobe AutoCAD can be used for interior design (You, Liu, & Liu, 2022), and is capable of producing accurate two-dimensional drawings, especially for construction. Therefore, Adobe AutoCAD version 2023 software was used for the design of the community library. To achieve a better visual perception, a two-dimensional drawing drawn with the CAD software was imported into Adobe Photoshop version 2011 to design a colorful floor plan with additional materials, colors, plants, furniture, and accessories. In this thesis, the first floor of the original building was designed as the interior of the community library, and the floor height is 4920 mm. The dimensions of the floor plan are 38622 mm (length) x 29940 mm (width). The floor plan design was combined with the safe social distancing principle of epidemiology. The furniture should be placed at a distance of 1 m to 2 m, at least 1m in the public reading area of the community library (Fig. 72), so that the room layout enables sustainable prevention.



There are two ways of presenting elevation drawings. One is CAD-drawn, uncolored construction paper, as is common in interior design, but the drawback is poor esthetics. Another way is to use SketchUp or other 3D software tools to cut the surface and create the elevation drawing. This visual esthetic of the elevation is faster and more beautiful, as shown in Fig. 73.



Figure 73 Community library elevations Source: Made by Jie Deng,2023

#### 4.5.2.3 Three-dimensional design sketch

The floor plan was imported into SketchUp to create 3D images of a community library, including the walls, floor, ceiling, columns, furniture, decorative plants and other ornaments. Meanwhile, choosing the camera angle with the best capture image is significant. Additional materials such as wood, fabrics and transparent glass were added to the community library. It is necessary to set up some lights, including spotlights that simulate daylight and incandescent lamps in the Enscape software. Figure 74 shows the yoga room designed with Enscape software.

# Spiritual space





Figure 74 A yoga room in Library Source: Made by Jie deng, 2023

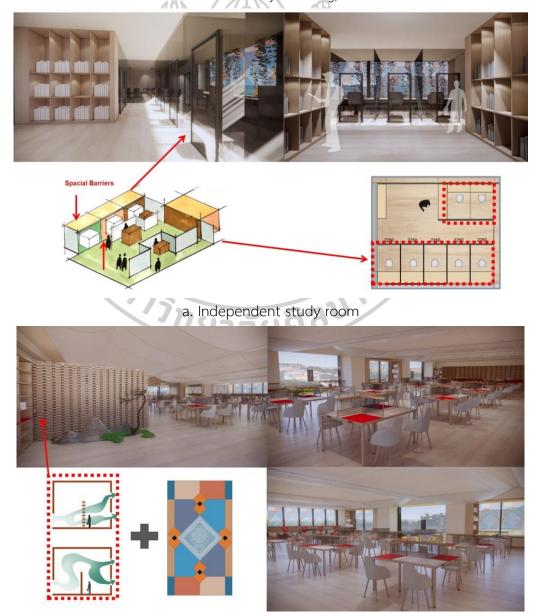
## 4.5.3 Library furniture

# 4.5.3.1 Different furniture

The public reading area was divided into several sections based on human reading behavior, including an area with individual high seats, an area with one seat, an area with two seats facing each other, and an area with a group of three or four people (Fig. 75). The high seats and desk were designed with unique perspective through the window. A single seating area was designed for one person who is better protected from disturbances and isolated from virus transmission (Fig.76a). Two opposite seats with the plants and windows were integrated into the bookshelf. Sometimes people could change their posture and lie down or take a nap when they were tired. This design took privacy into account when sitting opposite each other. Three or four people in a group sat separately, and the center tables were all covered with boards to prevent air transmission through droplets (Fig.76b).



Figure 75 Library furnitures with different behaviors Source: Made by Jie Deng, 2023



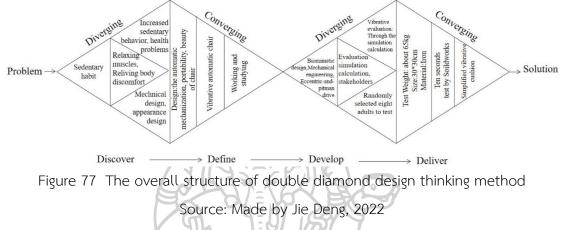
b. Public study hall

Figure 76 Library study room

Source: Made by Jie Deng, 2023

# 4.5.3.2 Vibrative chair

(1) Design thinking method



The Double Diamond Design Thinking method (Gustafsson, 2019; Tschimmel, 2012) was developed in 2005 as a simple graphical way of describing the design process (Council, 2015; Gustafsson, 2019). The Double Diamond design process is widely taught and applied in the design process. It was developed by studying 11 large corporations and their internal design processes. This thesis method is efficient in industrial design.

The Double Diamond Design Thinking method consists of four parts: Discover, Define, Develop and Deliver. In a more precise definition, the entire process consists of identifying the problem, defining the topic, exploring and developing the concept and finally evaluating it.

In this thesis, we should first examine the problems of the current public health crisis, including the strategies to prevent and control the public health crisis. The strategy of urban lockdown (Xinhua, 2020) has restricted regular travel and led to an increase in sedentary people (J. Liao et al., 2022), , while sedentary sitting would cause many health problems. Secondly, the issue of developing an automatic vibrating chair was raised on the assumption that it would solve the problems caused by sedentary activities. Thirdly, the design of the chair was developed in several aspects. The appearance is based on biomimetic design (Dickinson, 1999), in which the shape of a natural flower is imitated. The stem and bud of the flower look elegant and light. The ball of the chair mimics the bud of the flower and the legs of the chair mimic the stem. The interior structure is completed by theories of industrial design and mechanical engineering to achieve reasonable selection of components and arrangement of the interior space, as well as the use of structural materials. Among all interior structures, the eccentric and pitman drive is the core structural component, which realizes the function of activating vibration movement to relax muscles and relieve body discomfort. All chair structures can be verified by modeling and motion simulation using SolidWorks industrial design software. Thirdly, the design process of the chair is carried out, followed by design optimization, 3D model creation and vibration motion simulation. In the simulation, the input intensity is set to about 65 kg body weight, with the upper and lower iron plates of 30 x 30 cm. The vibration displacement, velocity and frequency data of the chair are the output parameters that show the vibration performance of the chair. Finally, the feedbacks in the simplified vibration cushion experimenters were randomly selected to participate in this experiment (as shown in Fig. 77).

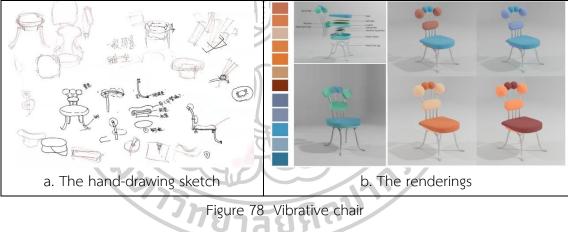
## (2) Innovation of chair

A small, practical vibrating chair has been developed to achieve physical movement through motorized vibration, especially for seated groups of people. Brainstorming is an essential part of furniture design. The inspiration for appearance design is derived from the shape of natural flowers based on the study of bionics (Junior & Guanabara, 2005).

Considering the requirements of industrial production, transportation and maintenance, the chair has been designed to be detachable. Therefore, all parts of the chair are easy to assemble and highly convenient for mass production. The backrest of the chair is made of a metal material that is produced using a unique bending technique. The curvature of the backrest has been designed according to the principle of human engineering in conjunction with the characteristics of the spine. The backrest of the chair is equipped with a soft cushion in the area of the spine and neck, which is beautiful and extremely comfortable. The shell of the chair is formed by unique plastic molding or 3D printing technology, with a soft cushion

placed on the surface to increase comfort. The chair consists of an upper and lower layer of plastic panels. The inner structure is equipped with a vibration box and connected to a plug intended for connection to an external power supply. To reinforce the chair, the underside of the chair is fitted with a metal plate. The frame of the chair is made of metal with one-time molding technology that is easy to install and remove (as shown in Fig. 78).

Conventional vibration devices usually require an exceptional environment and tools to manufacture, the volume of which is sometimes considerable. In addition, ordinary classified chairs, which usually provide limited functions such as sitting and resting, cannot meet the special needs of sedentary groups who lack movement. In contrast, the vibrating chair examined in this article is designed to be portable and combines the two functions of normal sitting and body relaxation through vibrating movements.



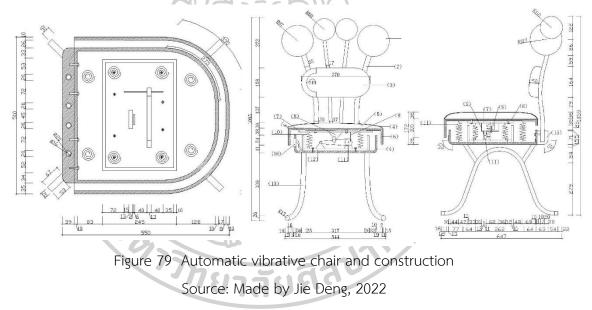
Source: Made by Jie Deng, 2022

# (3) Computer Aided Design

The design of the vibrating chair in this work was carried out using CAD and Blender software. Auto-CAD is widely used in architecture, interior design, landscape design, industry and other design fields (J. Li, 2022). CAD-based software systems can control the entire design process by simulating and analyzing the optimal positions of the measurement systems (Germani, Mandorli, Mengoni, & Raffaeli, 2010). The chair construction drawings were drawn in top view, front view and side view by using software CAD. The design drawings of the chair were drawn using the CAD software in top view, front view, and side view.

The Blender software was used to create the image for the product after a CAD design drawing of the chair had been made. The image of the chair construction was created using the small electronic mechanical devices shown in the attached drawings (Fig.79).

Figures 79 : (1) - Neck cushion (spinal mat); (2)- Chair with metal back; (3) - Waist cushion (backrest); (4) - Fabric cushion; (5) - Sponge cushion (soft fabric); (6) - Chair cover; (7)- Vibration plate; (8)- eccentric wheel; (9)- transmission rod; (10)- spring; (11)- crank disk; (12)- motor bracket; (13)- chair base; (14)- inner spring of the chair; (15)- unit integrated in the chair backrest; (16)- control panel (Deng, 2024).



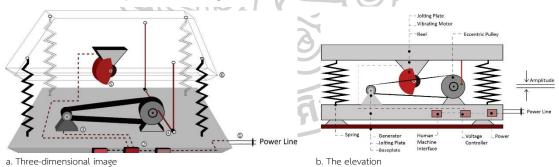
## (4) Technical scheme

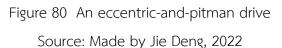
Similar to a small vibrating vehicle chair whose primary technology involves an internal motorized vibration device (D'Amore & Qiu, 2021), the comfortable vibrating chair in this work also uses internal motorized vibration devices. The mechanical and electrically operated devices were installed inside the chair and four internal springs were used to support the chair. The transmission mechanism consisted of a connecting rod gear, an eccentric wheel and springs to perform the vibration function. The vibration of the chair could be adjusted by extending and retracting the springs, which were connected to the rod mechanism. The eccentric wheel was used to

strengthen the vibration effect. Thus, the vibrating chair was equipped with two sets of vibrating mechanisms that work together to provide a reliable vibrating motion. The vibration frequency and intensity of the chair can be adjusted according to the user's needs.

## (5) Eccentric-and-pitman drive optimization

The vibration principle of the chair is explained as follows. The vibration plate is connected to the base by four springs. An eccentric wheel is mounted in the center position of the vibration plate, which is driven by an internal motor to generate a high-speed vibration for the vibration plate. The base of the chair is equipped with a belt drive that generates another vibrating source of motion for the chair, the following wheel of which is connected to a transmission rod near the outside. The other end of the rod is hinged to the vibration plate. These four parts constitute a crank-link mechanism. The pulley moves when the crank runs through the belt after the motor, which moves the vibration plate up and down. The dual function of the eccentric wheel and the dual functions of the motor cause the vibration plate to vibrate at high frequency, which is then transmitted from the chair to the human body (Shown in Fig. 80).





#### (6) Design of link drive mechanism

The hypothesized capacity of the comfortable chair is to support a person weighing about 65 kg and to overcome the inertial force due to the driving vibration. Consequently, the vibration process requires a high load capacity of the transmission mechanism. The link drive mechanism is considered as the main transmission structure for upward and downward vibration. The schematic diagram of the link

transmission mechanism shows that the mechanism mainly consists of the crank 1, the connecting rod 2, the vibration plate 3 and the frame AB. In order to ensure continuous vibration, the transmission mechanism must contain a crank 1, which can be realized by a pulley in the belt drive. To create the crank 1 in the transmission mechanism, the size ratio of the four structures should be in accordance with the principle of bar length. Combined with the appearance and size requirements of the chair, the following formulas should be satisfied.

$$L_1 < L_2 < L_{AB} < L_3$$

 $L_1 + L_3 < L_2 + L_{AB}$ 

 $L_1 + L_2 < H_{(1-1)}$ 

Where  $L_1$  is the length of crank 1,  $L_2$  is the length of link 2,  $L_3$  is the length of the chair's vibration plate,  $L_{AB}$  is the length of the frame and H is the height of the chair. Note: There should be a large medium link transmission mechanism. The detailed design process of the connecting rod mechanism can be designed as follows, see Figure 81.

