

Effects of COVID-19 on Sustainability of Residential Spaces and Communities

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Abstract. The effect of the pandemic on residential spaces and communities is a popular topic around the world. And some researchers found out that sustainable development in the living spaces is also affected, while the extent and the specific changes still lack explanation. Therefore, the theme of this article is to explore and assess the effects of COVID-19 on sustainability in residential spaces and communities. In order to get the result, the data were collected from questionnaires mainly from Jiangxi and Guangdong. After that, seven different interviews were conducted with different groups of people in these two places. Finally, these two sets of data were compared and analyzed and it can be found that the public now has more enormous expectations of the usage of existing resources and that they have made some changes simultaneously in order to respond to the current situation. Therefore, on the basis of people's expectations, the following suggestion is proposed to further improve their quality of life, including public parks, garbage classification, delivery lockers with monitors or purifiers, temporary buffering areas, multi-function areas, and entertainment areas. The purpose of previous suggestions is to hope that people can get relevant inspiration through these points, so as to better cope with the current global crisis.

Keywords: COVID-19, Sustainability, Residential Spaces, Communities, Pandemic.

1. Introduction

Pandemics such as the 1918 "Spanish flu", the 1957 "Asian Flu" and the 1968 "Hong Kong flu", each of which caused great damage to global public health and the economy, meanwhile, become even more serious [1]. After the COVID-19 outbreak in 2019, on average, 82% of the extra deaths (the number of deaths that exceeded expectations) in U.S. counties in 2020 were due to COVID-19 [2]. And therefore, the first and the most efficient way to prevent further infection of the epidemic is to quarantine, which means staying at home all day. However, today's houses, apartments, and complexes don't have the design that is suitable for pandemic conditions, since it is not hygienic and pandemic is not considered during the design period. Contrary to public expectations, the virus that has withstood the quarantine in the shelter is starting to have some serious health and psychological effects. It is vital to reconsider the inclusion of some applications and others from a health standpoint, to reduce unnecessary interaction among the masses from a social standpoint and the pressures that isolation puts on people through the appropriate housing design from a psychological perspective [3].

Sustainable development refers to a development model through which resources are utilized to meet human needs while protecting the environment so that these needs are met not only now, but for future generations. The debate on sustainability dates back to the eighteenth century. It was revived after the publication of the Brundtland report "Our Common Future" and the UNCED in Rio de Janeiro. Sustainability has three main pillars, including, social sustainability, environmental sustainability, and economic sustainability. First, social sustainability refers to the ability of a social system, such as a state, family, or company, to function at a defined level of social welfare. Issues like war, poverty, inequality and low levels of education all represent an unsustainable society. Environmental sustainability refers to the ability of the environment to support a certain level of environmental quality and resource extraction rates unlimitedly. The last one is economic

sustainability. It refers to the ability of an economy to support a certain amount of economic production without limit [4].

The COVID-19 pandemic and resulting economic fallout caused significant hardship. The consequences of the pandemic have affected people's requirements for their living communities and their expectations of housing, and previously unified considerations of houses, such as appearance, and location, have been transformed into some particular considerations of the practicality and flexibility of houses. The following analysis of the effects of COVID-19 on sustainable development in residential spaces and communities provides professional insights into how residents assess the functionality and usability of housing, which can help in future discussions on how to respond to the existing spaces and communities in order to make sustainable contributions.

In this article, the effect of COVID-19 on sustainable development in residential spaces and communities through interviews with house owners, real estate agencies, and after-sales staff are assessed; archival research on the internet and analysis the data collected from questionnaires or other sources.

2. Methodology

2.1 Interviews

Seven different interviews were done in order to collect enough information needed for analysis, including the interview with house owners, real estate agencies, and after-sales staff and local communities' authorities to have better understanding of how residential spaces and communities' function and design have changed to adopt the COVID-19 in a sustainable or unsustainable way. And the reason why we found those interviewees and companies is because they are the people surrounding us and meanwhile, they also have some changes that have taken place, so we can know and find out their demand and expectations better.

Firstly, in the interview with house owners, we basically asked questions about what they want and have changed the functions or design of their houses. The first house owner is Liu Xiaorong, who is now 41 years old and she is an administrative teacher at a university; due to the strict lockdown in 2020, she had increased the demand for tables and bathrooms, in order to be more convenient during that time.

