

## Analysis of Vulnerability to Covid-19 Transmission based on Building Function at Padukuhan Mancasan Kleben, Pandowoharjo, Sleman, Yogyakarta, Indonesia

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**Abstract.** The Coronavirus (COVID-19) pandemic is currently a concern in all parts of the world, including Indonesia. Yogyakarta Special Region, especially Sleman Regency, is a red zone, which is an area that has a very high Covid-19 transmission rate. Padukuhan Mancasan Kleben is one of the hamlets located near the government center of Sleman Regency where the amounts of community activity and mobility are quite high. There are many business buildings located along the main road. The purpose of this research is to analyze the vulnerability to Coronavirus (COVID-19) transmission based on building function using the Analytical Hierarchy Process (AHP) and Spatial Multi Criteria Evaluation (SMCE) methods. The types of buildings are identified using an Unmanned Aerial Vehicle (UAV) image and field check. The types of buildings are used as the physical variables in the analysis. The result shows there are a total of 363 buildings, consisting of 35 buildings with a high level of vulnerability and 328 buildings with a low level of vulnerability. The buildings with a high level of vulnerability was shop houses, due to the high degree of social interaction. A low level of vulnerability were found in stores and houses. This was because the stores in Mancasan Kleben were only occupied during operational hours during the pandemic. Activities also mainly done inside the house especially during limiting community activities policy (PPKM) based on Sleman Regent's Instruction No. 22 of 2021 (effective from August 10th-16th, 2021). The mitigation efforts that need to be implemented should be focused on increasing the awareness of ourselves and the surrounding environment. Healthy life-style habits can be promoted by implementing health protocols and encouraging people to maintain a distance from buildings with a high degree of interactions and mobility of people.

**Keywords:** pandemic, covid-19, building, vulnerability

### 1. Introduction

During the year 2020, people around the world experienced a pandemic. According to WHO (2021), a pandemic is a disease that spreads globally throughout the world. A pandemic situation can arise if a disease spreads rapidly among many people and in greater numbers than usual. The virus that spread globally was Covid-19. Covid-19 is an infectious disease caused by a new type of

corona virus. People infected with the virus experience mild to moderate respiratory disease depending on the health condition of each person. This condition made WHO give orders to all countries around the world to increase their preparedness for preventing and dealing with the Covid-19 pandemic.

Coronavirus (Covid-19) first appeared in Wuhan City, China in December 2019

(Wu, 2020). The virus spreads very quickly and causes respiratory problems to victims who are positively infected and can prove fatal. Various attempts were made by the Chinese government to suppress the spread of the Covid-19 virus, but the disease spread to various parts of the world. Indonesia is one of the countries that had confirmed case of the Covid-19 virus. Based on data from National Disaster Management Agency (BNPB) of Indonesia (2020), almost all provinces in Indonesia had cases of the Covid-19 virus. One of them was the Special Region of Yogyakarta Province, with the highest number of positive patients were in Sleman Regency.

One of the Padukuhans (hamlets) that are vulnerable to the spread of covid-19 in Yogyakarta Province is Padukuhan Mancasan-Kleben. Padukuhan Mancasan-Kleben is one of the Padukuhans in Pandowoharjo Village, Sleman District, Sleman Regency, Special Region of Yogyakarta, Indonesia. Pandowoharjo Village office has a registered total population in Padukuhan Mancasan-Kleben of 765 people. The location of this Padukuhan is strategic, as it lies on the main road, with several business premises located along the side of the road. In addition, this route also gives access to several tourist attractions located in Pandowoharjo Village. This ease of accessibility and economic activity made Padukuhan Mancasan-Kleben vulnerable to the Covid-19 virus. Based on the Instruction of the Minister of Internal Affairs Number 15 Year 2021 Concerning the Implementation of Emergency Community Activities Restrictions of Corona Virus Disease in Java and Bali commencing on 3 July 2021, several public facilities in Mancasan Kleben were not operational. The administrative boundaries of the Padukuhan Mancasan-Kleben are presented in Figure 1.