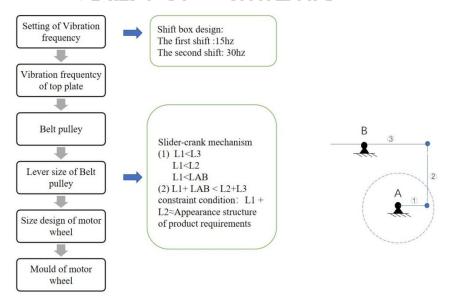


Figure 81 Schematic diagram of link gearing mechanism

Source: Made by Jie Deng, 2022

# (7) Design of eccentric wheel vibration mechanism

In order to acquire vibration with high frequency and proper amplitude, the eccentric wheel vibration mechanism connecting with the rod transmission vibration

(1)

mechanism was set in the middle position of the internal space of the chair. This eccentric wheel vibration mechanism is shown in Fig. 82.

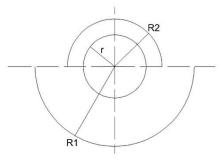


Figure 82 A semicircular eccentric wheel mechanism

Source: Made by Jie Deng, 2022

The eccentric wheel uses a semi-circular eccentric wheel mechanism to be made of carbon structural steel. In Figure 5,  $R_1$  is the outer radius of the semicircular eccentric wheel,  $R_2$  is the outer radius of the installation shaft of the semicircular eccentric wheel, r is the radius of the installation shaft of the eccentric wheel, and the axial length of the eccentric wheel is L. The chair vibrates under the action of the vibrating eccentric wheel, and the vibration frequency f is determined by the speed of the eccentric wheel.

f = n /60

(2)

In the formula, n is the speed of the eccentric wheel, and the speed of the *DC* motor is set as n=100 *rps* (round per second).

The eccentric wheel vibration mechanism should be able to vibrate the chair and the seated human body when operating alone at high frequency. The centrifugal force F of the eccentric wheel should overcome the gravitational sum G of the chair and the seated human body, resulting in F > G. When the eccentric wheel rotates, the centrifugal force is generated. And the centrifugal force F is the difference between the centrifugal force  $F_1$  of the larger semicircle and the centrifugal force  $F_2$ of the smaller semicircle.

$$F = F_1 - F_2$$

$$F_1 = m_1 \omega^2 * r_1 \text{ barycenter}$$

$$F_2 = m_2 \omega^2 * r_2 \text{ barycenter}$$
(3)

Where,  $m_1$  and  $m_2$  are respectively the quality of the big and small semicircles of the eccentric wheel.  $r_{1barycenter}$  and  $r_{2\ barycenter}$  are the radiuses from the center of gravity of the larger and smaller semicircles of the eccentric wheel to the center of the circle.  $\boldsymbol{\omega}$  is the angular velocity of the eccentric wheel.

$$m_1 = \frac{1}{2} \pi R_1^2 L \mu, \ m_2 = \frac{1}{2} \pi R_2^2 L \mu \tag{4}$$

 $r_{1\text{barycenter}} = 4R_1/3\pi$ ,  $r_{2\text{barycenter}} = 4R_2/3\pi$ 

 $\omega$ =2 $\pi$ n

Then, F=8/3\* $\pi^{2}(R_{1}^{3}-R_{2}^{3})*L*\mu*n^{2}$ 

To meet the requirements of appearance structural design, parameters of eccentric wheel mechanism follow  $R_1=0.025m$ ,  $R_2=0.005m$ , L=0.1m,  $\mu = 7\,800$  kg /m3and G=1500N.Calculated F is 3178.7N. Therefore, F>G is satisfied, meaning the designed eccentric wheel mechanism could vibrate the human body.

In this paper, the internal vibration structure of an automatic vibration chair was simplified in order to simulate the vibrations with SOLIDWORKS. Firstly, simplified models of the different structural parts of the chair were created and the entire three-dimensional model of the chair was assembled in the SOLIDWORKS environment. Secondly, the COSMOS Motion Module of SOLIDWORKS was plugged into the simulation analysis. The output results are the characteristic motion curve of the displacement and speed of the vibration plate and the energy consumption curve of the motor.

# (8) The output and Analysis of Simulation of Furniture

The SOILIDWORKS simulation model and instantaneous snapshot of simulated motion of the vibrative chair is shown in Figure 83. It can be shown that the chair can achieve exceptionally good reciprocating motion in vertical direction.

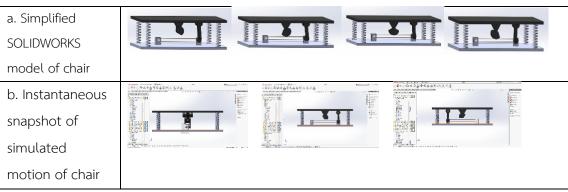




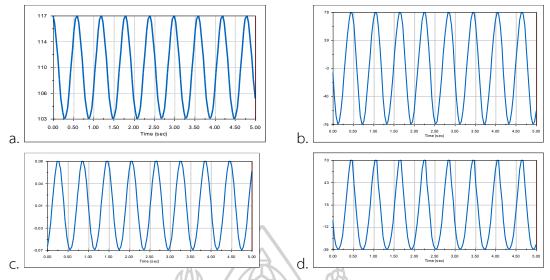
Figure 83 SOLIDWORKS Simulation calculations

Source: Made by Jie Deng, 2022

Simulated motion curves were put forward, shown in Figure 84. The motion curves included the displacement, velocity and energy consumption of the motor as a function of time in a vibratory motion driven by an eccentric wheel and a crank rod mechanism. The displacement curve shows that the chair can achieve a reciprocating vibration with a maximum amplitude of 2 mm and a vibration cycle of 0.6 s, which satisfies the vibration needs of the human body within the tolerable range. The speed curve shows that the maximum vibration speed of the chair is 79 mm/s. The energy consumption curves of the motor show that the average consumption power of the two eccentric wheels is less than 70W.

The motion curve is the reflection of the motion characteristics of the vibration chair. Adjusting parameters such as the motor speed or the physical parameters of the eccentric wheel can change the motion characteristics of the vibration chair, resulting in different motion curves. The corresponding relationship between the adjustment of parameters and motion curves can be used to optimize the vibration characteristic design of the chair.

The first step is to establish the corresponding mathematical model expressed by a theoretical formula with parameters related to the physical parameters of the vibration chair, such as the wheel speed and the rod length. Secondly, the COSMOS Motion module in SOLIDWORKS is used to simulate the vibration motion process of the chair under the combined conditions of the two vibration mechanisms. The motion curves are generated, and the motion characteristics are analyzed. Finally, the physical parameters of the vibrative chair, such as the motor speed or the parameters of the eccentric wheel, can be adjusted to optimize the vibration curve, and meet the requirements of the apparent design and customer needs to the highest degree.



 a. Displacement of Vibrating Plate Related to Lower Plate – Amplitude is about 2mm. b.
 Vibrating Velocity of Vibrating Plate-Amplitude is about 79mm/sec. c. Energy Consumption of Upper Eccentric Wheel. d. Energy Consumption of Lower Eccentric Wheel.
 Figure 84 Motion Curve Results of Simulation Source: Made by Jie Deng, 2022

4.5.4 Ventilation Design

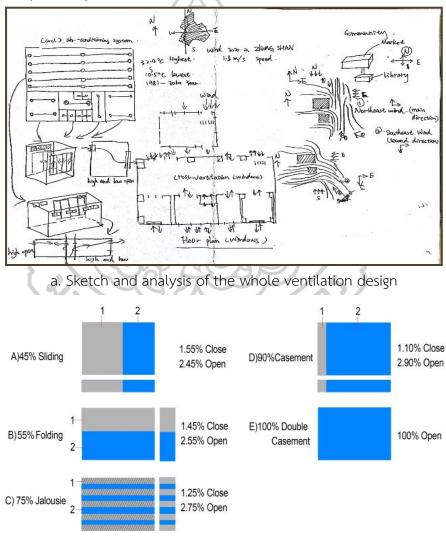
# 4.5.4.1 The problem of ventilation

Ventilation systems are the essential content of the transformation space. Ventilation systems are not only found in the market environment where the ventilation is poor, but also in the interior spaces where there are many problems such as the position and size of the window, the option of the window, the type of airflow and the effectiveness of the ventilation. This ventilation is related to human health and the transmission of the virus. It should be investigated that the Lu-yang Ju community's indoor public spaces lacked cross ventilation and natural ventilation systems, an existing problem that should be addressed.

#### 4.5.4.2 The method of ventilation

In many cities, the high attendance of visitors to the library is so astonishing that it is usually full of readers at peak times (Y.-. Xu, 2022). The community library is too close and convenient for people to choose it as their first option to visit. As a result, community libraries a higher safety risk of viral infections through airborne transmission. It is essential to assess the air quality and take measures to improve it so that the virus cannot spread through the air.

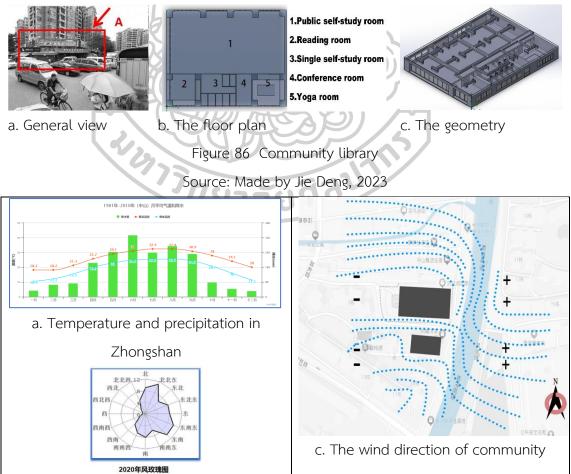
There is a method that develops the design process of natural ventilation (Fig.85). The preliminary data from the field research should analyze the condition of the space function. The analysis of external and internal factors includes wind meteorology analysis, environmental information, user factors, volume analysis, various ventilation requirements, indoor air flow simulation and other factors. The following steps are the design of the appearance between the wall and the window, the internal spatial organization and the evaluation with SolidWorks software.



b. Analysis of the different windows type of opening ratio
 Figure 85 Sketch analysis of ventilation design in community library
 Source: Made by Jie Deng, 2022

### 4.5.4.3 Ventilation location description

The main object of this case study is the community library to be rebuilt as part of the plan to modernize and transform the Lu-yang Ju Community in Zhongshan City, southern China. The overview of Lu-yang Ju Community before the transformation is shown in Figure 86. As per the location of this community, the Chinese National Meteorological Center reports that the local temperature in the 10 years between 1981 and 2010 ranged from 10.5°C to 32.4°C and the main wind direction was northeast. The secondary main direction is southeast (Fig. 87). The highest temperature was 32.4°C in July and August, and the coldest was 10.5°C in January and February. The average wind speed in 2020 was 1.8 m/sec. As a newly designed library, the municipal library has a total area of approximately 1156 m<sup>2</sup> and its volume is approximately 4531 m<sup>3</sup>. In terms of ventilation, the designer aims to look for the most suitable window types, opening ratios, opening approaches and ventilation of the municipal library. The hypothesis is that a redesigned community library will reduce the air transfer rate.



b. Wind Rose in Zhonghshan	location
----------------------------	----------

Figure 87 Meteorological analysis of zhong-shan city

Source: Zhong-shan Meteorological Center and Jie deng, 2022

### 4.5.4.4 Natural Ventilation Recommendation Based on ACH Calculation

ACH was also adopted to measure air quality in this case study. Detailed calculation method of ACH calculation can be performed under the guidance of the following formulas.

 $ACH = (Q / V) \times 3600$ 

Where Q is the level of natural ventilation (m<sup>3</sup>/s), and V is the volume of the room (m<sup>3</sup>). The level of natural ventilation (Q) itself is obtained using the formula (Hendrawati, 2021): Q=0.025Av (6)

Where, A is the area of the opening  $(m^2)$ , v is the wind speed at the opening (m/s), and 0.025 is the multiplier (Hendrawati, 2021).

Regarding to dealing with the viruses, the recommendation for the ventilation rate should be no smaller than the value when ACH is 8 (Hendrawati, 2021). Based on calculation results with ACH formula, the optimal window type and window opening rate for community library can be achieved.

# 4.5.4.5 CFD Simulation

The SolidWorks Flow Simulation module was the CFD software used to simulate the airflow of the library under investigation. The physical model was created using SolidWorks. Once created, the physical model was imported into the Flow Simulation Module and then the model was fixed, meshed, boundary conditions were applied, the calculation was performed and finally post-processing was carried out. As an example, the natural ventilation for the yoga room of the community library was simulated. The detailed simulation process and the results of this type of simulation were presented.

