JDEP Vol. 7 No. 3 (2024) 219-233

JDEP

Jurnal Dinamika Ekonomi Pembangunan

https://ejournal.undip.ac.id/index.php/dinamika_pembangunan/index

# Analysis of Determinants of Uninhabitable Houses (RTLH) in Indonesia

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***Abstract***

*Urbanization in Indonesia is rapidly increasing population density and the demand for habitable housing. This study examines the determinants of uninhabitable houses (RTLH) and evaluates provincial-level access to improved drinking water and sanitation facilities, focusing on uninhabitable housing issues. Significant gaps in access to adequate drinking water and sanitation persist in Indonesia. The research question addresses the determinants of RTLH and the state of access to improved drinking water and sanitation facilities in the country. This study uniquely integrates RTLH determinants with provincial-level data on water and sanitation access, along with regional and socio-economic indicators, providing a comprehensive perspective. Employing panel data regression with a Random Effects model, the study analyzes RTLH determinants using data from the Central Statistics Agency. Key determinants of RTLH include piped water, bottled water, refilled water, pumped water, protected well, protected spring, septic tank, WWTP, open pit, population density, homeownership, years of schooling, GDP per capita, open unemployment rate, informal labor, and agricultural labor. While 91% of households have access to improved drinking water sources, only 81% have access to improved sanitation facilities; unimproved sanitation facilities like open pits are still common in urban areas of Bengkulu, Lampung, and West Kalimantan. Government interventions are essential to ensure the availability of piped water and eliminate unimproved sanitation facilities, particularly open pits, in urban areas. The findings emphasize the need for improved educational facilities in high-RTLH regions like Papua, highlighting the critical nature of these interventions for reducing RTLH in Indonesia.*

*Keywords: Uninhabitable Houses (RTLH), Drinking Water, and Sanitation Facilities*

*JEL Classification: J18, O18, and R58*

https://doi.org/10.14710/jdep.7.3.219-233

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## Introduction

Uninhabitable housing conditions are a problem in many countries, especially developing ones. Ghana, a low-income developing country, faces an issue where poor physical characteristics characterize most of the homes in the country. Most households in Ghana live in houses with walls made of wood, mud bricks, or cement, and houses made of mud. Overcrowding also occurs in at least 44.5% of households

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in Ghana, and this condition has negative implications for health and urban planning (Fiadzo, 2004). Similar conditions are also found in Pakistan. Overcrowding still occurs, as indicated by the residential density reaching three people per room (Saddozai, Hussain, Shah, & Manan, 2013). The unmet need for habitable housing is also related to the low availability of improved drinking water sources. In 10 large cities in Pakistan, only 65.2% of households use piped water as a source of drinking water. The inadequate condition of sanitation facilities is also reflected in the unavailability of a waste processing system, which results in the contamination of water areas (UN-Habitat, 2023). Uninhabitable living conditions were also found in Poland, where, in 2017, there were houses with no sanitation facilities. In the same year, overcrowding occurred in so many households, reaching 44.8% (Habitat For Humanity, 2017), which indicates that the availability of habitable housing was slower than population growth in Poland.

As is the case in the three developing countries, the emergence of the problem of uninhabitable housing is closely related to urbanization. In 2018, 54.8% of Ghana's population lived in urban areas, which is predicted to reach 65% by 2030 (UN-Habitat, 2023). Similar to Ghana, 55% of Pakistan's population lives in urban areas, and it is predicted that by 2045, the number of urban residents will double to reach 155.7 million people (World Bank, 2015). Poland shows an even higher level of urbanization at 60.5% (Habitat For Humanity, 2017). Jenkins & Scotte (2007) in Ofori (2020) stated that the increasing population density in urban areas causes scarcity and increases in land prices. However, at the same time, demand for habitable houses has increased. As a result, more and more people live in uninhabitable houses where improved drinking water and sanitation facilities are unavailable.

Urbanization is occurring at a reasonably high speed. By 2030, 60% of the world's total population will live in cities, with 90% of urban population growth in the next decade occurring in low- and middle-income countries. The influence of urbanization will be felt in various aspects of human life, especially in terms of the need for housing. The high level of urbanization in developing countries, such as Ghana, Pakistan, and Poland, is a phenomenon behind the emergence of a new face of poverty, illustrated by the high concentration of uninhabitable houses in big cities (UN-Habitat, 2018).