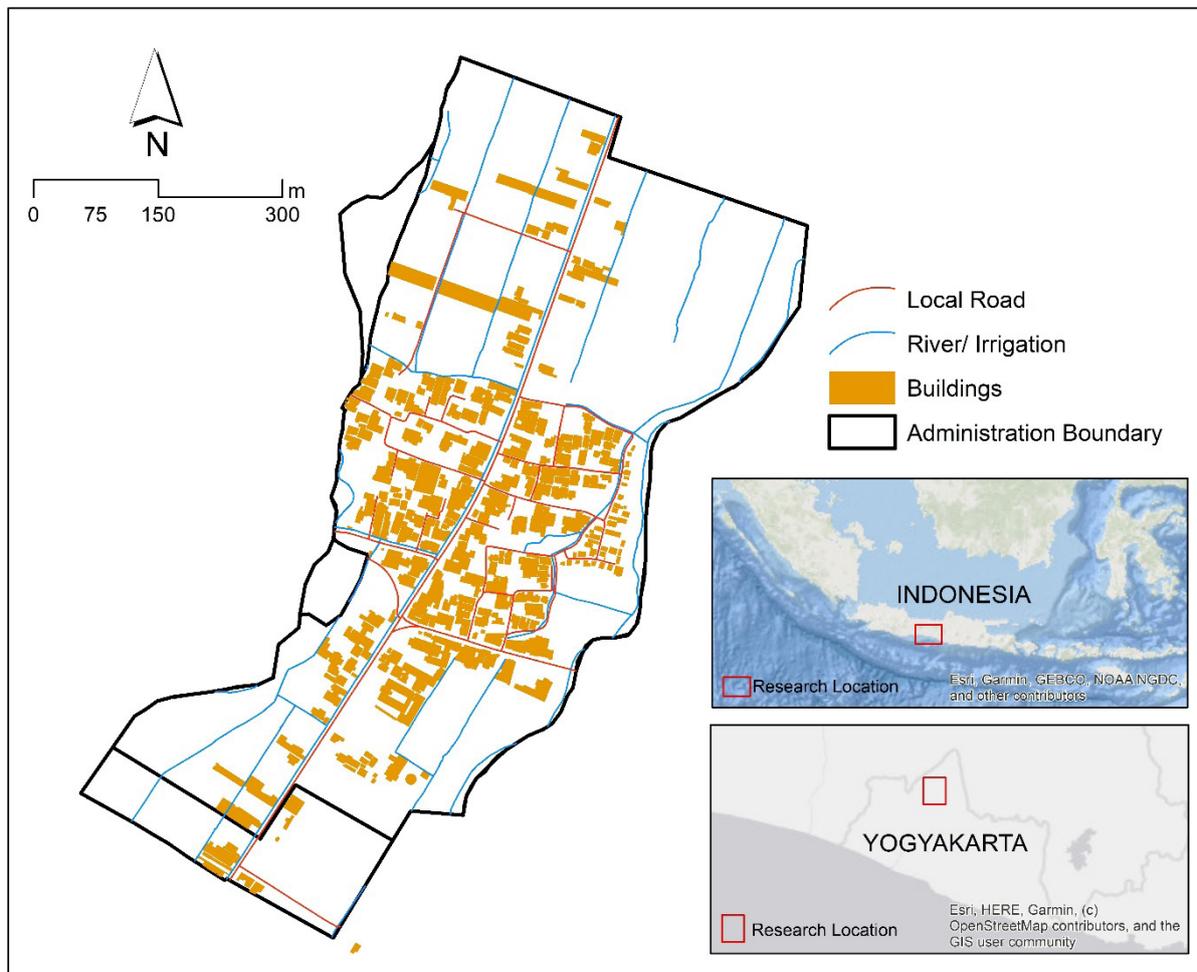
Vulnerability is the level of loss that can be experienced by the affected element with a certain severity resulting from a particular hazard. The level of community vulnerability to disaster impacts is determined by several conditions, namely physical, social, economic,

environmental conditions, and the processes that take place in it. The identification of building functions is a factor in the social vulnerability analysis of the Covid-19 virus. The function of buildings as business premises, public facilities and settlements are factors that can make them vulnerable regarding the Covid-19 virus (Tokazhanov, et al., 2020).

Although regulations for restricting community activities were implemented, there were still many people who needed to engage in activities outside their home due to their economic conditions, which meant that people had to keep working for a living and engaging in spatial mobility. Other considerations, namely spatial accessibility and population density, make physical distance and quarantine activities ineffective, so that the spread of viral infections can occur very quickly (OECD, 2020, Sharifi & Khavarian-Garmsir, 2020).