## 4.5.4.6 Physical Model

The community library consists of a public self-study room, an individual selfstudy room, a conference room, a reading room, and a yoga room. This means that

(5)

the total amount of air required is about  $3000 \text{ m}^3$  per hour. The outlook of the physical model of the entire library is shown as figure 85c.

The overview of the physical models of yoga room with different window types was shown in Figure 88. The southeastern windows of the model were defined as the entrance and the others as the exit. Five different types of windows were modelled and simulated for the yoga room to find suitable windows for the community library. The opening rates of the five representative types are between 45% and 100%. The internal dimensions of the yoga room are 10.3 m x 10.2 m x 3.5 m. Frame area of each inlet window is around 1.9 m x1.09 x m, and the total area is  $6.21 \text{ m}^2$  since there are three windows. The total outlet area, which includes the areas of six small windows with a size of 1.08 m x 0.44 m and the area of an open door with the size of 3.6 m x 3 m , is 13.65 m<sup>2</sup>.

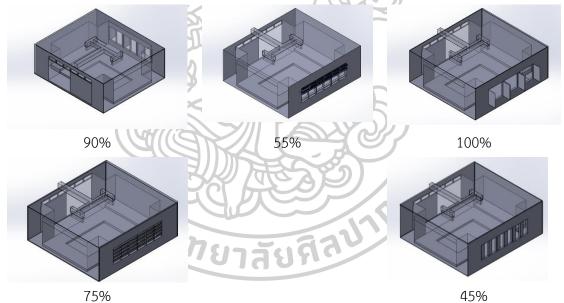


Figure 88 Physical models of yoga rooms with different window types Source: Made by Jie Deng, 2023

#### 4.5.4.7 Calculation Zone and Meshing

The simulation issue in this work is the problem of simulating the interior air flow field, where the inner space of the yoga room is attractive. In combination with the properties of the flow simulation software, the calculation zone could be defined as the area inside the outer wall of the yoga room. Before you define the calculation zone and the meshing, the physical model should be fixed after importing it into Flow Simulation. Since the aeration in the physical model was created in the form of windows, the model should be created with end caps at the ventilation locations to define some critical boundary conditions.

The meshing can be performed on the basis of a fixed physical model within the calculation region. As the flow is air, turbulent flow can be quickly expected, and the mesh should be relatively good. In flow simulation, the default mesh can be divided into seven grades, from coarse to fine, as numbers 1 to 7. Commonly, default mesh can be accepted if the simulation or trial-simulation results are satisfactory. Otherwise, a finer mesh should be created by labor. In this thesis, the authors tried the default meshing method with grade 5 for the yoga room and found that the mesh generated in this way is favorable enough for the simulation. The number of element amount of the mesh for the yoga room is 292184. The mesh for the yoga room, which assumes a window with an aperture ratio of 45% is shown in Figure 89.

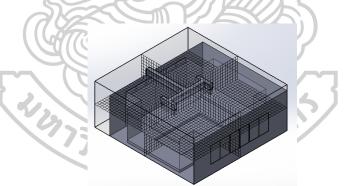


Figure 89 Physical models of yoga rooms with different window types Source: Made by Jie Deng, 2023

#### 4.5.4.8 Boundary Condition

There are three types of boundaries for simulating on the natural ventilation of a yoga room. At the end plates of the physical model which are corresponding to the windows, the inlet velocity boundary condition was set, and the velocity of the inlet airflow is 1.8 m/s. A pressure outlet boundary condition was set at the end plates of the physical model corresponding to exhaust air. For other surfaces of the physical model, no-skip wall boundary condition was set. All wall boundary conditions are adiabatic and consider a roughness of 0.0005 m. All simulations were performed under standard atmospheric pressure and 288.15 K temperature. Turbulence was considered in the simulation, and the k- $\mathcal{E}$  turbulence model was used.

#### 4.5.4.9 The outcome of Community Ventilation design

The ventilation design is crucial for health prevention. In this thesis, the ventilation system in community library was examined. The results showed that O. F. Alrebi pointed out that the height of 1.7 m and 1 m above the floor corresponded to the height of the library bookshelf and readers in sitting posture, respectively (Alrebi et al., 2022). As the yoga room differs from the reading room, planes at a height of 1.7 m, within the height of the windows, were selected to analyze the results of the for airflow simulation to better observe the airflow.

The result varies depending on the window type when simulating the natural ventilation of the yoga room. Using the ACH assessment method, ventilation is suitable to avoid virus transmission if the ACH value is greater than 8; louvered, casement, and double-hung window are the best choices for natural ventilation (shown in Table 15). It can be observed that the airflow velocity in the main space of the yoga room increases with the increase of the opening ratio. As natural air is a viscous fluid and can become turbulent relatively easily, the velocity of the airflow inside and in a corner of the space is also relatively low. The average airflow velocity in the whole room increases as the opening ratio increases. This result explains why larger AHC is beneficial to avoid the virus transmission (Fig.90). The velocity contours also showed that there are spaces with lower airflow velocities, mainly the hidden areas behind walls without windows, especially the corners. This phenomenon indicated that windows should be designed to cover larger areas on the walls if a better wind sensation is desired anywhere in the room. Moreover, the opening area of a window is not necessary to maintain integrity; distributed opening areas of the windows with closed parts are also applicable, judging by the simulation results of different window types.

Window Type	Total Frame Area (m <sup>2</sup> )	Opening Ratio	Inlet Velocity (m/s)	АНС	Main Range of Airflow Velocity (m/s)
Sliding	6.21	45%	1.8	7.24	0.419-1.468
Folding	6.21	55%	1.8	7.53	0.429-1.561
Jalousie	6.21	75%	1.8	8.03	0.574-1.722
Casement	6.21	90%	1.8	8.47	0.695-1.852
Double Casement	6.21	100%	1.8	8.75	0.717-1.913

Table 15 Results of ACH Calculation in five types of windows

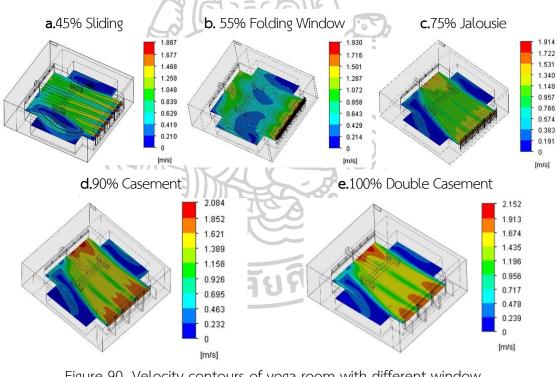


Figure 90 Velocity contours of yoga room with different window Source: Made by Jie Deng, 2023

### 4.5.5 Windows design

### 4.5.5.1 The design process of windows

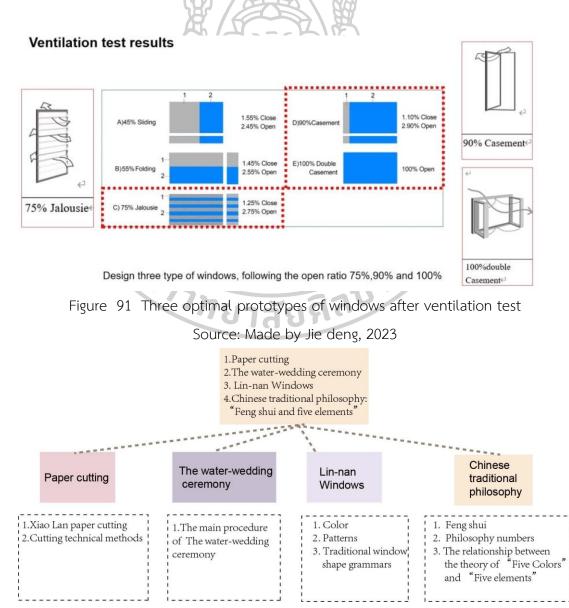
The design of the window is mainly based on the previous airflow simulation and calculation. The three window prototypes, namely, 75% opening ratio of Jalousie, 90% single casement, and 100% double casement, are the respective window types to be redesigned (Fig.91). The window design combines the elements of the Ling-nan windows, Feng-Shui and five-element theory, the local intangible heritage wedding elements and the graphic method of paper cutting. The design process is shown in Fig.93.

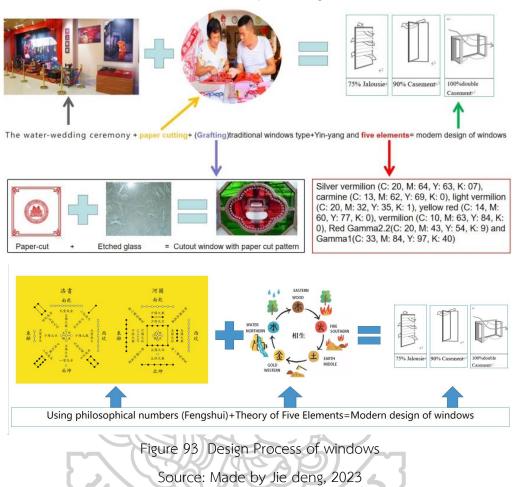
a. Collect architectural Ling-nan window patterns

b. Design elements: the traditional window, paper cut, the water wedding process, the numbers of Feng-shui philosophy, the five elements, and the main direction of the wind (Fig.92).

c. Redesign a new pattern and combine all the elements to redesign the windows

d. Create an accurate model

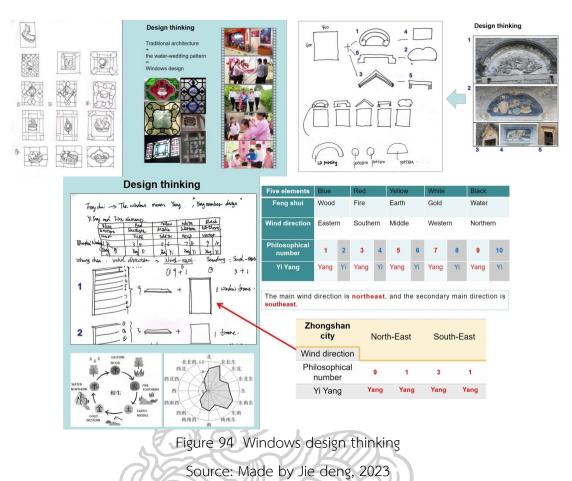




# Figure 92 The structure of Municipal intangible cultural heritage

Source: Made by Jie Deng, 2023

Based on the local wind direction and the wind flow figures, the relationship between wind and wind direction was created, and the main wind direction was considered in the design of the windows. The numbers are usually divided into "Ying" and "Yang"; usually, "Ying" represents the unlucky number, and "Yang" represents the luck. Therefore, the ancients strictly followed the construction method of "Ying" and "Yang" numbers. The ancients believed that the east corresponds to the "Yang" number 1, the south corresponds to "Yang" number 3, the west corresponds to "Yang" number 7, and the north corresponds to "Yang" number 9. Therefore, the numbers 1, 3, 7, and 9 were used as the promoting number for the leaf forms. The heads of windows have different shapes, including triangles, rectangles, arcs, and polygons, which can be combined with different types of window bodies. The formats of the windows can change constantly (shown in Fig.94).



The image of the intangible heritage of local marriage and the graphic of the paper cutting are in the traditional Ling-nan style, never used as design elements for window patterns (see Fig. 95).

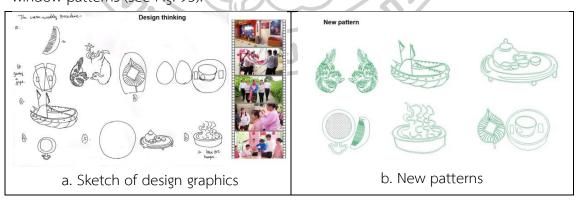
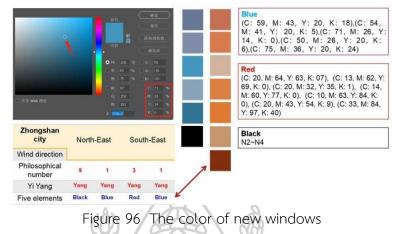


Figure 95 New patterns design Source: Made by Jie deng, 2023

The new window color combines feng shui and the five elements, as well as the traditional Ling-Nan window. The main wind direction is north-east and southeast. Black corresponds to the north, red for the south, and blue for the east. These colors are used on the windows in the corresponding directions (Fig.96).



Source: Made by Jie deng, 2023

## 4.5.5.2 The outcome of windows design

The software Adobe Photoshop version 2021 or Adobe Illustrator version 2023 was used to create the database of window patterns. As stated in the previous sections, the new pattern design could endlessly vary with different combinations of color and elements. The designed window patterns are shown in Fig. 97.