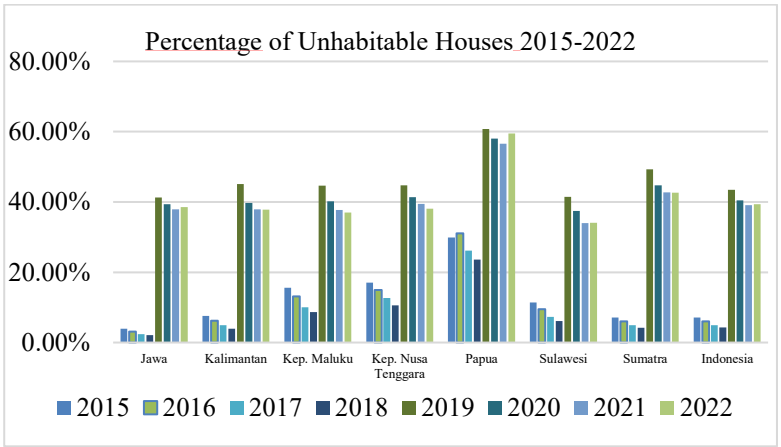



Figure 1. Percentage of Uninhabitable Houses 2015-2022
Source: Central Statistics Agency (2023), processed

Following the criteria for a habitable house, access to improved drinking water and sanitation facilities is essential. However, both still need to be maximally available to all households in Indonesia. Based on geographical units, it is known that the lowest percentage of households with access to unimproved drinking water sources is found on the island of Java, with a percentage of 5.24% in 2022, a very unequal condition compared to what occurs in Papua, with a percentage of 26.52% in the same year (Central Statistics Agency, 2022).

Conditions in Indonesia show that urbanization is occurring quickly, and population density is increasing, followed by housing needs. A house is a basic need and must, of course, meet housing habitability standards. However, this condition has yet to be found in Indonesia, as can be seen from the lack of optimal drinking water and sanitation facilities. Therefore, policies are needed to solve the uninhabitable houses problem. Based on the explanation above, studying the determinants of uninhabitable houses is necessary. The research results can become input for government policies, especially in terms of reducing the number of uninhabitable houses.

Rapid urbanization and increasing population density in Indonesia have heightened the demand for habitable housing. However, inadequate access to improved drinking water sources and sanitation facilities remains a challenge, highlighting the need for policies that address housing inadequacy. Understanding the factors associated with uninhabitable housing is therefore essential to inform efforts to improve housing conditions.

This study examines the determinants of uninhabitable housing in Indonesia, with particular emphasis on drinking water sources and sanitation facilities, while accounting for regional and socioeconomic characteristics. It also compares access to improved drinking water sources and sanitation facilities across provinces and regions. The findings are expected to inform government policies aimed at expanding access to habitable housing and reducing regional disparities in housing conditions.

## Literature Review

A house is considered habitable if it meets the four criteria established by Statistics Indonesia (BPS) in accordance with the Sustainable Development Goals (SDGs) metadata: sufficient living space, access to improved drinking water sources, access to improved sanitation facilities, and durable construction. This study focuses on access to improved drinking water sources and sanitation facilities, following the definitions adopted by BPS.

Access to improved drinking water includes the use of piped water, protected water sources, or rainwater as the household's primary drinking water source. Protected sources include drilled or pumped wells, protected wells, and protected springs. Households using bottled water are also classified as having access to improved drinking water if their water for bathing and washing comes from piped water, drilled or pumped wells, protected wells, protected springs, or rainwater. Access to improved sanitation facilities refers to the use of septic tanks or wastewater treatment plants (WWTPs) for final fecal disposal, with pit disposal facilities also included for households in rural areas under the BPS definition used in this study. United Nations (2017) classified types of drinking water and sanitation as follows:

Table 1. Drinking Water Classification

| | |
|---|---|
| Safely managed | Drinking water from an improved water source which is located on premises, available when needed and free of faecal and priority contamination |
| Basic | Drinking water from an improved source provided collection time is not more than 30 minutes for a round trip including queuing |
| Limited | Drinking water from an improved source where collection time exceeds over 30 minutes for a round trip to collect water, including queuing |
| Unimproved | Drinking water from an unprotected dug well or unprotected spring |
| No service | Drinking water collected directly from a river, dam, lake, pond, stream, canal or irrigation channel |

Notes: United Nations (2017)

While Table 1 classifies drinking water services according to source quality, accessibility, and availability, Table 2 presents the corresponding classification of sanitation services. The sanitation categories distinguish service levels based on facility type, whether facilities are shared, and how human excreta are managed.