The process of transmission through droplets and contact is very likely to occur in buildings that are constantly frequented by large crowds of people (Han, 2020). Physical vulnerability and capacity refer to the vulnerable conditions of risk elements in the form of buildings, infrastructure or other things that require considerable investment or ownership. Observations related to the spread of the Covid-19 virus are focused on the function of buildings as residences and business premises (Davisson & Losavio, 2020, Honey-Roses, et al., 2020). This makes it vital to conduct research on buildings' functions as a physical variable regarding Covid-19 transmission.

The research on the spatial distribution of the Covid-19 virus remains very limited in Indonesia. One of the methodologies for analysing phenomena related to spatial distribution is Spatial Multi Criteria Evaluation (SMCE). Using SMCE, spatial information is weighted for each parameter. The output of the SMCE is a map that displays classified areas that are very useful for decision-making (Widiatmaka, et al., 2016).



**Figure 1. Research Location**

The purpose of this research is to analyse the vulnerability to transmission of Coronavirus Disease (Covid-19) based on building function using the Analytical Hierarchy Process (AHP) and Spatial Multi Criteria Evaluation (SMCE) methods. The types of buildings, such as houses and stores, are identified using an Unmanned Aerial Vehicle (UAV) image and field check. The types of buildings were used as the physical variables in the analysis.

## 2. Research Method

The research method was to assess building vulnerability, which was carried out using the Spatial Multi Criteria Evaluation (SMCE) method. The SMCE method has been widely used for disaster-related research and to assist the decision-making process in accordance with the expected goals by using spatial criteria (Widiatmaka, *et al.*, 2016, Barinaga-

Rementeria, *et al.*, 2019, Meena, *et al.*, 2019). This method was chosen because it can present a spatial vulnerability assessment of an area. The basis of the SMCE method is the Analytical Hierarchical Process (AHP), which is a model to assist decision-making using a hierarchy, as well as solving complex and unstructured problems in groups. AHP has been used for various decision-making processes (Sangka & Muchsini, 2018, Sudaryono, *et al.*, 2020, Yunandar, *et al.*, 2021). The data processing was carried out using the SMCE (Spatial Multi Criteria Evaluation) method, including several stages, namely:

1. Compilation of the problem trees (problem tree analysis)
2. Standardization
3. Weighting
4. Scenarios (evaluation)

## 2.1. Compilation of the Problem Trees and Standardization

The first step when creating a problem tree is to determine the main objective. This research has the main objective of analysing vulnerability to the Covid-19 virus. The parameters of the physical vulnerability were the function of the building, namely, a house, shop house and business premises. The determination of each class of variables was analysed using the Analytical Hierarchical Process (AHP) method. The standardization process was applied to equalize different data sizes using a normalization matrix, so that they can have values between 0-1. The values in the variables must be equalized so that they can provide the same result. A shop house was considered as a priority with the highest value because of the crowd potential and high interaction between people.

## 2.2. Weighting

The third stage is weighting, using the pairwise comparison method. A pairwise comparison method was applied by comparing the paired factors. A pairwise Comparison was used to obtain the related tendencies about different variants and compare each variant to assess which one had a better score (George,

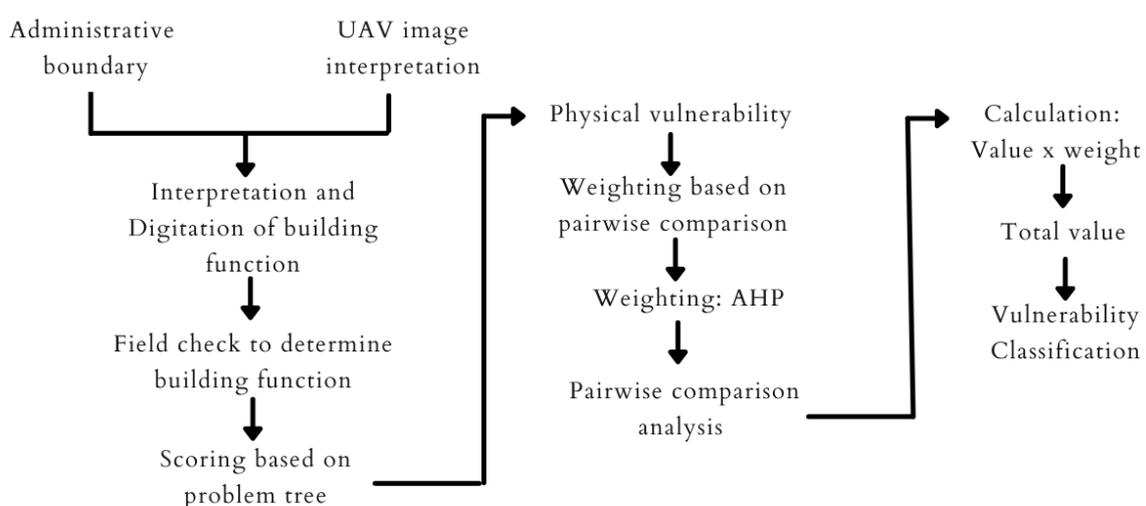
*et al.*, 2017, Bures, *et al.*, 2020, Moslem, *et al.*, 2020).