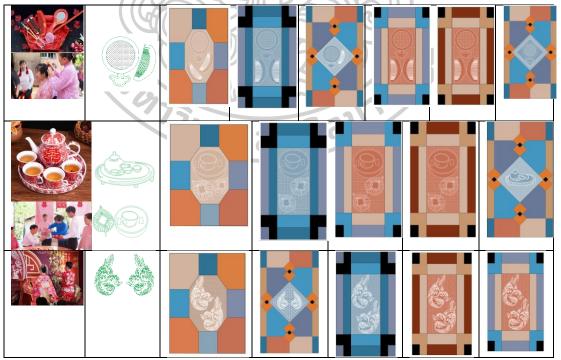




Figure 97 The glass pattern of window Source: Made by Jie deng, 2023

Adobe AutoCAD version 2022 was used for the construction drawings of the new window (Fig.98 and 99), and SketchUp version 2021 and Enscape version 3.1 (Fig.102) were used for the rendering of the new window. Three windows with an opening ratio of Jalousie of 75%, 90% casement, and 100% double casement were redesigned with new elements.

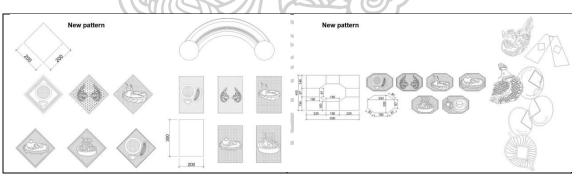


Figure 98 The new pattern in CAD Source: Made by Jie deng, 2023

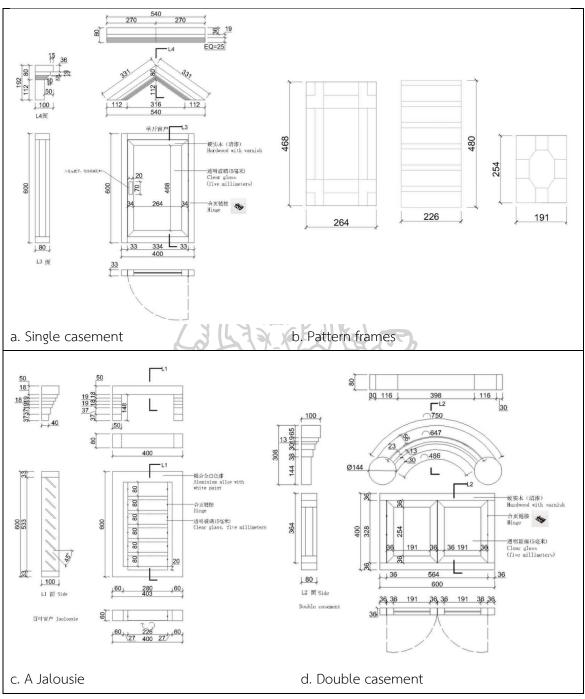


Figure 99 The construction drawing of three windows

### Source: Made by Jie deng, 2023



Figure 100 Windows materials

Source: Website pictures, 2023

The frame of the newly designed double casement and single casement windows was made of Fraxinus mandshurica and Cherry wood, shown in Fig.100b and 100c. The junction piece of the window was the hinge. Another type of window (Jalousie) was made of an aluminum alloy. The new Jalousie was designed with an additional mechanical structure that could support the electric generator (ASZO2-series: IP65, Power rating: DC24V, Duty cycle: 25%, Max. load: Push 1000N, Max. Current: Max.1.5Amp), wireless switch (Model: YC100-02GD, Input: 100-240VAC, 50/60Hz, Output: DC24V, Frequency: 2.4GHz, Working current:2.0A ) and remote control. The new Jalousie can be open and close. Moreover, the direction of the window opening can be adjusted to the wind direction by remote control (shown in Fig. 101).

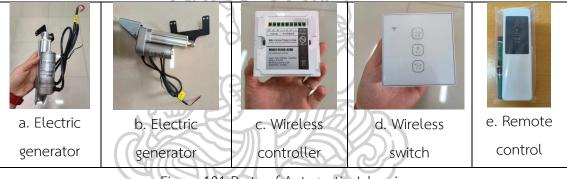


Figure 101 Parts of Automatic Jalousie



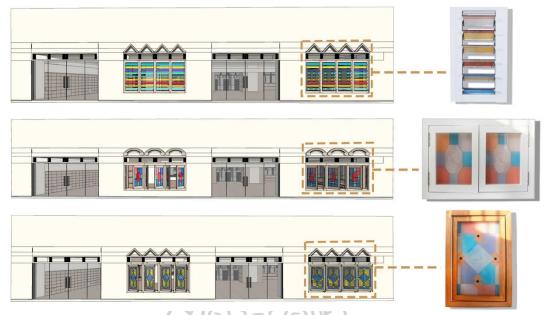


Figure 102 The Renderings of new windows Source: Made by Jie deng, 2023

Wind-driven cross ventilation was utilized in the window design. The window type of Jalousie was considered in three ways of convection high opening, high and low opening, and low opening. Table 16 presents the Jalousie window with different shutters. The design of the shutter opening was linked to the wind-driven cross ventilation. For example, for a high opening, the Jalousie was designed to open the top three or two shutters with a generator started at the first connecting rod. Two or three shutters would then open. Another generator was started on the second connecting rod so that the remained shutters could be opened or closed.

Regarding high and low openings, the upper and lower six or four shutters of Jalousie were designed to be opened by a generator with a connecting rod. Moreover, another connecting rod could open or close the rest of the shutters.

As for the low opening, a generator with a connecting rod opened the bottom two or three shutters of Jalousie. Meanwhile, the remaining shutters could be opened or closed with another connection rod.

Table 17 shows the results of the airflow simulation for the window types listed in Table 16. New windows with different opening types have different airfields inside the room. This indicates that the design of new window types is practical and necessary to meet the requirement of a larger number of users. Table 18 shows the airflow sketches of the new windows corresponding to Table 16 and some earlier window types such as transom windows, single casements, and double casements. By combining these types, the convection of high and low openings can be realized.

The renderings of Jalousie with different shutters are shown in Table 18. The application of the airflow source is shown in Fig.103. The airflow layout of the library floor plan used high and low openings. Fig.103a shows the design with transom windows, and Fig.103b shows the design without transom windows.

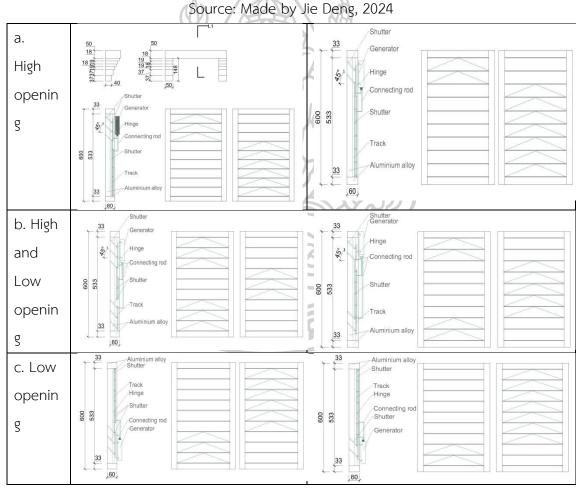
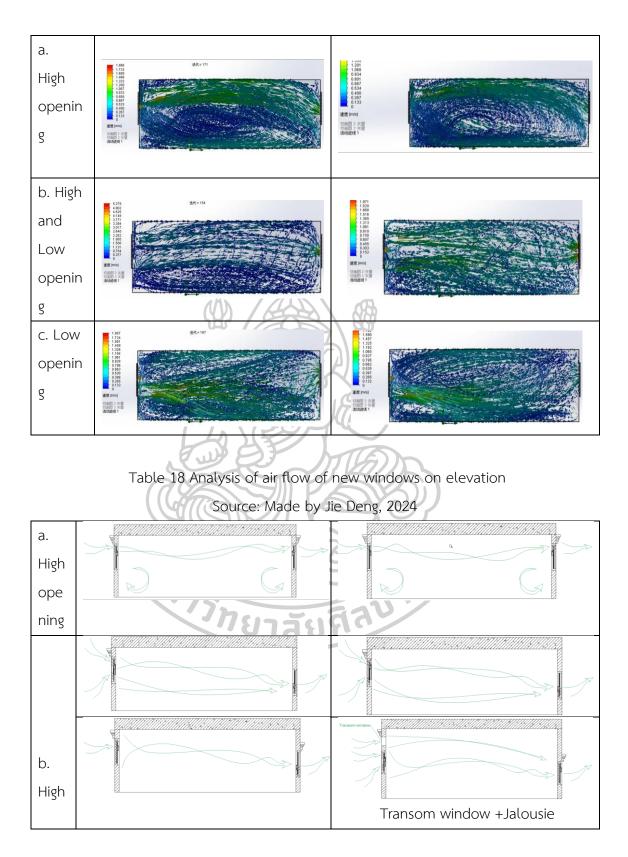


Table 16 The construction drawing of new windows

Table 17 Airflow simulation results of new windows corresponding to Table 16Source: Made by Jie Deng, 2024



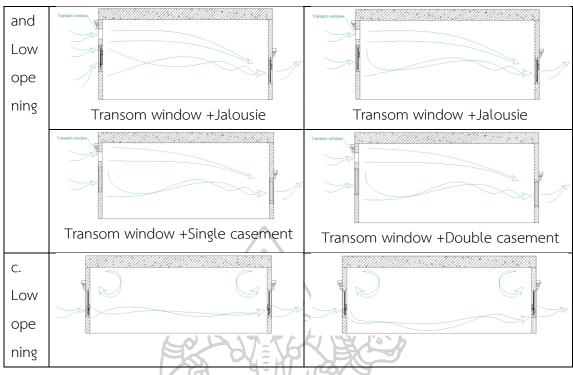
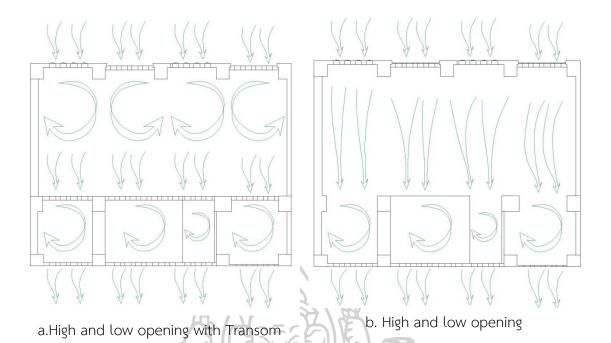


Table 19 the Jalousie with different shutters Source: Made by Jie Deng, 2024





window Figure 103 The air flow layout of library floor plan Source: Made by Jie Deng, 2024

# 4.6 Model-making

The model construction consisted of a scaled crafted model, a 3D model, and the factory customization of the real model. Table 19 shows the cost of all models, which totaled more than 54878 Thai Bath.

Table 20 Materials list and cost

Source:	Made	by .	Jie	Deng,	2022
---------	------	------	-----	-------	------

White card paper	620 Thai Bath
Iron wire	110 Thai Bath
Tweezer	125 Thai Bath
Iron wire cutter	63 Thai Bath
A ruler	100 Thai Bath
Cutting knife	120 Thai Bath
Glue	500 Thai Bath
Plastic clay	150 Thai Bath
Colored ribbon	50 Thai Bath
Clear cut adhesive	120 Thai Bath

Pigment	250 Thai Bath	
Base thick cardboard	140 Thai Bath	
Blue transparent material	120 Thai Bath	
Plastic white clay (NARA Thai Clay)	160 Thai Bath	
Pencil	50 Thai Bath	
Acrylic paint	350 Thai Bath	
Sandpaper	50 Thai Bath	
3D printing fee	4500 Thai Bath	
Others	200 Thai Bath	
(Jalousie) Windows model and engines	50000 Thai Bath	
(Single and double casement ) Windows model	4000 Thai Bath	
The glass film	500 Thai Bath	
Window gable	1500 Thai Bath	
Varnish color	100 Thai Bath	
Total amounts	54878 Thai Bath	

### 4.6.1 The scaled model of community library

The material of the scale model consisted of white cardboard, iron wire, etc. (shown in Table 19). The scale model should preferably represent artificial images to understand the design. The whole process of the scaled-crafted models is shown in Figure 104.

### (1) Scaled prototype of vibrating chair

The scaled prototype of the chair was created on a scale of 1:100 using metal wires, poster board, and NARA Thai Clay. The prototype was scaled proportionally in conjunction with the construction drawings. The scaled model saved the design production time to discover the design flaws immediately and improve the design quickly, which helps to avoid defective products (Fig.104c).

In terms of esthetics and dimensions, on which the chair's appearance depends, the justified dimensions of the seat width and height, backrest, spine mat, and seat base were deemed appropriately. A scaled-down prototype was also fabricated to evaluate the structure and function of the designed vibrating chair. This prototype was produced using a handmade model, scaled proportionally in link with construction drawings. Esthetic and dimensional tests were also conducted to ensure the appearance of the scale model was appropriate. The scaled model is more accessible to the intuition of esthetic perception; Subsequently, the natural product enables the ideal demonstration on the market and avoids defective goods.





