# The mapping of high-risk districts with economic, physical, and environment-vulnerable factors to COVID-19 infection in Palembang city

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**Abstract.** The Corona Virus Disease 2019 (COVID-19) pandemic caused by SARS-CoV-2 (SC-2) is a novel type of human-to-human transmission, first reported in late December 2019 in the Chinese city of Wuhan and has confirmed more than 597 million cases by August 18, 2022. The dangerous worldwide virus has spread from the epicenter to remote parts of the world. The relationship between the vulnerability of sub-districts in Palembang city to COVID-19 transmission is unknown. The research method is ecology with spatial analysis. Temporal analysis of pandemic risk related to regional vulnerability and response capacity to hazards, using the ArcGIS software. Secondary data were obtained from the Palembang City Health Department and Statistics Office Bureau. The most vulnerable sub-districts are Ilir Timur II, Seberang Ulu I, and Ulu II, while the least adaptive sub-districts are Ilir Barat I, Seberang Ulu I, and Sematang Borang, and the most vulnerable sub-districts are Ilir Barat 1 and Seberang Ulu 1. Real-time tracking reports are recommended, and measures should be taken to reduce the vulnerability in the sub-districts that are still high. Anticipating silent transmission through faster laboratory test results and large-scale tracking can help central and local authorities act quickly and accurately to reduce transmission rates.

**Keyword:** Mapping, of High-Risk Districts, Economic, Physical, Environment-Vulnerable Factors, COVID-19

## 1. Introduction

Corona Virus Disease 2019 (COVID-19) pandemic caused by SARS-CoV-2 (SC-2) is a new type of human-to-human transmission causing severe respiratory infections such as SARS and MERS [1]. Acute symptoms range from asymptomatic high fever, chills, headache, cough, and difficulty breathing to pneumonia occurring within 2 days to 2 weeks of

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coronavirus exposure [2]. As of June 2, 2022, confirmed cases of infection were 527,878,071, with a death toll of 6,302,819 or a fatality ratio of 1.2% [3]. This dangerous virus is highly contagious and has spread from the epicenter to all parts of the world.

Pandemics that cause high mortality and morbidity can be controlled by reducing transmission according to epidemic control principles, i.e., pharmacological or non-pharmaceutical interventions (NPI) [4]. New antiviral and immunomodulatory drugs and SC -2 targeted vaccines are expected to provide adequate safety and high efficacy [5]. NPI principles consist of mandatory measures (such as isolation, quarantine, house bans, prohibition of public gatherings, closure of nonessential businesses, and school closures) and voluntary measures (social distancing, hand washing, respiratory etiquette, and use of universal masks) [6]. The NPI can help contain the COVID -19 pandemic when mass vaccination has not yet been fully achieved worldwide, and the threat of the variant of concern SC -2 (VoC) remains in sight.

The priority for reducing mortality rates is identifying areas at the highest risk for severe illness and death [7]. The priority for providing interventions to address disease outbreaks must consider the community's physical, social, economic, and environmental vulnerability factors [8]. Inadequate public health infrastructure is a risk for economic vulnerability [9]. The spatial analysis method's function of monitoring the spread of disease by region can create a disease surveillance system and a sound reporting system. The relationship between the susceptibility of sub-districts in Palembang City to the transmission of COVID -19 is not yet clearly known. Decision-makers should establish regulations to improve the adaptation and management of the outbreak of COVID -19 in Palembang City.

## 2. Methods

The study uses descriptive-analytical research with a cross-sectional design. Secondary data for 2020 were obtained from the Palembang City Health Office (Dinkeskot Palembang) and from the Statistics Center Office (BPS) Palembang. Mapping of distribution using ArcGIS application (georeferenced software from ESRI) 10.3.

### 2.1 Measuring instruments

The research instrument used in the study was questionnaires. Vulnerability data included economic (percentage of poor population), physical (percentage of population density, number of public centers), and environmental factors (percentage of vulnerable age group in the population, population density), as well as adaptive capacity, such as number of health workers and number of health facilities.

### 2.2 Statistics Analysis

Randomization was performed using a simple Excel Office® application presented in tabular form. In a further analysis using the ArcGIS application, the tables were later prepared in map form for better visualization. The ecological, physical and economic vulnerability categories were determined by standard deviation analysis.