Table 2. Sanitation Facility Classification

| | |
|---|---|
| Safely managed | Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite |
| Basic | Use of improved facilities that are not shared with other households |
| Limited | Use of improved facilities shared between two or more households |
| Unimproved | Use of pit latrines without a slab or platform, hanging latrines or bucket latrines |
| No service | Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces or with solid waste |

Notes: United Nations (2017)

In a study conducted by Ren, Yuan, & Hu (2018), research was done on housing habitability and determinants of housing habitability in rural areas across 31 provinces in China. The research focused on the habitability of houses as a latent variable measured using factors such as the availability of piped water and sanitation facilities. The findings revealed that sanitation facilities and piped water availability were the most influential variables affecting the habitability of the houses. Additionally, the study highlighted the impact of government intervention in reducing uninhabitable houses, showing that areas in China receiving government assistance, such as financing or subsidies for piped water provision and sewer construction, had lower rates of uninhabitable houses compared to areas without such support.

Ulman & Cwiek (2020) conducted research on uninhabitable housing in Poland and noted that the country does not have a housing classification system. In another study on the determinants of house habitability in Ghana, Ofori (2020) utilized standard physical house characteristics set by the UN and data from the Core Welfare Indicator Questionnaire (CWIQ) survey. The survey classified households based on welfare quintiles and provided information on household welfare. The study employed indicators such as drinking water sources (e.g., bottled water, rivers, wells, piped water) and sanitation facilities (e.g., toilets, latrines) to assess housing habitability in Ghana.

Based on previous studies and research, there are regional and socioeconomic indicators that significantly affect housing habitability, making it essential to explore these factors further. Ofori (2020) analyzed uninhabitable houses in Swedru, a city in Ghana with a high population and urbanization level. The research results indicate that high population density contributes to uninhabitable housing through overcrowding, where two households live in the same house, leading to situations where five people occupy a single room despite the standard being two people per room. This study underscores the impact of population density on housing habitability.

The importance of homeownership in enhancing house habitability is evident from various studies. Ahmad et al. (2000) identified homeownership as a crucial factor of housing habitability in Karachi. Their analysis demonstrated that owners are more likely to make improvements to their homes compared to renters. Similarly, Hussain & Jawaria (2015) found that rental properties had 0.96 points lower habitability scores than owned properties. However, Fiadzo (2004) presented a contrasting view in his research on Ghana, showing that owned houses had 2.35 points lower habitability scores than rented ones.

Education, particularly the years of schooling of the household head, also plays a significant role in housing habitability. Ren, Yuan, and Hu (2018) found a positive correlation between the head of the household's education and housing habitability in China, a conclusion supported by Fiadzo (2004) in Ghana. Hussain & Jawaria (2015) in Pakistan and Saddozai, Hussain, Shah, & Manan (2013) further confirmed that higher education levels lead to housing habitability. Ofori (2020) highlighted the critical role of knowledge in making informed decisions about housing improvements in Swedru. In Kenya, Koske, & Koech (2013) demonstrated that higher education levels correlate with access to improved sanitation facilities, an observation supported by research in Ghana by Adams, Boateng, & Amoyaw (2016) and Agbadi, Darkwah, & Kenney (2019). However, Ahmad et al. (2020) found no significant impact of education on housing habitability in Karachi.

Income is another pivotal factor in determining housing habitability. Studies by Ren, Yuan, & Hu (2018) in China, Fiadzo (2004) in Ghana, and Hussain & Jawaria (2015) in Pakistan all show a positive relationship between income and housing habitability. Ulman & Cwiek (2020) in Poland found that higher household incomes reduce the likelihood of living in uninhabitable houses. Saddozai, Hussain, Shah, & Manan (2013) identified that in Pakistan, households with the lowest incomes live in non-permanent houses (uninhabitable housing). Ofori (2020) emphasized that low income is a major factor contributing to uninhabitable housing in Swedru, linking income directly to the ability to develop and repair homes.