Figure 104 The process and results of handmade mode

Source: Made by Jie Deng, 2022-2023

# 4.6.2 3D printing model

The 3D model was created using the SketchUp software. After preparing the 3D printing material (photosensitive resin) and the 3D model, the 3D printer (EOS FORMIGA P110) can print a large 3D model (Fig.105), which is 420 x 338 x 66 mm (Fig.106e).



Figure 105 3D Printer Source: https://www.aeroexpo.cn/, 2023

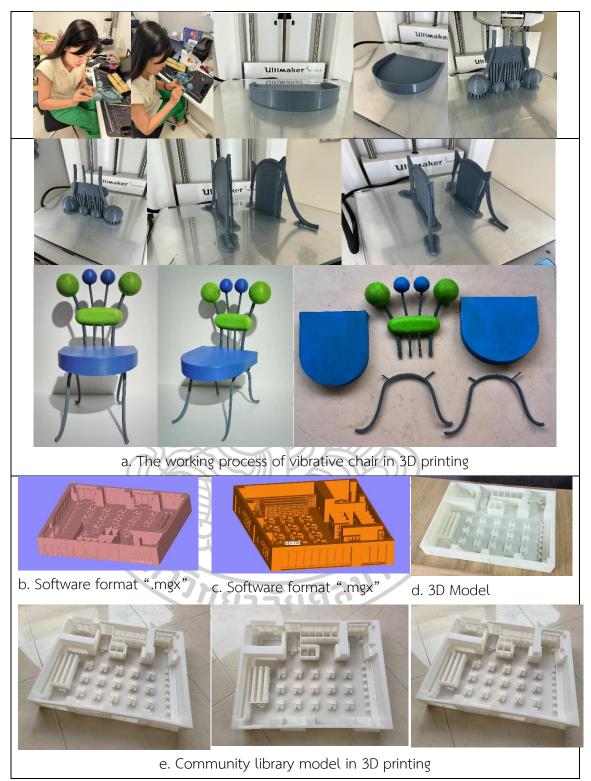


Figure 106 3D Printing models Source: Made by Jie Deng, 2023

#### 4.6.3 The real model of windows

The actual size of the windows is based on the construction drawing. The hardwood was chosen as the raw material and cut into components using the wood workshop's machine according to the construction drawings. The actual window model was then assembled, sanded, glued, painted, and dried, as shown in Fig.107.



Figure 107 The process of producing a real size of window Source: Made by Jie Deng, 2023

### 4.6.4 The factory customization

Three factories were selected to produce the three types of natural windows, including a glass film of the window, a window frame made of wood and inner glass, and a window frame made of an aluminum alloy. Hardwood was used as the

material for the single and double casements windows and the traditional window technology was restrained. The Jalousie was supplemented by the mechanical design of the automatic window opening. The main design of the automatic window is shown in Fig.108:

a. The opening direction of the automatic Jalousie is adjusted by the wind direction, the remote control, and the automatic switch.

b. Glass pattern (extraction of elements of Ling-nan intangible cultural heritage), glass color (integration of local wind direction, Ling-nan window color, and the five elements of Feng-shui color system)



Figure 108 The real picture of Jalousie Source: Photos made by Jie Deng, 2023



b. The Poster of Double casement



c. The poster of single casement Figure 109 The poster of windows Source: Photos made by Jie Deng, 2024

### 4.7 Summary

This chapter presents the general redesign plan of the old community, which forms the main content of the visualization design of the thesis.

The general plan of the whole Lu-Yang Ju community was designed, and the design of the community functional facilities such as the main entrance, secondary entrance, parking lot, water pavilion, swimming pool, and outdoor fitness park were presented.

The design of the community facilities mainly includes the application of elements of Ling-nan architecture traffic flow planning, plant arrangement, limiting the space between spaces, and expanding the boundary space. In the context of Ling-nan architecture, the curve element of the "wok yi uk" wall has been widely used in the planning and design of community facilities. In order to design a healthy space, plants with purifying functions for air and water were selected in the plant disposition. To strengthen the residents' bodies, an outdoor fitness park was designed for people of all ages to exercise. To improve the accessibility the outdoor area was connected to two areas by a cross bridge. Subsequently, two case studies on the community vegetable market and library were conducted in detail and selected as examples of a detailed transformation design.

The transformation design of the vegetable market was carried out for both the external market environment and the internal market space. For the external environment, the transformation design focused on renovating the entrance and exit, streamlining the site, and a green belt. The transformation design focused on functional layout, internal streamlining, and stall arrangements in the internal market.

When redesigning, the community library, the room space arrangement, ventilation system, indoor furniture, and windows were taken into account. When standardizing the interior spacing of the community library, the redesigned space should be controlled strictly by maintaining a distance of 1 m to 2 m, but at least 1 m. The interior furniture studied includes bookshelves, desks, and chairs, with chairs specially examined to avoid sedentary problems. The ventilation system was designed mainly according to the ACH method, including natural ventilation, in which five window types of the yoga room of the community library were studied using the CFD method to find the optimal window type that avoids the transmission of virus through the air in cross-ventilation. Among these windows, three optimal windows were specially selected such as a 75% open ratio of Jalousie, a 90% casement and 100% double casement in the community. The design of the three types of windows has absolved design factors, such as Chinese Feng-shui and element theory, Ling-nan window culture, and the intangible cultural heritage of the community.

Finally, the model of the chair and the community library were crafted. The vibrating chair and the community library were 3D printed. An automatic Jalousie with remote control and automatic switch was made in the factory. However, the double and single casements were kept in the traditional opening mode.

### **CHAPTER 5**

### Conclusions and contributions

### 5.1 Conclusions

#### 5.1.1 Community planning and design

The old Lu-Yang Ju community has some environmental problems, which are detrimental to preventing public health problems and improving the quality of life of community residents. The problems of Lu-Yang Ju community are shown from different perspectives, such as poor space arrangement, messy surrounding environment, and mixed and chaotic transportation systems.

The redesign of the Lu-Yang Ju community was conducted on the integration of Ling-nan culture, arrangement of the traffic system, plant disposition, the spacing between rooms and the widening boundaries, etc. The community vegetable market and library were selected as case studies to demonstrate the transformation work in detail. The primary transformational strategy of the community considers the integration of Ling-nan culture, the traditional philosophy of Chinese Feng-shui and Five Elements theory, the philosophy of art design, and the method of mechanical engineering.

The Lu-Yang Ju community, after transformation, is of both the beauty of modern art and the function of public health crisis prevention based on the original of the purpose of occupancy, which is more humane and comfortable for people lives. All the findings and successful designs are the positive analysis results of a combination of literature review, field research, and case study methods. However, the traditional community studied in this thesis has not been put into practice, which is a great pity and needs further efforts.

#### 5.1.2 Community Vegetable Market

The traditional vegetable market has environmental problems such as chaotic distribution of infrastructures, chaotic traffic flows, dirty sanitary facilities, and odors. In the traditional market, developing a design against infectious diseases is significant. By studying the problems of Tan-Zhou vegetable market in Zhong-Shan City, China, and carrying out a transformation design for this vegetable market, this thesis has put

forward a comprehensive renovation design for the vegetable market both the exterior environment and the interior space, which has successfully solved the problems of traditional markets and realized the transformation at the level of design.

#### 5.1.3 Community Library

Community libraries play an essential role in the daily life of the residents. Many old communities were remodeled to meet the development of modern society with improved functions.

When we look at the history of the public health crisis, we realize that the danger of virus transmission is hidden in public spaces. In order to avoid large-scale virus transmission, the design of public spaces, including community libraries, should be based on long-term prevention. In this thesis, firstly, a large amount of data about the community environment was first collected through observation, photography, and satellite maps. The online questionnaire was randomly distributed to the residents in Guangdong province, and the data (n=260) were investigated. Analysis of the data showed that 67.31% of respondents wanted a library in their community, and only 22.69% of the respondents related their community satisfaction as high, indicating that there is still much room for improvement in the community. The satellite map explained that the neighborhood was surrounded by commercial space, and the nearest library was far away. Therefore, in this thesis, part of the commercial space in the Lu-yang Ju community was transformed into a community library and related to the principles of epidemiology. Secondly, a new spatial layout was designed, including a public reading area, a single study room, a yoga room for selfhealing, a small academic conference room, and lounges. The overall layout of the floor plan provided for limited social distancing of 1 m to 2 m, but at least one meter, to prevent the virus transmission. The Chinese element and Zen culture were considered in the design of the community library, especially in the yoga room. People can find solace in the community library. The ceilings in the public reading area were decorated with scroll elements, and the space was filled with a lively cultural atmosphere. The spatial layout combines with different human behaviors, the public reading area set up different types of tables and chairs and has a variable

combination and kept at a certain distance, such as single high seat, single room seat, two opposite seats, three or four people in a group. The independent reading room can maintain privacy and play the role of virus isolation. To better understand the transformative effect of the community library, 2D and 3D software such as CAD, Photoshop, and Sketchup were used to draw floor plans, elevations, and 3D renderings.

The transformational design contributes to the safety of community libraries, reduces the specific rate of virus spread and meets the emotional needs of residents.

#### 5.1.3.1 Community Ventilation

This thesis studied natural ventilation in epidemiological insight for a designed concept of a community library. The epidemiological insight is mainly related to the prevention of virus transmission since the community library is a public space where many people are usually present. When designing the natural ventilation in this thesis, several types of windows were selected and connected with the orientation of the wall openings, which optimized the air quality in the community library and reduced airborne disease transmission.

Natural ventilation, as a necessary component of ventilation, was studied by simulating different types of windows with different opening ratios with the inlet velocity set at a fixed value suggested by other scientists based on their research studies. It is shown that window types with larger opening ratios corresponding to larger AHC values are more likely to meet the requirement of avoiding virus transmission, and the velocity inside the library room is also more significant for window types with larger opening ratios. This paper focuses on the ventilation of community libraries ventilation. According to the ASHRAE seven-point scale theory, people feel comfortable at an indoor temperature of about 23.3°C with natural ventilation. Otherwise, mechanical ventilation is required. Therefore, mechanical ventilation systems can be studied in further research.

#### 5.1.3.2 Community Library Furniture

In the context of public health crisis in which the number of sedentary people and the time they spend sitting has increased, this thesis proposes to design an automatic vibrating chair driven by an eccentric-and-Pitman drive system aimed at the care of sedentary people. The idea was developed using the double-diamond thinking design method, and the detailed design process was realized using biomimetic and industrial design methods. The final design is simulated and verified using SOLIDWORKS software. The vibrating chair is designed to be portable and automatically controlled by switches. The simulation results show that the vibrating chair for a 65 kg person can meet the design target with good motion characteristics and energy-saving properties. The design of a vibrating chair can be expanded in various aspects such as colors, materials, and application purposes, which in turn increases the application possibilities.

The design philosophy of the chair follows the automated vibration mechanisms, which are initially aimed at relieving physical pain, reducing other existing and potential health problems and preventing the worsening of existing health problems in sedentary people.

The design of the chair can be extended in various ways on the basis of the designs already shown. The vibrating chair can be further designed so that different colors and materials can be used to meet different customer needs. The possible uses can also be extended so that the market for the chair can be enlarged.

When expanding the extension design of colors, the vibrating chair can use the most popular colors of each year. In addition to a single color of the most popular colors, a combination of several types of the most popular colors as well as other colors can also be used. Different phases, brightness and purities of the colors can have different effects on the appearance of the vibrating chairs.

If you decide to extend the materials, you can match the upholstery fabric of the chair to the latest upholstery fabrics. Standard upholstery fabrics mainly include cotton fabrics, flannel fabrics, linen fabrics and blended fabrics. Each fabric gives people a different feeling and a different seating experience. Cotton fabric chairs have a soft texture with good air permeability, which gives people a comfortable feeling of softness. Flannel chairs are smooth and delicate and give a feeling of mercerization. Linen chairs, which have a stronger texture compared to other materials, can give a simple, restrained feeling. The blended chair has a soft and delicate touch and can create more fashionable changes. By focusing on expanding the purpose of application purpose, the application scenarios can be extended to other purposes that are not limited to sedentary people. The automatic vibrating chair can be used in ordinary families and places where the body needs physical relaxation, such as factory resting rooms, company offices and gymnasiums. The vibrating chair can even be placed in other places such as cafes, theme parks and shopping malls to attract more tourists or customers. The appearance should be designed to suit the users' preferences for leisure and entertainment.

In terms of relevance to industry, the potential applications are extensive and will contribute to the furniture and gym equipment industries. The eccentric and pitman drive will benefit enormously from the successful and widespread application of automatic vibrating chairs. The design method of the automatic vibrating chair in this thesis, using the double diamond design method and utilizes eccentric and pitman drives, can also serve as a reference for the design of other industrial products.