## 2.3. Scenario Building

The purpose of building a scenario is to determine the social vulnerability variable which, in this study is a physical variable. The types of physical variables analyzed were the function of the building as a house, a combined house and shop (shop house) and business premises (a shop). These three criteria will be assessed using the main priority scale according to the problem tree analysis.

## 2.4. Identification of the Buildings' Functions

The identification of the buildings' functions was carried out by interpreting the results of aerial photos taken by Unmanned Aerial Vehicles (UAV). The interpretation of aerial photographs involves the study of various basic characteristics of an object with reference to spectral bands, which is useful in visual analysis. The basic elements are the shape, size, pattern, tone, texture, shadows, location, association and resolution. The data collection technique was carried out by conducting a census and field observations of all of the buildings in Mancasan-Kleben Village. Figure 2 shows the research diagram.



**Figure 2. The Research Diagram.**

### 3. Results and Discussion

#### 3.1. Assessment of priority, Standardization and Weight Values

Housing facilities have already experienced the outbreak of COVID-19. Based on the results of the analysis, the first priority was homes and business premises, with business premises as the second priority and homes as the third priority. Shop house was more vulnerable than others because these are related to community mobility and the potential for crowds. The spread of Covid-19 through various media will be very dangerous if it is in a crowd (markets, service centres and activity centres, including business premises) (WHO, 2021). The assessment of the priority and weight values for each variable, based on a pairwise comparison, is presented in Table 1.

**Table 1. Variable and Weight Assessment**

Criteria	Priority	Rank
Shop house	74.3%	1
Store/Business Premises	19.4%	2
House	6.3%	3

#### 3.2. Vulnerability Analysis

Padukuhan Mancasan Kleben is experiencing very fast development. During a period of approximately 5 years, there were many changes in land use. This is because the amount of economic activity is growing very fast. There are many business premises located on the side of the road. In addition, geographically, Padukuhan Mancasan Kleben is located close to the administrative center of Sleman Regency, and close to the provincial road, namely Jogja-Magelang Highway. This makes people's mobility very high.

Building identification was carried out using an aerial image taken by an Unmanned Aerial Vehicle (UAV) from 85 meters up. They were highly detailed images, with a pixel size of 2.5 cm. Based on the results of the aerial photograph and digitization, it was established that there are 363 buildings. Each building was then categorized into the class of house, house and business premises (shop house), business only (store), and other buildings, via a field check.

Other buildings, which are not included in this category, were mosques, churches, village offices, elementary schools (SD), kindergartens (TK) and warehouses. Buildings that were not included in the analysis variable were given a score of 0 because, during the Covid-19 pandemic, these buildings were rarely used. School pupils, during the pandemic, did their schooling from home, and several places of prayer are still closed.

Based on the results of the analysis, there are a total of 363 buildings, consisting of 35 buildings with a high level of vulnerability and 328 buildings with a low level of vulnerability. The buildings with a high level of vulnerability are shop houses, due to the high degree of social interaction in these buildings. Stores have low level of vulnerability because some of the business establishments in Mancasan Kleben are only occupied during operational hours; namely, on average, from 07.00 am to 09.00 pm or when the store starts operating until it closes. Based on the results of interviews with the respondents, no one slept in or lived at the business premises, because most of those on the business premises are employees who arrive in the morning and leave at night, so the social interactions that occur do not last for 24 hours.