The open unemployment rate (TPT) also influences housing habitability. Research by Koske & Koech (2013) showed that unemployment correlates with inadequate access to drinking water, as unemployed households lack the funds for proper facilities. Ren, Yuan, & Hu (2018) found that the number of working household members positively impacts housing feasibility, suggesting that employment improves housing conditions. Lastly, the type of employment, particularly in the informal and agricultural sectors, affects housing habitability. Fiadzo (2004) reported that in Ghana, households headed by individuals working in agriculture, forestry, and fisheries, or in the informal sector, have lower housing habitability. Hussain & Jawaria (2015) observed that moving out of the agricultural sector significantly improves housing habitability in Pakistan. Saddozai, Hussain, Shah, & Manan (2013) noted that rural

households with heads working in agriculture or manufacturing live in better-quality houses compared to those in other sectors.

## Methodology

This study examines the determinants of uninhabitable housing (RTLH) in Indonesia using secondary data obtained from Statistics Indonesia (BPS) for 34 provinces during 2019–2022. The geographical coverage follows provincial boundaries before the administrative division of the Papua region, with newly established provinces not treated as separate units of analysis. This approach maintains consistent geographical units throughout the study period. The dataset combines cross-sectional observations across provinces with observations over time and is therefore analyzed using panel data regression (Gujarati, 2003).

The dependent variable is the percentage of uninhabitable housing. The main explanatory variables comprise six drinking water sources: piped water, bottled water, refill water, drilled or pumped wells, protected wells, and protected springs, and three sanitation facilities: septic tanks, wastewater treatment plants (WWTPs), and open pits. The control variables include population density, homeownership, years of schooling, GDP per capita, the open unemployment rate, informal employment, and agricultural employment. These variables are included to account for regional and socioeconomic characteristics associated with housing conditions.

The analysis tests whether the explanatory variables are associated with the percentage of uninhabitable housing. For the joint significance test, the null hypothesis states that all slope coefficients are equal to zero, whereas the alternative hypothesis states that at least one coefficient differs from zero. Individual significance tests assess the contribution of each explanatory variable, conditional on the other variables included in the model.

Model selection considers pooled ordinary least squares (OLS), fixed-effects, and random-effects specifications. The Hausman test evaluates whether the random-effects assumption that unobserved provincial effects are uncorrelated with the explanatory variables is supported. A p-value below 0.05 leads to rejection of the null hypothesis and favors the fixed-effects specification; otherwise, the null hypothesis is not rejected, supporting consideration of the random-effects specification. The Breusch–Pagan Lagrange multiplier test assesses whether the variance of the unobserved provincial effects is zero. A p-value below 0.05 provides evidence in favor of random effects over pooled OLS, whereas a p-value of 0.05 or greater indicates insufficient evidence to reject pooled OLS on this basis. Diagnostic testing was conducted to assess heteroscedasticity in the panel regression model. The results indicated non-constant residual variance; therefore, robust standard errors were used to account for heteroscedasticity

## Result and Discussion

The ideal condition for improved drinking water is sourced from piped water, where distribution can be done directly to all households, accessed whenever needed, and free from contamination. However, the analysis reveals that the most significant reduction in uninhabitable houses occurs when the percentage of households using pumped wells and bottled water as their primary drinking water sources increases, resulting in reductions of 1.10% and 0.91%, respectively. Pumped wells are an open

source of drinking water, and bottled water is available when households have the purchasing power. However, this condition is certainly not ideal as it does not meet the United Nations' (2017) indicators for a safely managed drinking water source (located in the house/area within the house fence, available when needed, and free from.