The comfortable, vibrating chair is still in the design phase and has not yet been fabricated into a tangible object. Moreover, the actual market response to the promotion of vibrating chairs for sedentary care and other purposes such as leisure and entertainment is still unknown. These can be investigated in the following studies.

1819

#### 5.1.3.3 Community Windows

Considering social health, the original three window shapes tested with the Flow Simulation module of SolidWorks as the optimal ventilation type are the most important formats for the design of new windows. In this thesis, the Ling-nan window culture, the intangible cultural heritage of the city, Feng Shui and the five elements were combined to design the new windows. The Jalousie window was equipped with mechanical devices, including an electric generator, a wireless switch and a remote control, so that the window could be opened and closed automatically from a distance. The single and double casement windows remained in manual mode. The new windows include pediments, window film with patterns and window frames. In the future, the windows can be designed in different patterns, colors, materials and opening modes. The control of humidity and wind rotation will be further explored.

#### 5.2 Contribution

#### 5.2.1 Solving the problems

1. A community has a dense population where people have a greater chance of coming into contact with each other, which brings a higher risk of infectious disease and even the onset of a public health crisis. Typical old communities are even worse at preventing airborne transmission of viruses, while the volumes of typical old communities are enormous. In this paper, a blueprint for the transformation of a typical old community with consideration of public health was made, which is a solution for the transformation of the old community. The study of this work is therefore of great social significance.

2. In this thesis, an overall plan of the whole community was presented with a series of functional facilities such as a main entrance, secondary entrance, a parking lot, a water pavilion, a swimming pool, an outdoor fitness park, etc. Moreover, two case studies of the community's vegetable market and library were conducted in detail as example of detailed design. The transformation design was based on a literature review, field research, and need of assessment of residents. All of this work ensured that the transformation design was sufficiently sensible and practical.

3. The transformation design strategy of the community has integrated various disciplines, including art, mechanical engineering, traditional Chinese philosophy, and local culture. Significantly, this study used 3D printing technology to create models for presentation, which is a method to utilize the latest technology of today. The post-transformation community is characterized by both the beauty of modern art and the function of public health prevention, which make people's lives more humane and enjoyable. The works in this paper provide a practicable and valuable method for designing visualization to update other urban communities with public health.

#### 5.2.2 A knowledge gap

1. The Ling-nan culture and Feng-shui and the five elements, as traditional knowledge, were adopted and integrated into design as a cultural icon that represents the local Identity value of Zhong-Shan city and distinguishes the community from other communities.

2. Knowledge, such as spatial distance, purified plants, engineering software simulations, ventilation analysis, sedentarization problems, and 3D printing, were adopted in the transformative design of the community.

#### 5.2.3 The confirmation of the findings

1. The methodology of "Macro-Meso-Micro" was proposed as a design method for community design (Fig.110).

2. The data collection framework, including safety space requirements and Ling-nan culture, was proposed, and the data collection supported the research in related fields (Fig.112).

3. The framework of this thesis's experiments on spatial distance, cross ventilation, and relief of sedentary muscle fatigue confirmed the idea of preventing public health crises (Fig.111).

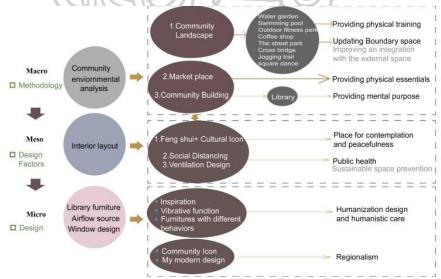
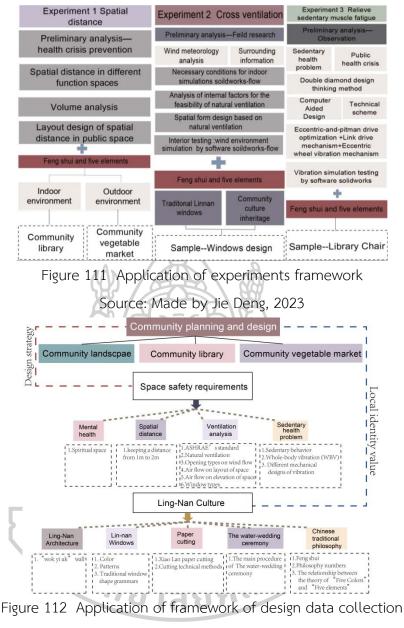


Figure 110 Application of flow chart Source: Made by Jie Deng, 2023



Source: Made by Jie Deng, 2024

### 5.3 Recommendations

#### 5.3.1 Professional field

Sustainable long-term prevention in hygienic public spaces has become especially significant. The development of effective methods for long-term prevention and the avoidance of cross-infection via the air in hygienic public spaces is a major problem. The community is a representative component of the hygienic public space, with the old communities falling are short in the prevention of public health crisis. The old community has problems such as disorganized layout, dilapidated facilities, outdated character, and less considered functions. The public space and facilities cannot meet the growing needs of community residents. According to preliminary statistics, there are nearly 160,000 old communities in China with more than 42 million households and a construction area of about 4 billion square meters. The transformation design of old communities hold enormous potential.

Based on the study of this thesis, it is recommended that the transformation design of the old community be examined more thoroughly and comprehensively. This thesis has investigated old communities and presented a visualization design for the transformation of an old community. However, the research works in this thesis are more out of the perspective of public health related to epidemic prevention. In today's fast-developing society, high-technology design theories such as green theory and human-artificial design should also be considered in the design of new communities, including the transformation of old communities.

#### 5.3.2 Education field

As a professional lecturer in the major of Art and Design, the researcher has applied design methods and experience to design teaching activities for undergraduate students. At the same time, the researcher continues to use in-depth research knowledge to promote design methods.

The researcher has participated in several academic conferences. In 2022, the researcher was invited as a moderator in the conference (FCIC 6), the 6th Friendly City International Conference organized by the Architecture Department, Universities Sumatera Utara, Medan-Indonesia. The researcher shared the article" Analysis transformational strategy of an urban vegetable market in the post-epidemic: A case study in Tan Zhou market in China" at this conference, and the article will be published in the AIP Publishing Journal Index Scopus. In 2023, the researcher attended the conference (CTMCD 2023 included computer technology, digital design, and innovative design, and discussed the new computer work technology) and shared a critical article titled "Creative Design of Automatic Vibrating Chair with Eccentric-and-Pitman Drive in Response to Caring for Sedentary People", and received the feedback from the professors of related fields which was beneficial for further

research. In 2023, the researcher participated in the conference (CMSDA 2023) and presented the paper "Research on Natural Ventilation of a Community Library Related to Epidemiological Insight by Using CFD Simulation Method," for which she received the feedback from specialists.

As a PhD candidate, four articles were accepted during the studies (Fig.115). The researcher has endeavored to complete PhD course. In 2023, the researcher was granted the Certificate of Policy Mission scholarship from Silpakorn University (Fig 116). The researcher investigated the topic "Development of Inclusive Furniture Design for Obese Adolescent School-children" in the first year of her Ph.D. and conducted in-depth research from 2022 to 2023. The researcher applied for more than 20 design patents for furniture design, and the Chinese government granted six patents for furniture design (Fig.117).

Based on the PhD candidate's experience in art design, the researcher recommends combining art design with actual social activities. However, as art design is a human discipline, it should be combined with other engineering disciplines, such as mechanical engineering, to solve social problems related to intellectual concepts. Moreover, a doctoral student of philosophy could achieve success in other disciplines besides philosophy while insisting on learning the subject of philosophy well.





Figure 113 FCIC 6 Conference





a. Paper accepted One, AIP Publishing (Index Scopus)





d. Paper accetped Four, Contemporary Social Sciences and Humanities (Index TCI 1)

Figure 115 Four Acceptance Letters

Source: Granted by Journals, 2022-2024



Figure 117 Six Design Patents

Source: Granted by the Chinese National Patent, 2022-2023

#### REFERENCES

- Aabø, S., & Audunson, R. (2012). Use of library space and the library as place. Library & information science research, 34(2), 138-149. doi:<u>https://doi.org/10.1016/j.lisr.2011.06.002</u>
- Aganovic, A. (2019). Airflow distribution for minimizing human exposure to airborne contaminants in healthcare facilities.
- Ahmed, I., Ahmad, M., & Jeon, G. (2021). Social distance monitoring framework using deep learning architecture to control infection transmission of COVID-19 pandemic. *Sustainable cities*

society

*69*, 102777.

- Alnazly, E., Khraisat, O. M., Al-Bashaireh, A. M., & Bryant, C. L. (2021). Anxiety, depression, stress, fear and social support during COVID-19 pandemic among Jordanian healthcare workers. *PloS* one, 16(3), e0247679. doi:<u>https://doi.org/10.1371/journal.pone.0247679</u>
- Alrebi, O. F., Obeidat, B., Abdallah, I. A., Darwish, E. F., & Amhamed, A. (2022). Airflow dynamics in an emergency department: A CFD simulation study to analyse COVID-19 dispersion. *Alexandria Engineering Journal*, 61(5), 3435-3445.
- ASHRAE. (2020). ASHRAE Position Document on Infectious Aerosols. Retrieved from https://www.ashrae.org/file%20library/about/position%20documents/pd\_infectiousaerosols\_202 0.pdf
- Atwa, S. M. H., Ibrahim, M. G., Saleh, A. M., & Murata, R. (2019). Development of sustainable landscape design guidelines for a green business park using virtual reality. *Sustainable Cities and Society*, 48, 101543.
- Authority, M. A. H. (2022). Interpretation of the Notice of the General Office of the National Health Commission on the issuance of Infection Prevention and Control Guidelines for Home Isolation and Medical Observation in the Prevention and control of novel Coronavirus Pneumonia (Trial). Retrieved

http://www.nhc.gov.cn/yzygj/s7659/202002/cf80b05048584f8da9b4a54871c44b26.shtml

- Aw, S. B., Teh, B. T., Ling, G. H. T., Leng, P. C., Chan, W. H., & Ahmad, M. H. (2021). The covid-19 pandemic situation in malaysia: Lessons learned from the perspective of population density. *International Journal of Environmental Research and Public Health*, 18(12), 6566.
- Begum, D., Roknuzzaman, M., & Shobhanee, M. E. (2022). Public libraries' responses to a global pandemic: Bangladesh perspectives. *IFLA journal*, 48(1), 174-188. doi:https://doi.org/10.1177/03400352211041138.
- Berche, P. (2022). Life and death of smallpox. La Presse Médicale, 51(3), 104117. doi:<u>https://doi.org/10.1016/j.lpm.2022.104117</u>
- Bhattacharyya, S., Dey, K., Paul, A. R., & Biswas, R. (2020). A novel CFD analysis to minimize the spread of COVID-19 virus in hospital isolation room. *Chaos, Solitons & Fractals, 139*, 110294.
- Bohannon, C. L. (2004). The urban catalyst concept. Virginia Tech,
- Brody, J. S. (2009). Constructing professional knowledge: The neighborhood unit concept in the community builders handbook: University of Illinois at Urbana-Champaign.
- Cai, Y., Yang, X., & Li, D. (2017). Micro-transformation": The renewal method of old urban community. *Urban Development Studies, 24*(04), 29-34.
- Campioli, S., & Peraboni, C. (2022). Diversity, community and participation: how Covid-19 has boosted the main issues of public space design. Paper presented at the Proceedings of the International Conference on Changing Cities V: Spatial, Design, Landscape, Heritage & Socio-Economic dimensions.
- Chandra, S., Kassens-Noor, E., Kuljanin, G., & Vertalka, J. (2013). A geographic analysis of population density thresholds in the influenza pandemic of 1918–19. *International journal of health geographics*, *12*, 1-10.
- Chang, Z. (1995). Ruhara Yoshiyoshi's theory of outer space. WORLD ARCHITECTURE(3), 72-75.
- Chen, C. s. (2009). The transformation and influence of reading space Friends of the editor(11), 61-63.
- Chen, J., Wang, Y., Xiao, R., & Zeng, X. (2018). Innovation And Practice Of The Micro Transformation Of The" Three Old" Community In Wuhan—A Example Of Shuiguohu Street Community Reconstruction Of Wuchang District. *Topics in Economics, Business and Management, 2*(1), 32-36.