Another house owner is Xiong Yiwen, who is now 37 years old and is a civil servant. She has 4 members in her family; she bought a lot of epidemic prevention products like masks, and a treadmill to lose weight. Moreover, she added two tables in the bedrooms to improve the working and studying quality, since they only have a large table outside, which is not convenient for them during the lockdown period when everyone needs to work or study at home.

The next one is the interview with a real estate agency and after-sales staff. Bi Hai Long Wan is a housing estate in Jiujiang. There are also some changes in the expectations of the functions.

For the interview with local communities' authorities in Nanchang, the communities in both Qingshanghu district and Xihu district have no large changes in facilities, but some changes in the system, rules, and some sorts of services that are provided in the communities.

In contrast, the Baoan and Futian districts in Shenzhen have done much better work on COVID prevention compared with Nanchang's communities.

2.2 Questionnaires

A questionnaire survey is a kind of liberalized response. The form of expression of survey questions, the order of questioning, and the way and method of answering are not likely to allow respondents to put their own subjectivity and preference into the survey research, so as to ensure the authenticity and accuracy of the entire research. By making a questionnaire, the crowd can be divided into hidden classifications, such as different living locations, through different questions, which can make the subsequent analysis more detailed and organized. In addition, by putting a large number of questionnaires on the Internet and familiar people around this time, this opportunity can make the

results of the entire research and analysis of the questionnaires more convincing. In this questionnaire, the questions are divided into two categories as shown in Table 1. The first category is for the changes that people enjoy or have made under the current pandemic background. The second category is to ask about the sources and needs that people expect after experiencing the pandemic or the lockdown period. The survey was collected through an online questionnaire with the nearby neighborhood. Online questionnaires were distributed through social media and compared according to the total number of people.

Table 1 Contents of questionnaire

No.1	Question	Where do you live?
	Choices	A: Jiangxi, B: Guangdong, C: Others
No.2	Question	Changes you've made to your home during the pandemic
	Choices	A: Add fitness equipment, B: Plant green plants (vegetables) on the balcony, C: Purifier, D: Disinfection facilities/tools, E: Desks and other study or work supplies, F: Bathroom (add a toilet), G: Others
No.3	Question	Changes you want to make to your home during the pandemic
	Answer	
No.4	Question	Does your community use public areas such as squares or parking lots for covid testing?
	Choices	A: Yes, B: No
No.5	Question	If you have the opportunity to change houses, do you want a large shopping mall in your neighborhood
	Choices	A: Yes, B: No
No.6	Question	If you have the opportunity to change houses, do you hope that the community you live in has supporting kindergartens and primary schools with good educational resources.
	Choices	A: Yes, B: No
No.7	Question	If you have the opportunity to change houses, do you consider the house you live in has a roof garden
	Choices	A: Yes, B: No
No.8	Question	What would your ideal home look like after the pandemic?
	Answer	
No.9	Question	Is there a trash can for throwing masks alone in the community?
	Choices	A: Yes, B: No
No.10	Question	Do you think the use of community resources before the pandemic is more reasonable or the use of community resources is more reasonable now?
	Choices	A: Before the pandemic, B: After the pandemic
No.11	Question	Whether the epidemic prevention and control in your community makes reasonable use of digital technology applications such as data base, 5G transmission, etc., to improve community governance capabilities (such as health codes)?
	Choices	A: Yes, B: No
No.12	Question	If the houses pandemic prevention and control of your community has made reasonable use of digital technology applications such as data base, 5G transmission, etc., to improve community governance capabilities, please list the high technology used.
	Answer	

3. Results

3.1 Interviews Analysis

For the first interviewee, we design a new housing structure for her based on the original blueprint of her house. Figure 1 is the original design and functions of the house, and Figure 2 is the new blueprint that drew based on the changes and expectations of Liu Xiaorong. The yellow circle is the new table added for her younger son in the living room because her daughter is using the desk in the study room, but the younger brother also needs to take online classes, thus she adds one more table in the living room, which is also more convenient for parents to supervise him. Also, the red circle is the bathroom that Ms. Liu wants to add since there are four members in her family, sometimes grandparents also come to live, especially during the epidemic when everyone needs to stay at home, and the bathroom is sometimes not enough.