Table 3. Results of Panel Data Regression

| Variable | RTLHRE |
|---|---|
| Piped water | -0.7868*** |
| | (0.005) |
| Bottled water | -0.9060*** |
| | (0.000) |
| Refilled water | -0.8784*** |
| | (0.000) |
| Pumped water | -1.096*** |
| | (0.000) |
| Protected well | -0.7982*** |
| | (0.000) |
| Septic tank | -0.1801* |
| | (0.083) |
| WWTP | 0.6131 |
| | (0.297) |
| Open pit | -0.1161 |
| | (0.428) |
| Long population destiny | 6.7102 |
| | (0.216) |
| Homeownership | 0.0967 |
| | (0.314) |
| Years of schooling | -10.8662*** |
| | (0.001) |
| Long GDP per capita | 6.4334 |
| | (0.235) |
| Open unemploy rate | 0.4906 |
| | (0.155) |
| Informal labor | -0.2362 |
| | (0.076)* |
| Log agricultural labor | -0.5060 |
| | (0.777) |
| Constant | 974903 |
| R-squared: | |
| Within | 0.7945 |
| Between | 0.1461 |
| Overall | 0.1622 |
| Prob (F-statistic) | 0.0000 |
| Observations | 136 |

t statistic in parentheses
* p<0.1, ** p<0.05, *** p<0.01

The results of the Pearson Correlation analysis show that the high influence of pumped wells and bottled water is correlated with population density. Population density in Indonesia shows an increase every year. Data from the Central Statistics Agency for 2019-2022 show that Indonesia's population density continues to increase, with Java and Nusa Tenggara being the regions with the highest density. Java also has households with the highest use of bottled water and pumped wells in all of Indonesia,

with the highest in DKI Jakarta (population density 15,967 people/$m^2$). High use of bottled drinking water is also found in Bali (population density 754 people/$m^2$).

The denser the population, the higher the area's need for improved drinking water. Unfortunately, this need does not include equal coverage of plumbing services. In Jakarta, the PDAM pipe network only reaches 64% of the area, while areas that do not receive services rely on groundwater obtained from pumped wells, jet pumps, and artesian wells (Ministry of Communication and Informatics, 2020). Due to the limited coverage of groundwater and piped services, drinking water sources must include not only pumped wells but also bottled water. However, referring to the criteria set by the United Nations, piped water remains the ideal source of improved drinking water, as it allows for better control over water quality and quantity. Therefore, the optimal solution for meeting the need for improved dirnking water is through expanding piped water services.

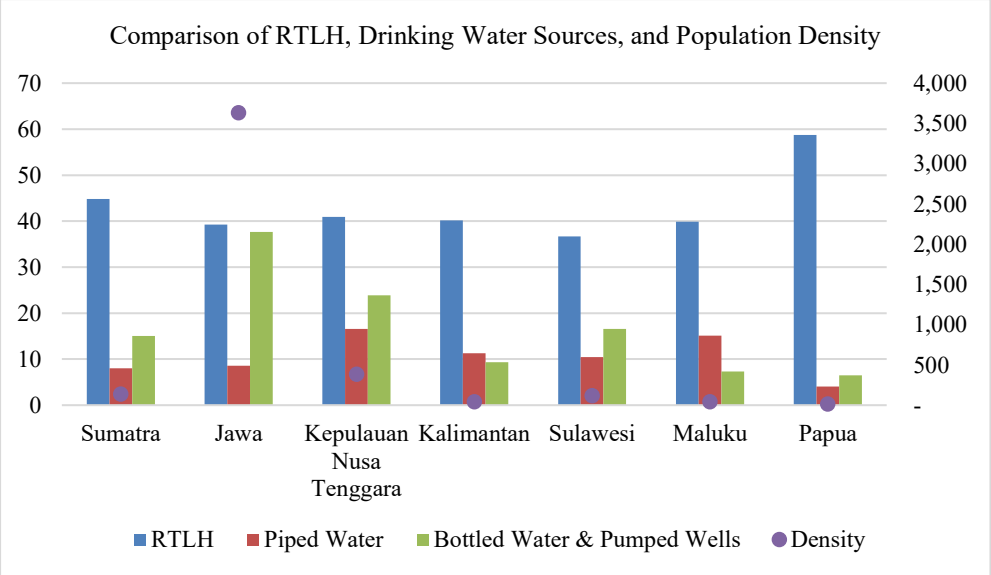



Figure 2. RTLH (%), Drinking Water Sources (%), and Population Density (people/$km^2$)

Source: Central Statistics Agency (2019-2022), processed

The analysis results indicate that septic tanks are the most widely used sanitation facilities (TPAT) in Indonesia, demonstrating that the majority of households are utilizing improved sanitation options. This aligns with the findings of Ren, Yuan, & Hu (2018), which highlight that sanitation facilities significantly impact housing habitability. In addition to septic tanks, Wastewater Treatment Plants (WWTPs) are also considered improved sanitation facilities. However, WWTPs, which are used communally and provided by the government, have the lowest usage in Indonesia. This low usage is attributed to the use of septic tanks in over 80% of households and the high investment costs associated with WWTP construction (Ministry of PUPR, 2009). Consequently, regression analysis shows that WWTP does not affect the prevalence of uninhabitable houses.