- Chen, Y.-L., Chan, Y.-C., & Zhang, L.-P. (2021). Postural Variabilities Associated with the Most Comfortable Sitting Postures: A Preliminary Study. Paper presented at the Healthcare.
- Cho, J. (2019). Investigation on the contaminant distribution with improved ventilation system in hospital isolation rooms: Effect of supply and exhaust air diffuser configurations. *Applied thermal engineering*, 148, 208-218.
- Chong-Sheng. (2006). International cooperation Respond to infectious diseases and public health crises (Master). Shandong University,
- Clement, J., Maes, P., Ducoffre, G., Van Loock, F., & Van Ranst, M. (2008). Hantaviruses: underestimated respiratory viruses? *Clinical infectious diseases*, 46(3), 477-479. doi:https://doi.org/10.1086/524896
- Council, D. (2015). The design process: What is the double diamond. online] The Design Council. Available at: <u>https://www</u>. designcouncil. org. uk/news-opinion/design-process-what-doublediamond (Accessed 21.11. 2018).
- D'Amore, F., & Qiu, Y. (2021). Vibration Transmission at Seat Cushion and Sitting Comfort in Next-Generation Cars. Paper presented at the Congress of the International Ergonomics Association.
- Da-peng Li, Y. W., Yan Chen. (2012). Transformation Design of Public Park in Urban Historical Streets. Modern agricultural science and technology(15), 264-265. doi:007-5739(2010)15-0264-02
- Data, J. H. U. C. C.-. (2022). Daily new confirmed COVID-19 deaths per million people. Retrieved from https://ourworldindata.org/explorers/coronavirus-data-explorer
- Deng, J., Vongphantuset, J., Fang, L. & Cheng, W. (2024). Design of automatic vibrating chair witheccentric-and-pitman for prolonged sedentary activities. *New Design Ideas*(8(1)), 245-259. doi:https://doi.org/10.62476/ndi81245
- Department of Public Services, M. o. C. a. T. (2011). Guidelines on Epidemic Prevention and Control Measures for Public Libraries and Cultural Centers (Stations) (Revised November 2021). Retrieved from https://www.filib.net/zx/yqfk/202203/t20220314\_469368.htm
- Diamond, R., & Byrd, E. (2020). Standing up for health-improving mental wellbeing during COVID-19 isolation by reducing sedentary behaviour. *Journal of affective disorders*, 277, 232-234.
- Dickinson, M. H. (1999). Bionics: Biological insight into mechanical design. *Proceedings of the National* Academy of Sciences, 96(25), 14208-14209.
- Djongyang, N., Tchinda, R., & Njomo, D. (2010). Thermal comfort: A review paper. Renewable and sustainable energy reviews, 14(9), 2626-2640.
- Drees, K. H., Wenger, J. D., & Janu, G. (1992). Ventilation air flow measurement for ASHRAE Standard 62-1989. ASHRAE Journal (American Society of Heating, Refrigerating and Air-Conditioning Engineers); (United States), 34(10).
- Du, B. B., Bigelow, P. L., Wells, R. P., Davies, H. W., Hall, P., & Johnson, P. W. (2018). The impact of different seats and whole-body vibration exposures on truck driver vigilance and discomfort. *Ergonomics*, 61(4), 528-537.
- Ekelund, U., Brage, S., Froberg, K., Harro, M., Anderssen, S. A., Sardinha, L. B., . . . Andersen, L. B. (2006). TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS medicine*, 3(12), e488.
- Emmerich, S. J., Dols, W. S., & Axley, J. W. (2001). *Natural ventilation review and plan for design and analysis tools*: US Department of Commerce, Technology Administration, National Institute of ....
- Fattorini, L., Piccaro, G., Mustazzolu, A., & Giannoni, F. (2013). Targeting dormant bacilli to fight tuberculosis. *Mediterranean journal of hematology and infectious diseases*, 5(1). doi:10.4084/MJHID.2013.072
- Fears, J. R. (2004). The plague under Marcus Aurelius and the decline and fall of the Roman Empire. Infectious Disease Clinics, 18(1), 65-77. doi:<u>https://doi.org/10.1016/S0891-5520(03)00089-8</u>
- Fitzpatrick, K. M., Harris, C., & Drawve, G. (2020). Living in the midst of fear: Depressive symptomatology among US adults during the COVID-19 pandemic. *Depression and anxiety*, 37(10), 957-964. doi:<u>https://doi.org/10.1016/S0891-5520(03)00089-8</u>
- Fraser, C., Riley, S., Anderson, R. M., & Ferguson, N. M. (2004). Factors that make an infectious disease outbreak controllable. *Proceedings of the National Academy of Sciences*, 101(16), 6146-6151. doi:<u>https://doi.org/10.1073/pnas.0307506101</u>
- Fu, L. (2020). Research on Renewal Design of Beijing Old Community Public Space Based on Resident Demand (Master). Beijing forestry university,
- Gallè, F., Sabella, E. A., Ferracuti, S., De Giglio, O., Caggiano, G., Protano, C., . . . Liguori, G. (2020).

Sedentary behaviors and physical activity of Italian undergraduate students during lockdown at the time of COVID- 19 pandemic. *International Journal of Environmental Research and Public Health*, 17(17), 6171.

- Germani, M., Mandorli, F., Mengoni, M., & Raffaeli, R. (2010). CAD-based environment to bridge the gap between product design and tolerance control. *Precision Engineering*, 34(1), 7-15.
- Ghiaus, C., & Roulet, C.-A. (2012). Strategies for natural ventilation. In *Natural Ventilation in the Urban Environment* (pp. 136-157): Routledge.
- Goetz, C. G. (2009). Jean-Martin Charcot and his vibratory chair for Parkinson disease. *Neurology*, 73(6), 475-478.
- Gonzaga, V. (2022). Do Vibration Plates Work? An In-Depth Review Of The Research Supporting The Benefits Of Vibration Plates. Retrieved from <a href="https://the-unwinder.com/insights/do-vibration-plates-work/">https://the-unwinder.com/insights/do-vibration-plates-work/</a>
- Gray, L., Rose, S. B., Stanley, J., Zhang, J., Tassell-Matamua, N., Puloka, V., . . . Johnston, D. M. (2021). Factors influencing individual ability to follow physical distancing recommendations in Aotearoa New Zealand during the COVID-19 pandemic: a population survey. *Journal of the Royal Society* of New Zealand, 51(sup1), S107-S126. doi:<u>https://doi.org/10.1080/03036758.2021.1879179</u>
- Gustafsson, D. (2019). Analysing the Double diamond design process through research & implementation.
- Haddad, R. (2014). Research and methodology for interior designers. *Procedia-social and behavioral sciences*, 122, 283-291.
- Han, E., Tan, M. M. J., Turk, E., Sridhar, D., Leung, G. M., Shibuya, K., ... Hanefeld, J. (2020). Lessons learnt from easing COVID-19 restrictions: an analysis of countries and regions in Asia Pacific and Europe. *The Lancet*, 396(10261), 1525-1534. doi:https://doi.org/10.1080/03036758.2021.1879179
- Harrison, D. D., Harrison, S. O., Croft, A. C., Harrison, D. E., & Troyanovich, S. J. (1999). Sitting biomechanics part I: review of the literature. *Journal of manipulative and physiological* therapeutics, 22(9), 594-609.
- Hendrawati, D. (2021). Natural Ventilation Performance for Schools During a Pandemic and the Post-Pandemic COVID 19. Journal of Architectural Research and Design Studies, 5(2), 55-62.
- Hobday, R., & Dancer, S. (2013). Roles of sunlight and natural ventilation for controlling infection: historical and current perspectives. *Journal of hospital infection*, 84(4), 271-282. doi:https://doi.org/10.1016/j.jhin.2013.04.011
- Hsia, C.-J. (1998). Re-theorizing Public Space. Environmental Theory Arena, 5(1).
- Huang, X. (2013). *The Research On Windows to South of the Five Ridges in the Architecture*. (Master). South China University of Technology,
- Huo, G., & Guo, Q. (1995). Community Library. Library Journal of China, 21(4), 54-59.
- Jan, S. U. (2020). COVID-19 and preventive measures for libraries in Pakistan: A commentary. *Journal Of Medical Sciences*, *28*(3), 201-204. Retrieved from <u>https://jmedsci.com/index.php/Jmedsci/article/view/942</u>
- Jayaweera, M., Perera, H., Gunawardana, B., & Manatunge, J. (2020). Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy. *Environmental research*, 188, 109819.
- Jiang, L., Cheung, V., Westland, S., Rhodes, P. A., Shen, L., & Xu, L. (2020). The impact of color preference on adolescent children's choice of furniture. *Color Research & Application*, 45(4), 754-767. doi:<u>https://doi.org/10.1002/col.22507</u>
- Junior, W. K., & Guanabara, A. S. (2005). Methodology for product design based on the study of bionics. Materials & Design, 26(2), 149-155.
- JUST, N. L. (2014). SOLIDWORKS FLOW SIMULATION. LEA, 500, 3D.
- Kelly, J. (2006). The Great Mortality: an intimate history of the Black Death. Retrieved from http://hdl.handle.net/10822/976017
- Kim, S.-H., Kang, H.-J., & Moon, D.-H. (2013). Vibration transfer characteristic of foaming sponge seat with the auxiliary member for movie theater chair. *Journal of Power System Engineering*, 17(6), 40-46.
- Kong, J., Li, W., Hu, J., Zhao, S., Yue, T., Li, Z., & Xia, Y. (2022). The Safety of Cold-Chain Food in Post-COVID-19 Pandemic: Precaution and Quarantine. *Foods*

11(11), 1540.

Kretzman, J., & Rans, S. (2005). The engaged library: Chicago stories of community building. Evanston:

Northwestern University. In.

- Kudo, D., Sasaki, J., Ikeda, H., Shiino, Y., Shime, N., Mochizuki, T., . . . Lee, J. J. (2018). A survey on infection control in emergency departments in Japan. *Acute medicine & surgery*, 5(4), 374-379.
- Leinberger, C. B. (2005). *Turning around downtown: Twelve steps to revitalization*: Brookings Institution Center on Urban and Metropolitan Policy Washington, DC.
- Li, C.-g. (2017). Feng shui and the planning and construction of ancient architecture in China. *Chinese national architecture*, 38-55.
- Li, G. (2016). Research on innovational development mode of community Library *Library Theory and Practice*(1), 82-84.
- Li, J. (2022). Application of Auto CAD Technology in Interior Furniture Layout Art Design.
- Li, R., Richmond, P., & Roehner, B. M. (2018). Effect of population density on epidemics. *Physica A: Statistical Mechanics and its Applications, 510*, 713-724.
- Li, T. (2021). Research on spatial Transformation design of wholesale markets in post-epidemic era. (Master). Qingdao University of Technology,
- Li, X. (Ed.) (2010) Standard Dictionary of Modern Chinese. Beijing: Foreign Language Teaching and Research Press.
- Li, Z., Zheng, J., & Zhang, Y. (2019). Study on the layout of 15-minute community-life circle in third-tier cities based on POI: Baoding City of Hebei Province. *Engineering*, 11(9), 592-603. doi:doi:10.4236/eng.2019.119041
- Lian-fu Guo, J.-h. Z. (1992). Aesthetics of color: Shaanxi People's Fine Arts Publisher.
- Liao, J., Hu, M., Imm, K., Holmes, C. J., Zhu, J., Cao, C., & Yang, L. (2022). Association of daily sitting time and leisure-time physical activity with body fat among US adults. *Journal of Sport and Health Science*.
- Liao, Z. (1992). On the establishment of community library. Library World, 4, 4-8.
- Lim, M. A., & Pranata, R. (2020). The danger of sedentary lifestyle in diabetic and obese people during the COVID-19 pandemic. *Clinical Medicine Insights: Endocrinology and Diabetes, 13*, 1179551420964487.
- Liu, D.-B. (2020). Repetition and transcendence : Experience and lessons of epidemic prevention and control in world history. *Studies of international politics*(3), 26-32.
- Liu, K., Zhang, X., & Xu, D. (2023). Research on Community Fitness Spaces under the Guidance of the National Fitness Program. Sustainability, 15(17), 13273.
- Liu, X. (2016). Design of multi-functional public community vegetable market -- Case study of Tangjiawan vegetable market. (Master). Shanghai Normal University,
- Liu, Z. (2021). Research on the Inheritance and Innovation of Folk of "Doumen Water Wedding" in Zhuhai. Proceedings of the 2020 International Conference on Language, Communication and Culture Studies (ICLCCS 2020): Conference Proceedings.
- Lu Zhou, F. Z. (2023). Research on the practicial micro-transformation of Old Communities in the postepidemic era -- A case study of Nanguan Community. *Planners*, 488-496. doi:10.26914/c.cnkihy.2023.040995
- Luo, Z.-w., & Luo, Z.-z. (2008). Planning and creation of ancient Feng shui architecture in China. *Ancient* gardening technology(2), 10-16.
- Lynch, K. (1995). City sense and city design: writings and projects of Kevin Lynch: MIT press.
- MA, Z., HU, J., LI, D., WANG, K., ZHANG, J., ZHU, Y., ... XU, Y. (2008). Administrant & Technical practice for markets of agricultural products. Retrieved from <a href="http://ltfzs.mofcom.gov.cn/article/rdzx/202110/20211003208557.shtml">http://ltfzs.mofcom.gov.cn/article/rdzx/202110/20211003208557.shtml</a>
- Malaktou, E., Philokyprou, M., Michael, A., & Savvides, A. (2016). Environmental behavior of semiopen spaces in Mediterranean vernacular architecture. The case of rural traditional dwellings of Cyprus. *Renew Energy Power Qual J*, 14, 599-604.
- Memarzadeh, F., & Xu, W. (2012). Role of air changes per hour (ACH) in possible transmission of airborne infections. Paper presented at the Building simulation.
- Mendell, M. J., Fisk, W. J., Kreiss, K., Levin, H., Alexander, D., Cain, W. S., . . . Milton, D. K. (2002). Improving the health of workers in indoor environments: priority research needs for a national occupational research agenda. *American journal of public health*, 92(9), 1430-1440. doi:https://doi.org/10.2105/AJPH.92.9.1430
- Metnitz, P. G., Metnitz, B., Moreno, R. P., Bauer, P., Sorbo, L. D., Hoermann, C., . . . Investigators, S. (2009). Epidemiology of mechanical ventilation: analysis of the SAPS 3 database. *Intensive care medicine*, 35, 816-825.