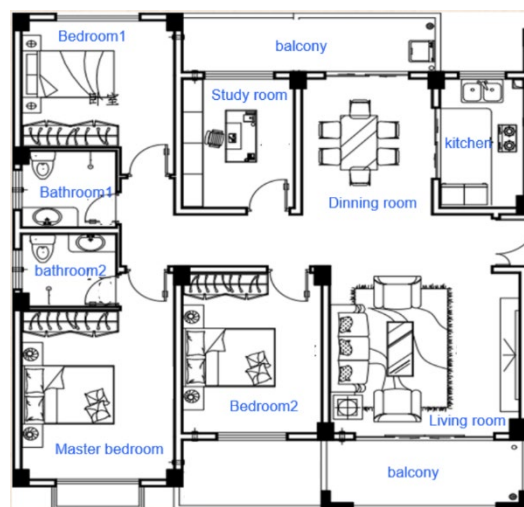


Figure 1. Blueprint of original housing structure

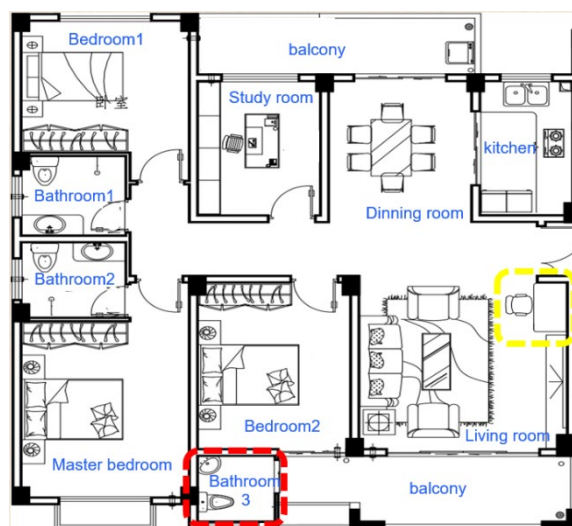


Figure 2. Blueprint of new housing structure

And for the second interviewee, according to her expectations of changing we also make a new design of her house based on the original structure of the house. Figure 3 shows the original blueprint of her house, and Figure 4 is the new blueprint that drew based on the changes and expectations of Xiong Yiwen.

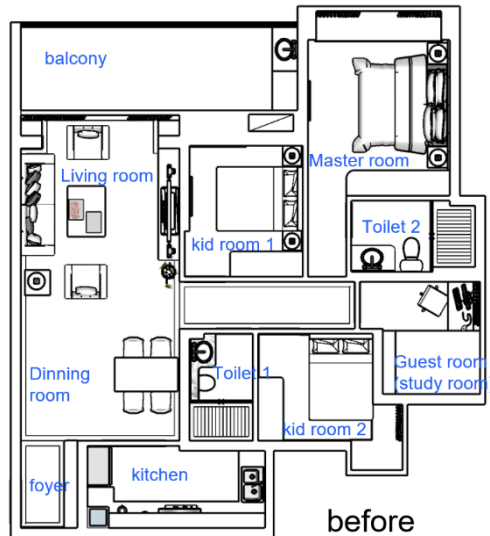


Figure 3. Blueprint of original housing structure

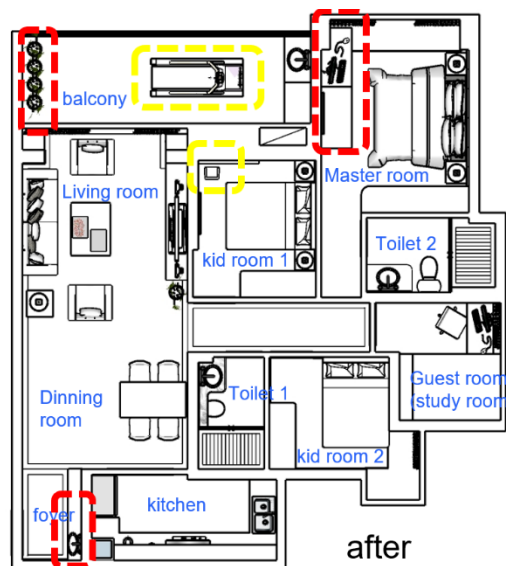


Figure 4. Blueprint of new housing structure

For the interview with the real estate agency, the result was that when the residents bought a house before, they just wanted to go downstairs to the public activity area of the community to relax. However, now during the epidemic, everyone is in the lockdown situation and must spend more time at home, and then they hope to have activity space, leisure space, etc. at home to help them kill time and have a better living standard during the lockdown period.