The case is different for buildings that are houses and also business premises. The occupants remain in the building all day long. Thus, more social interactions occur. A low level of vulnerability was also found in buildings used as houses and public facilities. This is because, during the pandemic, several public facilities in Mancasan Kleben were not operational, especially during the limiting community activities policy (PPKM), based on Sleman Regent's Instruction No. 22 of 2021 (effective from August 10th-16th, 2021). Activities also limited and most work were done from house during PPKM, so there was not much mobility and interaction in the community. Although most of the buildings in Padukuhan Mancasan Kleben have a low level of vulnerability, the community must not be careless when facing the Covid-19 pandemic. The vulnerability to potential Covid-19 transmission based on building function in Padukuhan Mancasan Kleben is presented in Figure 3.

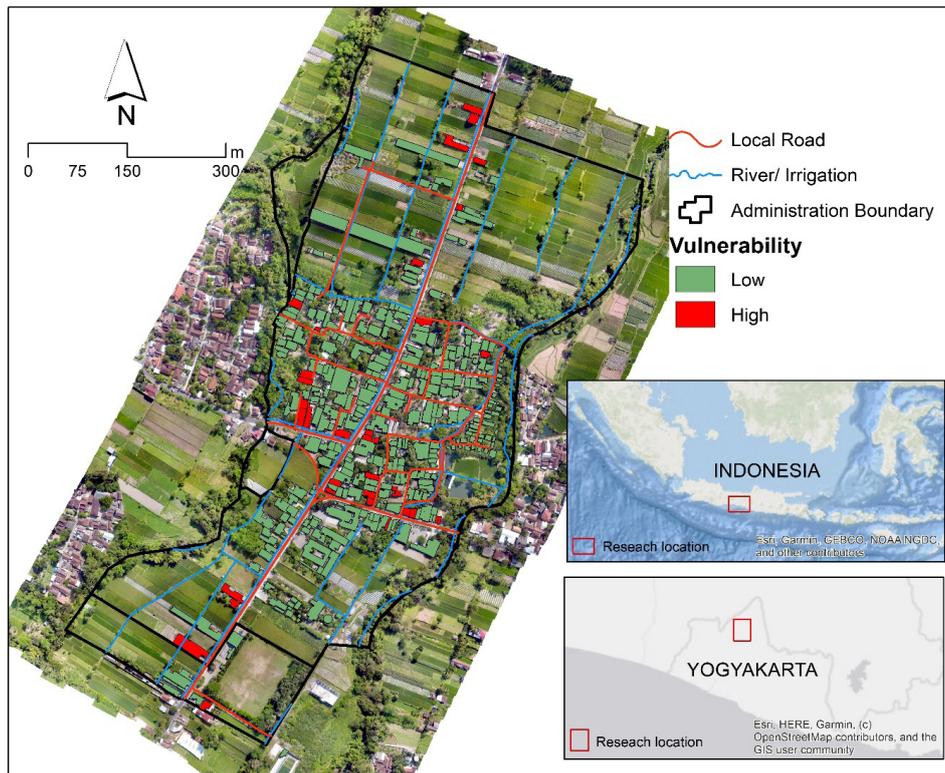


Figure 3. Vulnerability to Covid-19 Virus Transmission in Padukuhan Mancasan Kleben