Although the use of open pits in rural areas in Indonesia is still considered in the improved sanitation facilities category by the Central Bureau of Statistics, the United Nations (2017) states otherwise, namely that the disposal of feces in fields, forests,

bushes, open water bodies, beaches, or other open spaces is included in open defecation behavior. The use of open pit implies that waste management is not carried out and without management, disease and pollution will spread in the ground and surface water. This will impact groundwater contamination as a drinking water source (United Nations, 2017). If we look further, open pits are still found in urban areas, with the highest percentage in Bengkulu, Lampung, and West Kalimantan. This indicates that there are still households that do not have improved sanitation facilities, either for private use (septic tank) or for communal use (WWTP), even though the government can provide both. This demonstrates that the provision of sanitation facilities, which should be facilitated by the government, remains uneven.

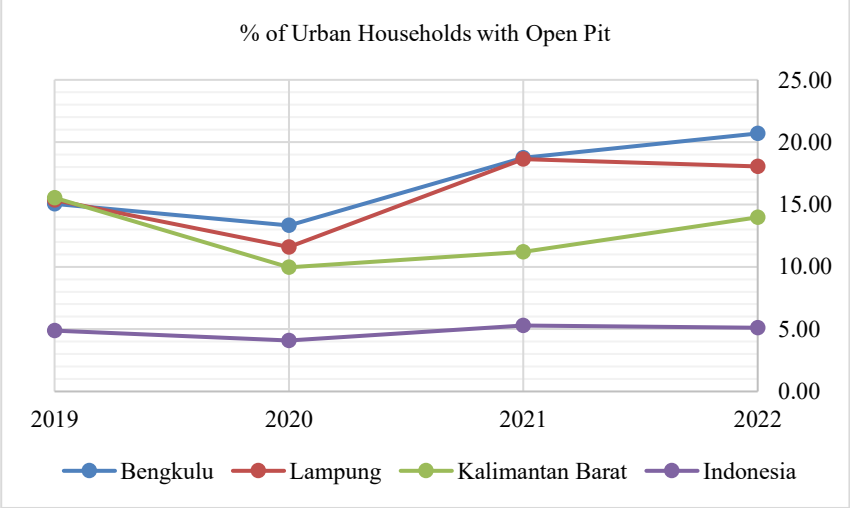



Figure 3. Percentage of Urban Households with Open Pit as Sanitation Facility
Source: Central Statistics Agency (2020-2022), processed

### *Regional and Socio-Economic Characteristics*

Apart from access to drinking water sources and sanitation facilities, other determinants of housing habitability are population density, homeownership, years of schooling, GDP per capita, TPT (Open Unemployment Rate), labor status (informal), and the labor sector (agriculture). The results of the analysis show that population density does not have a significant effect on uninhabitable houses. High population density limits land availability and increases the demand for habitable housing, leading to the existence of more uninhabitable housing. This condition is seen in areas with very high population density, such as DKI Jakarta with a population density of almost 16,000 people/km$^2$. Ofori (2020) found a similar situation in Ghana, where high population density is associated with many uninhabitable houses, especially in urban areas.

DKI Jakarta does have a high percentage of uninhabitable houses and high population density, but conditions at the regional level show the opposite. A comparison of the average population density with RTLH in 2019-2022 shows that Java, as the region with the highest population density (3,629 people/km$^2$), has a low percentage of RTLH, namely 39.27%. Meanwhile, Papua, where population density is very low (12 people/km$^2$), has the highest percentage of RTLH, namely 58.71%. This indicates that the government's policy to reduce uninhabitable houses has not been

evenly implemented. Data from the PUPR Ministry shows that in 2019 and 2020, 51% of aid for building and repairing houses through the BSPS program was distributed to the Java and Sulawesi regions, which have the lowest number of uninhabitable houses and the highest population density. The government's realization in the Java region reached 55% in 2021 and increased to 58% in 2022. This is evident in DI Yogyakarta, the province with the lowest RTLH from 2019 to 2022, where the RTLH in the province remained under 20% annually, despite a high population density of over 1,000 people per $km^2$. This condition shows that government intervention in housing provision and assistance significantly impacts the reduction of uninhabitable houses, even in densely populated areas.