The communities in Xihu district Nanchang added disabled access and warmth to the service and provided a “365 community no-closing hours” for convenient services, which not only satisfy the special demand for residents but also enhance the relationship between the community and residents. Moreover, the community in Qingshanhu district developed some sustainable amenities, like waste separation bins and hand-washing sinks, as well as low-cost water purification equipment, which is placed in the square for the convenience of the owners. In addition, the real estate staffs even provide some educational courses for the tenements to gain a better understanding of COVID-19 and environment protection and thus increase residents’ awareness.

For the communities in Shenzhen. For example, they have placed a lot of disinfection areas. When everyone was in the lockdown period, they even wrapped the inside of the elevator with plastic paper to carry out corresponding inspection and disinfection. After the lockdown period during the pandemic, they have placed some covid testing areas near other streets but considering that there are many

construction sites around the community and the needs of the surrounding residents, they have added a covid testing place inside the community with limited time accounting, which largely increases the convenience of residents. Moreover, they updated the express lockers beside the gate, which now have the functions of a temperature monitor to check everyone's in and out, which is a sustainable way to use the resources efficiently. Similarly, in the Futian district, they have placed a special place for covid testing. In addition, some people need to be quarantined at home. they also provide residents with indoor covid testing according to the relative announcement. Furthermore, due to the reason that many residents purchased some spare supplies and express delivery for themselves during the quarantine period, so they have equipped special express delivery racks to store the sterilized express delivery, which reduces the inconvenience of can't purchase daily needs significantly.

3.2 Data Analysis

Jiangxi and Guangdong are two provinces in China. By comparing two different provinces, we can understand the differences between different cities' relative policies during the pandemic.

First, through the first question, the provinces and regions with a total of 193 respondents can be distinguished, of which 110 are from Jiangxi, 71 are from Guangdong, and the rest are from other cities or provinces that are excluded in the following analysis. Both data are greater than or equal to 50, so these samples can be used to illustrate the total population.

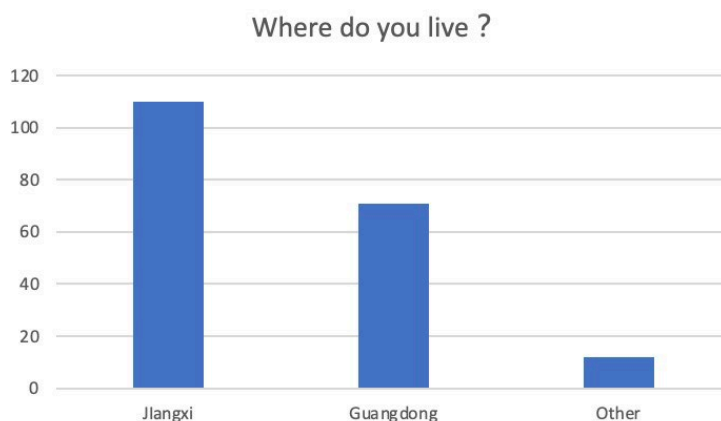


Figure 5. Source of Data

Regarding the second question, "renovations you have made or want to make in your home during the pandemic", the number one option in Guangdong is to increase disinfection facilities, accounting for 59.15% of the total, and the second is to increase fitness equipment, accounting for 52.11%. The first choice of Jiangxi is to increase fitness equipment, accounting for 47.27% of the total number of people, and the second is to increase green plants, accounting for 36.11%. And in the opening question in the questionnaire "During the pandemic, you have done or want to do renovations to your housing", the majority of respondents from both sides have added more usage to the existing functions of the house, such as planting flowers and plants, or adding other recreational facilities.

In the fourth, fifth, and sixth questions, people were asked about their expectations and needs for ideal community resources, including covid testing areas, large shopping malls, kindergartens and primary schools with good educational resources, and roof gardens. The answers from people in two cities are overwhelming need. In the opening question in the questionnaire "what is your ideal house like after the pandemic", in order to ask and understand the requirements and expectations of residents for the community and housing, both of which are almost all-around larger housing spaces and more advanced facilities.

In Jiangxi, regarding the use of existing pandemic prevention resources and community areas, such as trash cans for throwing masks, the proportion of the two answers is approximately half and half. Compared to Guangdong, although there is no special trash can in Guangdong, 71.83% of respondents, 51 people, believe that the current use of community resources is more reasonable in the questionnaire. Therefore, as to whether the community's pandemic prevention and management can reasonably use digital technology applications to improve community governance capabilities, most of the respondents in the two cities answered "yes". With the collection on the use of existing digital technology applications in the two cities, the answers of the two cities contained the most health codes and temperature detection.