- Milanese, C., Cavedon, V., Sandri, M., Tam, E., Piscitelli, F., Boschi, F., & Zancanaro, C. (2018). Metabolic effect of bodyweight whole-body vibration in a 20-min exercise session: A crossover study using verified vibration stimulus. *PloS one, 13*(1), e0192046.
- Mohajer, N., Abdi, H., Nahavandi, S., & Nelson, K. (2017). Directional and sectional ride comfort estimation using an integrated human biomechanical-seat foam model. *Journal of Sound and Vibration*, 403, 38-58.
- Nembhard, M. D., Burton, D. J., & Cohen, J. M. (2020). Ventilation use in nonmedical settings during COVID-19: Cleaning protocol, maintenance, and recommendations. *Toxicology and industrial health*, 36(9), 644-653.
- Nicol, F., & Raja, I. (1997). Modelling temperature and human behaviour in buildings. *IBPS News*, 9(1), 8-11.
- Nordh, H., & Østby, K. (2013). Pocket parks for people-A study of park design and use. Urban forestry & urban greening, 12(1), 12-17.
- Organization, W. H. (2008). Implementing the WHO Stop TB Strategy: a handbook for national tuberculosis control programmes: World Health Organization.
- Organization, W. H. (2020). Modes of transmission of virus causing COVID-19: Implications for IPC precaution recommendations. Retrieved from <u>https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations</u>
- Owen, N., Healy, G., Matthews, C., & Dunstan, D. (2010). The population health science of sedentary behavior: too much sitting. *Exerc Sport Sci Rev, 38*, 105-113.
- Pan, H. (2018). Research on spatial layout of urban vegetable market in the "Internet+"
- Pan, J. a. M. G. (2020). Analysis of the impact of COVID-19 on agricultural products circulation. Business economics research, pp. 155-157.
- Pardee, P. E., Norman, G. J., Lustig, R. H., Preud'homme, D., & Schwimmer, J. B. (2007). Television viewing and hypertension in obese children. *American journal of preventive medicine*, 33(6), 439-443.
- Park, S., Choi, Y., Song, D., & Kim, E. K. (2021). Natural ventilation strategy and related issues to prevent coronavirus disease 2019 (COVID-19) airborne transmission in a school building. *Science of the total environment*, 789, 147764.
- Peng, D.-d. (2023). Landscape renovation design of old community based on the perspective of infectious disease prevention and control -- A case study of Nanyuan Garden in Nanchang City. (Master). Agricultural university of jiangxi,
- Peterson, P. K. (2020). Microbes: The Life-changing Story of Germs: Rowman & Littlefield.
- Petsko, G. A. (2005). H5N1. Genome Biology, 6(11), 1-4. doi:https://doi.org/10.1186/gb-2005-6-11-121
- Planchard, D. (2017). SOLIDWORKS 2017 reference guide: Sdc Publications.
- Popa, L. I., & Popa, V. N. (2017). *Products eco-sustainability analysis using CAD SolidWorks software*. Paper presented at the MATEC Web of Conferences.
- Primack, B. A., Swanier, B., Georgiopoulos, A. M., Land, S. R., & Fine, M. J. (2009). Association between media use in adolescence and depression in young adulthood: a longitudinal study. *Archives of general psychiatry*, 66(2), 181-188.
- Ramos, T., Dedesko, S., Siegel, J. A., Gilbert, J. A., & Stephens, B. (2015). Spatial and temporal variations in indoor environmental conditions, human occupancy, and operational characteristics in a new hospital building. *PloS one*, 10(3), e0118207.
- Ricci, F., Izzicupo, P., Moscucci, F., Sciomer, S., Maffei, S., Di Baldassarre, A., . . . Gallina, S. (2020). Recommendations for physical inactivity and sedentary behavior during the coronavirus disease (COVID-19) pandemic. *Frontiers in public health*, 8, 199.
- Rizi, S. E. M. (2015). Airborne infection in healthcare environments: Implications to hospital corridor design: The University of Nebraska-Lincoln.
- Rocklöv, J., & Sjödin, H. (2020). High population densities catalyse the spread of COVID-19. *Journal of travel medicine*, 27(3), taaa038.
- Salimath, S., & Tuljapure, S. (2023). Design of vibrating chair to introduce limited fatigue to reduce insomnia. *Materials Today: Proceedings*, 72, 1624-1630.
- Schneider, I. E., Wynveen, C. J., Wolfson, J., Shinew, K., Stein, T., Hendricks, W. W., . . . Budruk, M. (2023). Cases and context: Mask-related behaviors among US trail visitors during the COVID-19 pandemic. *Journal of Outdoor Recreation and Tourism*, 41, 100494. doi:https://doi.org/10.1016/j.jort.2022.100494

Talen, E. (2010). The spatial logic of parks. Journal of Urban Design, 15(4), 473-491.

- Tao, H.-g. (2020). Research on the Spatial Form of Nantang Ancient Village, Zhongshan City, Guangdong Province. (Master). Guangdong University of Technology,
- Tao, M.-Q. (2023). A study on the vitality remodeling of public space in old communities under the background of normal epidemic situation: A case study of Cuiyuan District in Hangzhou. (Master). East China Normal University,
- Tiao, X. (2019). Research Status and Path Analysis of the Academic Libraries Participating in Public Cultural Service in Recent Ten Years. *Library and Information Service*, 63(9), 5. Retrieved from https://www.lis.ac.cn/CN/0252-3116/home.shtml
- Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. *Applied physiology, nutrition, and metabolism, 35*(6), 725-740.
- Tschimmel, K. (2012). *Design Thinking as an effective Toolkit for Innovation*. Paper presented at the ISPIM Conference Proceedings.
- Underwood, D., & Sims, R. (2019). Do office workers adjust their chairs? End-user knowledge, use and barriers to chair adjustment. *Applied Ergonomics*, 77, 100-106.
- Wagner, A., & Reifegerste, D. (2022). From Black Death to COVID-19: The mediated dissemination of fear in pandemic times. *Media and the Dissemination of Fear: Pandemics, Wars and Political Intimidation*, 19-41. doi:https://doi.org/10.1007/978-3-030-84989-4\_2
- Wikipedia. (2009). Community. Retrieved from <u>http://en.wikipedia.org/w/index.php?title=Community&oldid=273343710</u>
- Wu, Y., Chen, Z., & Chen, J. (2021). Historical Memory and Resident's Suffering Consciousnes: The LongTerm Impact of SARS on Preventing COVID-19. Industrial Economic Review, 3, 19-33.
- Wunsch, H. (2020). Mechanical ventilation in COVID-19: interpreting the current epidemiology. In (Vol. 202, pp. 1-4): American Thoracic Society.
- Wunsch, H., Linde-Zwirble, W. T., Angus, D. C., Hartman, M. E., Milbrandt, E. B., & Kahn, J. M. (2010). The epidemiology of mechanical ventilation use in the United States. *Critical care medicine*, 38(10), 1947-1953.
- Xinhua. (2020). Fighting COVID-19: China in Action. Retrieved from http://english.scio.gov.en/whitepapers/2020-06/07/content 76135269 3.htm.
- Xu, H. (2021). Green Design of Community Public Space in the Context of the COVID-19 Epidemic. Paper presented at the International Conference on Applied Human Factors and Ergonomics.
- Xu, Y.-. (2022). The long queue of readers at the entrance of Wuhan Library is spectacular. Retrieved from https://www.toutiao.com/article/7134999327155421709/?source=seo\_tt\_juhe
- Yang, L. (2021). Study on spatial layout of residential community in central urban area of Hejin. (Master). Xian building university of science and technology,
- Ying-ying Song, X. H., Yao Xiong, Xiao-meng Liu (2023). Research on community spatial response strategy based on sudden respiratory infectious diseases. Urban safety and disaster prevention planning, 402-417. doi:10.26914/c.cnkihy.2023.042801
- Ying, K. (2018). Research on the design of Complex community vegetable market *Henan Building Materials*(2), 351-352.
- You, Y., Liu, G., & Liu, L. (2022). Art Design Method of Interior Space Layout Based on CAD Drawing. doi:https://doi.org/10.14733/cadaps.2022.S8.44-54
- Yu, W.-b. (2005). Research on the planning theory and method of urban community (PHD). Zhejiang University
- Yuancheng, M. (2023). Research on the Transformation of Community Space in the Post-Pandemic based on Metabolism Talks. (Master). GUANGZHOU UNIVERSITY,
- Zhang, N., Fard, M., Bhuiyan, M., Verhagen, D., Azari, M., & Robinson, S. (2018). The effects of physical vibration on heart rate variability as a measure of drowsiness. *Ergonomics*, 61(9), 1259-1272.
- Zhang, R.-r. (2018). Research on the Methodology of Space Design for Open Community. CAFA(Central Academy of Fine Arts),
- Zhou, S.-J., Zhang, L.-G., Wang, L.-L., Guo, Z.-C., Wang, J.-Q., Chen, J.-C., . . . Chen, J.-X. (2020). Prevalence and socio-demographic correlates of psychological health problems in Chinese adolescents during the outbreak of COVID-19. *European child & adolescent psychiatry*, 29, 749-758. doi:https://doi.org/10.1007/s00787-020-01541-4



# VITA

NAME	Jie Deng	
INSTITUTIONS ATTENDED	2008-2012 Bachler of Environmental Art and Design,	
	Guangdong University of Petrochemical Technology,	
	China.	
	2012-2015 Master of Design and Arts, Shenzhen University,	
	China.	
	2021-2024 Entered the Doctor of Philosophy Design Arts	
(j	International Program at Silpakorn University, Thailand.	
	1. Transformational Strategy of Community Library Related	
	to Epidemiological Insights:A Case Study in China, Journal	
	of contemporary social sciences and humanities,TCI	
	1,2024.03 (1st);	
S. E. W.	2. Design of Automatic Vibrative Chair with Eccentric-and-	
	Pitman for Prolonged Sedentary Activities, Journal New	
	Design Idea, Scopus Q1, 2023.03 (1st);	
	3.Analysis transformational strategy of urban vegetable	
4-13-73	market in the post-epidemic A case study in Tan Zhou	
~73	market in China, Journal AIP publishing, Scopus, 2022.08	
	(1st);	
	4.Research on Natural Ventilation of a Community Library	
	Related to Epidemiological Insight by Using CFD	
	Simulation Method, Conference Proceedings, EI/	
	Scopus,2023.08(1st);	
AWARD RECEIVED	1. The Sculpture "Endless" exhibited in National small fine	
	Art Exhibition, Exhibition Department of National Art	
	Museum of China, 2022.12;	
	2.The Sculpture "Jingwei" was selected into the "5th	
	Guangdong-Hong Kong-Macao Greater Bay Area School Art	

Works & 7th Guangdong Provincial University Art Works Academy Award Biennale" sponsored by Guangdong Provincial Department of Education, and won the first prize, Guangdong Provincial Department of Education, 2022.12 (Top 3);

3. The Sculpture "FUSHION" exhibited in Bangkok Design Week, 2022.3 (1st).

4.Design "Floating Lotus" exhibited in "The city of the river" project of Thai University of Arts and Florence University of Arts, Italy, International level, 2022.9 (1st).

5.National design patent "Table (acrylic water drop)" has been approved: patent No. ZL202230481744.5, National Patent Office, July 2022.

6.National design patent "Display frame (shaped surface)", has been approved: Patent No. ZL 2022 3 0702417.8, National Patent Office, October 2022.

7.National design patent "Chair (shell) " has been approved: Patent No. ZL 2022 3 0703078.5 "State Patent 4277 Office, October 2022.

8.National design patent "Exhibition Cabinet (push-pull type)" has been approved: Patent No. ZL 2022 3 0713422.9, State Patent Office, October 2022.

9.National Design patent "Dining Table (Wok ear House)" approved: Patent No. ZL202230444681.6, National Patent Office, July 2022.

10.National Design Patent "Exhibition Case (Wok ear wall)" approved: Patent No. ZL202230703077.0, National Patent Office, October 2022.