The analysis also reveals that homeownership does not have a significant effect on uninhabitable housing. The high level of homeownership is not accompanied by a low percentage of uninhabitable homes due to government policy primarily focusing on promoting homeownership, as is evident from the numerous programs encouraging people to become homeowners, such as the One Million Houses Program and FLPP (Housing Financing Liquidity Facility) for MBR (Low-Income Communities). Although intended for MBR, these programs are accessible only to those with stable incomes who have access to banking services. Additionally, in Indonesia, individual households often construct their homes independently without adequate knowledge about the standards for habitable housing. As per the research results of Ofori (2020), a lack of knowledge about housing habitability is a major factor causing uninhabitable housing.

In terms of education, the results of the analysis show that years of schooling have a significant effect on uninhabitable housing. This is in line with the results of the research conducted by Fiadzo (2004) in Ghana, Ren, Yuan, & Hu (2018) in China, Saddozai, Hussain, Shah, & Manan (2013) in Pakistan, Koskei, Koskei, Koske, & Koech (2013) in Kenya, as well as Adams, Boateng, & Amoyaw (2016) and Agbadi, Darkwah, & Kenney (2019) in Ghana. Increasing the length of education increases sufficient knowledge about finance and housing, which then affects the reduction of uninhabitability.

Data from the Central Statistics Agency for 2019-2022 also shows a correlation between years of schooling and RTLH. When comparing the average length of education with RTLH, the Maluku Islands have the highest years of schooling at 9.84 years and a lower RTLH at 39.87%. In contrast, Papua has the lowest years of schooling at 8.53 years and a higher RTLH at 58.71. These conditions indicate that years of schooling correlate with financial knowledge, which is necessary for understanding the costs and resources required for building and repairing a house. Additionally, knowledge about housing habitability is crucial as it informs decisions about building habitable housing (Ofori, 2020).

Apart from regional characteristics, several macroeconomic indicators, one of which was GDP per capita, were also analyzed. The research results show that GDP per capita does not significantly affect uninhabitable houses. This result is different from the findings of Ren, Yuan, & Hu (2018), Fiadzo (2004), Saddozai, Hussain, Shah, & Manan (2013), and Ulman & Cwiek (2020), which show that income has a positive effect on house quality. A comparison of the average GDP per capita with the RTLH in 2019-2022 reveals that Sulawesi with an average GDP per capita of around IDR 34.2 million has the lowest RTLH at 36.71%. In contrast, Papua, with a higher average GDP per capita of around IDR 46.6 million, has the highest RTLH at 58.71%. This

suggests that high purchasing power does not necessarily translate to housing habitability. Purchasing power is linked to the level of expenditure, with spending priorities influences expenditure distributions. Data shows that in the Papua region, food expenditure constitues 54% of the total expenditure, whereas in Java, this portion is smaller at 46% (Central Statistics Agency, n.d.). Expenditures used for non-food needs indicate that there are expenditures used to meet the housing habitability criteria, such as ensuring access to improved drinking water sources. This is in line with Ofori's research (2020), which states the financial requirement for providing habitable housing.

Furthermore, the analysis indicated that TPT (Open Unemployment Rate) does not have a significant effect on uninhabitable houses. Ren, Yuan, & Hu (2018) suggest that the human capital variable, represented by the number of employed household members, determines housing habitability. The more employed household members, the higher the income they will earn in the future to finance the construction of habitable housing.