## 2.3 Results

The results were the vulnerability and adaptive capacity of the districts and the analysis of their risks for transmission of COVID -19. Table 1 shows the social vulnerability, consisting of the population density and the percentage of the age group at risk, then the economic vulnerability, consisting of the poor population. The physical vulnerability table consists of the percentage of settlement density and the number of crowded centers. Table 2 shows the adaptive capacity, consisting of health facilities and health personnel variables. These include the hospital, maternity hospital, polyclinic, puskesmas, sub-puskesmas, pharmacy, doctor, dentist, nurse, midwife, pharmacists, public health workers, Kesling force, nutrition force, and medical laboratory experts. For the mapping form analysis, Figure 1 showed the susceptibility index, Figure 2 showed the adaptability, and Figure 3 showed the transmission risks.

# 3. Discussion

Ilir Timur subdistricts II, Seberang Ulu I, and Ulu II are areas of high susceptibility to infection COVID -19 (Figure 1). Three of the 18 sub-districts are very high vulnerability areas in the city center around the Musi River. Population density and household density are considered, as high population concentration can lead to a rapid spread in the community [10]. Europe experienced the Black Death in the 14th century, which claimed many lives, with most deaths occurring in underprivileged populations with a high proportion of low-income households and lower-class people [11]. Economically and socially vulnerable people are at higher risk of contracting the virus because living in urban areas increases the risk of transmission.

**Table 1.** The district's vulnerability distribution based on environment, physical, and the economy (N=18)

| DISTRICTS | ENVIRONMENTAL VULNERABILITY | | PHYSICAL VULNERABILITY | | ECONOMY VULNERABILITY |
|---|---|---|---|---|---|
| | Population density | Vulnerable age population ratio | Population density percentage | Number of Public Centers | Poor population ratio percentage |
| Alang-Alang Lebar | 3084 | 4.151311409 | 4.63 | 143 | 15.90417252 |
| Bukit Kecil | 3888 | 7.016543069 | 4.11 | 61 | 9.011660817 |
| Gandus | 1096 | 4.229779558 | 4.55 | 35 | 24.27171188 |
| Ilir Barat Dua | 10876 | 6.522092628 | 4.44 | 38 | 13.92973683 |
| Ilir Barat Satu | 7175 | 6.103415459 | 4.48 | 145 | 8.785758569 |
| Ilir Timur Dua | 7894 | 6.889729211 | 4.31 | 20 | 7.995758218 |
| Ilir Timur Satu | 10175 | 10.44681334 | 4.12 | 128 | 8.320825516 |
| Ilir Timur | 4944 | 7.461663903 | 4.26 | 106 | 3.544202981 |

| | | | | | |
|---|---|---|---|---|---|
| Tiga | | | | | |
| Jakabaring | 9922 | 5.446623094 | 4.42 | 91 | 7.8975517 |
| Kalidoni | 4450 | 5.785203786 | 4.46 | 101 | 8.022036295 |
| Kemuning | 8960 | 7.094142156 | 4.39 | 128 | 9.784596627 |
| Kertapati | 2170 | 5.126483583 | 4.24 | 20 | 13.74346395 |
| Plaju | 6206 | 6.111978586 | 4.34 | 43 | 15.47839302 |
| Sako | 6239 | 5.217986193 | 4.56 | 122 | 5.624311266 |
| Seberang Ulu Dua | 9399 | 5.770302548 | 4.46 | 57 | 13.45936561 |
| Seberang Ulu Satu | 11067 | 5.66583367 | 4.32 | 41 | 11.9358805 |
| Sematang Borang | 1538 | 4.06512642 | 4.89 | 35 | 8.81300813 |
| Sukarami | 3646 | 4.422830953 | 4.56 | 158 | 9.536784741 |

**Table 2.** The district adaptive capacity distribution based on environment, physical, and economy (N=18)

| DISTRICTS | ADAPTIVE CAPACITY | |
|---|---|---|
| | Number of health workers | Number of health facilities |
| Alang-Alang Lebar | 142 | 13 |
| Bukit Kecil | 135 | 13 |
| Gandus | 177 | 14 |
| Ilir Barat Dua | 57 | 8 |
| Ilir Barat Satu | 224 | 24 |
| Ilir Timur Dua | 165 | 12 |
| Ilir Timur Satu | 333 | 18 |
| Ilir Timur Tiga | 266 | 12 |
| Jakabaring | 120 | 10 |
| Kalidoni | 303 | 17 |
| Kemuning | 521 | 20 |
| Kertapati | 324 | 12 |
| Plaju | 244 | 14 |
| Sako | 237 | 11 |
| Seberang Ulu Dua | 417 | 13 |
| Seberang Ulu Satu | 244 | 10 |
| Sematang Borang | 358 | 6 |
| Sukarami | 407 | 25 |