For the highly developed and advanced cities like Shenzhen and Liaoning, the sustainability was not that significant increased during the pandemic period, because they already have many advanced and high-tech facilities like 5G, smart city, and cloud computing, which can be used immediately after the COVID-19 exist [5].

4. Discussion

According to the methodology and results, we found some problems and immediate needs during COVID-19 in the community and residential spaces. Therefore, we have some suggestions about that. Firstly, the communities can build a public park inside of it, because it not only can help the residents to relax and talk a walk but also can reduce the carbon emission inside the community to purify the air naturally. For example, the Parc de la Distance in Vienna designed by Studio Precht provides safe social distancing during the pandemic and creates temporary solitude after the epidemic. In addition, inside the residential spaces, before construction, the designer needs to think about providing multi-function spaces to increase the practicality of the housing, since most people need to work or study at home during the lockdown situation and people can't predict when it will happen. So, the existence of multi-function spaces is important. Like the shared spaces such as dining areas are also used for multiple purposes, such as temporary study areas, family meals, and so on [6]. Moreover, community authorities can use some facilities to divide the public space, thus this can ensure the normal interpersonal socialization and the social distance at the same time. For instance, the "Here Comes the Sun" designed by Paul Cocksedge, which can make sure people stay a safe distance of two meters in social situations, such as picnics or sunbathing [7]. Furthermore, communities can provide a public water purifier to help the residents who don't have or no enough purified or safe water to drink during the lockdown period with a low payment being made since people hardly went out or even can't go out. For example, the water purifier installed in Qingshanhu district in Nanchang, which five liters of water cost only one yuan.

When people suffer from a long-term lockdown period and pandemic, due to some requirements stipulated in the prevention policy, people lose certain opportunities to go out and enjoy the entertainment [8]. With this opportunity, in order to make the house with a variety of functions and to meet people's satisfaction that can be fulfilled the concerns caused by the pandemic, the house can add some diversified areas, including the fitness areas, greenery areas or entertainment areas for people [9]. In addition, the buffering space should be added to every room to cope with emergencies and pandemics as well. When this temporary space is incorporated into a dwelling, people entering or leaving the building can be disinfected in this buffer space that has been installed at the entrance or near the shoe racks to prevent the spread of bacteria. This buffer space can also reduce the extra socialization entering the home, such as the resident order delivery and the need for a delivery courier to come to the door [6]. With some assumptions, when someone is infected with the bacteria, this area can be used as an emergency isolation area to ensure the safety of the remaining residents and to keep the required social distancing by the relative policy. Another strategy is garbage sorting, which can reduce the spread of viruses brought about by environmental pollution, especially in the context of this epidemic, the awareness of environmental protection has reached a peak. In addition, effective garbage

can also reduce the footprint of garbage, so that people or relevant departments can make better use of existing public areas. The last strategy is to install the delivery lockers with the monitors. When the pandemic comes, people often buy a variety of resources to maintain their normal quality of life, so installing a delivery locker in the community can ensure the transportation of logistics and people's satisfaction with these items. Such facility is necessary to install a camera or a monitor to supervise the corresponding transportation, so as to ensure that everyone can get their own supplies [10].

5. Conclusion

This study found that the effects of COVID-19 on sustainable development really depend on the development level of the city. For the highly developed and advanced cities, sustainability was not that significantly increased during the pandemic period. However, for cities that are less developed like Nanchang, with very few resources and facilities available before the COVID, have experienced a dramatic change. As the effects of Covid-19 become increasingly severe on humanity and society, individuals are beginning to feel obligated to preserve their standard of living and quality of life. From the standpoint of the community and their own houses, it is inevitable that they will adopt their relevant pandemic strategies step by step. The current situation is to convince individuals to make some practical transformations and modifications in reality. However, people's prior levels are insufficient to completely eliminate the dilemma caused by the pandemic, and existing resources cannot meet all of the people's needs, so the article mentions some suggestions for existing situations, such as public parks, garbage classification, delivery lockers with monitors or purifiers to maintain sustainable development in communities; as well as temporary buffering areas, multi-function areas, and entertainment areas. As mentioned in this research literature, the impact of the pandemic on sustainable development can be large or small based on the development level of the area, but this is only at the present stage. In the future, the above-related variables can be further refined to facilitate the in-depth study of this topic.

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