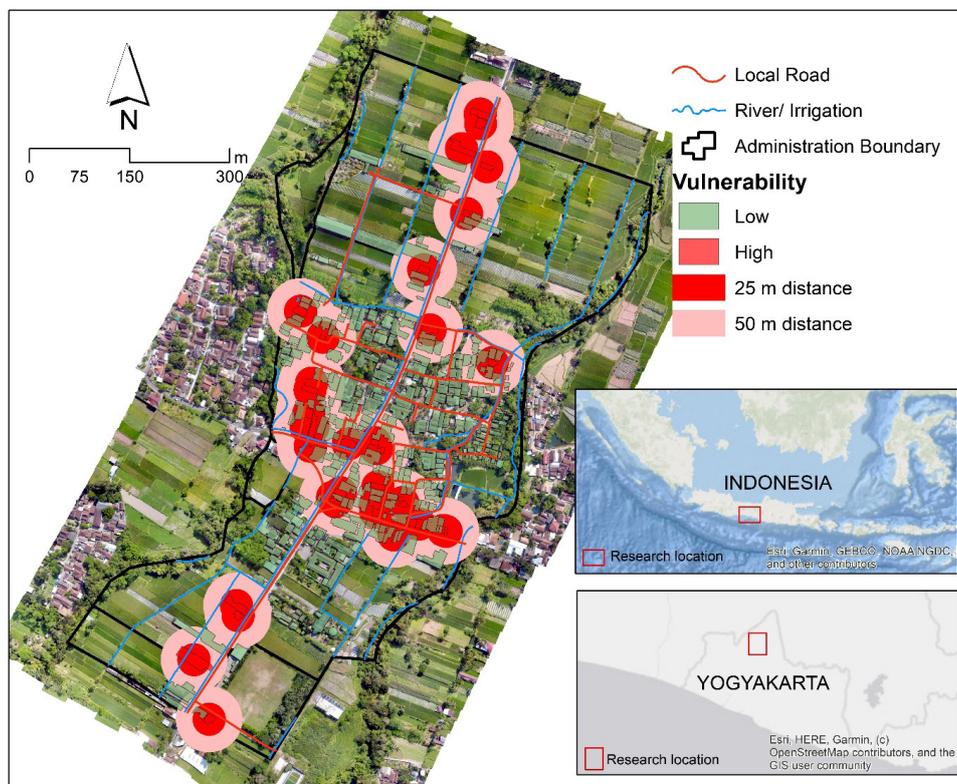


Figure 4. Alert Level of Covid-19 Virus Transmission in Mancasan Kleben Village.

### 3.3. Mitigation Efforts

The community and government play an important role in the efforts to break the chain of transmission of the Covid-19 virus. Efforts to keep wearing masks, maintaining social distancing, avoiding crowds and adopting a healthy lifestyle are things that must be obeyed by the community.

Vulnerability mapping based on the function of buildings in Padukuhan Mancasan Kleben can be one of the community efforts to deal with the pandemic. By establishing which centers are vulnerable or have the potential to transmit the virus, the community can be alert and make mitigation efforts, namely by continuing to comply with the health protocols, i.e., wear a mask properly, wash your hands with soap and running water regularly and maintain a safe distance from others of 1.5 to 2 meters. Related to the recommendations regarding Covid-19 transmission in Pandowoharjo Village, it is important to avoid buildings with a high level of interactions and mobility of people. In order for the community to carry out mitigation and preparedness efforts, the following is a model of 25 meters and 50 meters radius from highly vulnerable building, as shown in Figure 4.

The map showing the radius of highly vulnerable buildings regarding Covid-19 transmission serves as a precaution and offers information to the community to avoid crowds and provides information about the exact distance from the possible transmission center of Covid-19. The community is expected to keep their distance and continue to follow a clean, healthy lifestyle. People whose houses are located within a radius of 25 to 50 meters of buildings with a high level of vulnerability are expected to increase their awareness of the possibility of the spread of the Covid-19 virus. This effort is not designed to concern or frighten the public, but instead can alert the community to the spread of the Covid-19 virus.

This study uses a detailed scale, whereby the unit of analysis is a single building block. Previous research that discussed the spatial

distribution of Covid-19 by Li (2000) and Przech and Galebiowska (2021) discussed more about understanding Covid-19 map reading, with the results showing that choropleth maps have higher map comprehension accuracy. Other research about disasters in Indonesia, mainly natural disasters, focused on the application of information technology and spatial analysis (Kusmiyarti, *et al.*, 2018, Permatasari, *et al.*, 2020, Permatasari, *et al.*, 2021, Suherningtyas, *et al.*, 2021, Wiguna, 2021).

### 4. Conclusion

Based on the results of applying the hierarchical vulnerability and spatial multi criteria evaluation (SMCE) approach to buildings regarding the transmission of the Covid-19 virus in Padukuhan Mancasan Kleben, it was found that, of a total of 363 buildings, 35 had a high level of vulnerability and 328 had a low level of vulnerability. The high level of vulnerability were found at shop houses, because it were visited by crowds of different people every day. A low level of vulnerability were found in buildings used as stores and houses. This is because the business establishments in Mancasan Kleben were only occupied during operational hours during the pandemic. During the limiting community activities policy (PPKM), based on Sleman Regent's Instruction No. 22 of 2021 activities also limited and most work were done from home, so there was not much interaction inside the house. To prevent covid-19 transmission in Padukuhan Mancasan Kleben, it is important to keep a distance from buildings with a high level of interactions and mobility of people. It is also important to always implement health protocols i.e, wearing a mask properly, washing hands and maintain physical and social distancing.

### Suggestions

It is suggested that the community needs to increase their awareness of healthy living behavior by implementing health protocols, maintain a distance from buildings with a high level of interactions and mobility of people. If

there are people who experience symptoms of the virus, please contact the nearest health facility immediately.

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