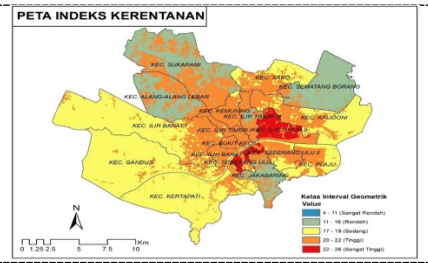


**Figure 1.** The Vulnerability Index Map presents the level of vulnerability of the area in the city of Palembang to exposure to COVID-19 infection. The class is divided into 5, with Ilir Timur II, Seberang Ulu I, and Ulu II sub-districts as areas with very high vulnerability


**Figure 2.** The Adaptive Capacity Index map shows the service level in the distribution of health facilities and personnel. The class is divided into 3, with Ilir Barat I, Seberang Ulu I, and Sematang Borang sub-districts as areas with low adaptive capacity.

Ilir Barat I, Seberang Ulu I, and Sematang Borang subdistricts are areas with low adaptive capacity to infection with COVID -19 (Figure 2). Three sub-districts are not yet fully covered with health services and personnel, namely the western and eastern suburbs. At the beginning of the pandemic in 2020, the number of referral hospitals was limited, e.g., in RSMH and BBLK; the government immediately responded to the increasing number of infection cases by increasing the number of hospitals and controlling referrals. Economically vulnerable people have limited access to health facility resources and are, therefore, more vulnerable to disease [12]. Public health infrastructure includes subordinate health centers, main health centers, health centers, health and fitness centers, urban hospitals, and referral hospitals [13]. Accessibility of public health infrastructure is one of the critical components of epidemic management [14]. Low adaptability in the form of uneven distribution and health services increases the risk of COVID -19 transmission.

Ilir Barat 1 and Seberang Ulu 1 subdistricts are at the highest risk for infection with COVID -19 (Figure 3). The risk of transmission changes dynamically depending on the number of COVID -19 cases. For the second week in September 2021, the highest risk is known in the area with the highest susceptibility and lowest adaptive capacity, Seberang Ulu District 1. Poor economic conditions increase the inability to withstand the impact of a hostile pandemic situation [15]. Inadequate public health infrastructure is a significant constraint and strategic disadvantage during pandemics as it increases vulnerability risk [9]. The elderly population, as a percentage of the total population, is considered a vulnerable community because they are more susceptible to disease due to their weak immune systems [16].

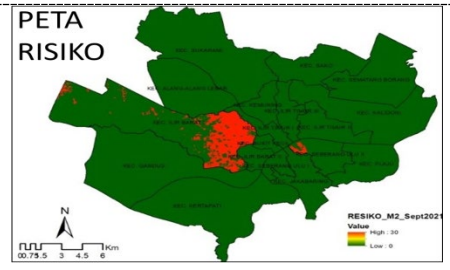


**Figure 2.** The Risk Map shows the combined hazard data layer with the vulnerability (and adaptive capacity) of transmission risk that changes dynamically, moving from the low number of COVID-19 cases. In September 2021, in the second week, it was known that the areas with the highest risk were Ilir Barat 1 and Seberang Ulu 1.

The variability of the settlement has hampered the limitations of the study. Because the addresses of patients in the first wave are unknown, it is impossible to measure the potential foci of disparity in each subdistrict. It is also impossible to compare the risk dynamics of the first wave of transmission with the incidence of the second wave. It is necessary to consider other factors, such as pharmacological interventions, i.e., the effectiveness of vaccines in reducing transmission.

## 4. Conclusion

There is a significant correlation between the incidence of transmission and vulnerability factors. The most vulnerable sub-districts are Ilir Timur II, Seberang Ulu I, and Ulu II. In contrast, the sub-districts with the lowest adaptive capacity are Ilir Barat I, Seberang Ulu I, and Sematang Borang, and the most vulnerable sub-districts are Ilir Barat 1 and Seberang Ulu 1. It is recommended that real-time information tracking reports be prepared and measures are taken to reduce vulnerability in the sub-districts that are still high. Anticipating silent transmission with faster lab test results and large-scale tracking can help central and local authorities act quickly and accurately to reduce transmission rates.

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