A comparison of the average TPT with RTLH in 2019-2022 shows that the Nusa Tenggara Islands have the lowest average TPT. In the same period, the region also had a lower RTLH than Papua, where TPT was higher. However, Java has the highest average TPT at 6.89% and has a lower RTLH than Papua (Central Statistics Agency, 2021). This indicates a continued focus on development in the Java region, which has benefited significantly from government intervention. Despite its high TPT and other regional characteristics such as very high population density, Java maintains relatively low RTLH. The analysis also reveals that informal labor has a significant effect on uninhabitable houses. This is supported by the findings of (Ahmad, Ahmad, & Ali, 2000) that underscore the significance of employment type (permanent/temporary) in house habitability. This relates to the income earned, where workers with permanent employment types have guaranteed income that can be allocated for creating habitable housing. The results of Fiadzo's (2004) research also state that heads of households who work in the informal sector resided in uninhabitable housing.

Data from the Central Statistics Agency in 2019-2022 show that Papua, with the highest percentage of informal workers (Central Statistics Agency, 2023), also has the highest percentage of RTLH. In contrast, Sulawesi, with a similar proportion of informal workers, has much lower RTLH rates, even the lowest in Indonesia. Informal workers do not have guaranteed income necessary for accessing habitable housing. Therefore, intervention from the government is needed evenly throughout Indonesia, particularly policies assisting informal workers to have access to habitable housing so that the reduction in RTLH can occur evenly.

Data from the Central Statistics Agency for 2019-2022 shows that the decline in uninhabitable houses occurred by an average of 1.97% in Indonesia. Papua, as the region with the highest RTLH, only experienced a decline in housing of 0.45%. Meanwhile, the Maluku and Sulawesi Islands experienced the highest decline in uninhabitable houses at 2.55% and 2.46% on average. The importance of government investment towards the inhabitables housing showed by one of the research findings conducted by Luo, et al. (2018) in China and by Mulenga, Bwalya, & Kaliba-Chishimba (2017) in Zambia that shows the higher the investment, the higher the access society has to improved drinking water and sanitation facility. Therefore, if the disparity in the implementation of government policies persists, regions like Papua will continue to face limited access to habitable housing.

Furthermore, the analysis indicates that labor in the agricultural sector has no effect on uninhabitable houses, contradicting the findings by Fiadzo (2004) and Saddozai, Hussain, Shah, & Manan (2013). Both results suggested that households whose head of household was employed in the agricultural sector resided in uninhabitable housing. Observing the regional aspect, the number of agricultural sector laborers dominates in the rural areas, where the increase in habitable houses is higher than in urban areas. This is due to the lower population density, allowing for more available land for habitable housing development.

Table 4. Percentage of Habitable Housing in Urban and Rural Areas

| Area | Percentage of Habitable Housing | | | | Average |
|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | |
| Urban | 61.09 | 63.24 | 64.70 | 63.50 | 63.11 |
| Decrease/Increase (%) | | 2.15 | 1.41 | -1.20 | 0.79 |
| Rural | 50.67 | 54.82 | 56.00 | 56.80 | 54.57 |
| Decrease/Increase (%) | | 4.15 | 1.13 | 0.89 | 2.06 |

Notes: Central Statistics Agency (2019-2022), processed

On the expenditure side, Sulawesi, as the region with the lowest RTLH, has the highest non-food expenditure (housing needs included) in rural areas (Central Statistics Agency, n.d.). This indicates that rural residents, where the majority of the people are agricultural laborers, allocate their income towards housing needs. As emphasized by Ofori (2020), housing habitability correlates with the financial resources required to meet the habitability standards.

## Conclusion

The findings indicate that drinking water sources, sanitation facilities, and selected socioeconomic characteristics are associated with uninhabitable housing in Indonesia. Higher proportions of households using piped water, bottled water, refill water, pumped wells, protected wells, and protected springs are associated with lower percentages of uninhabitable housing. Years of schooling also show a significant negative association with uninhabitable housing, while septic tank use and the proportion of informal workers exhibit negative associations that are statistically significant at the 10% level. In contrast, the analysis finds no statistically significant associations for wastewater treatment plants (WWTPs), open pits, population density, homeownership, GDP per capita, the open unemployment rate, or agricultural employment.

Access to improved drinking water sources is more widespread than access to improved sanitation facilities, with national coverage reaching approximately 91% and 81%, respectively. Substantial regional disparities nevertheless persist. Papua has the lowest access to both services, with approximately 65% of households having access to improved drinking water sources and only 40% having access to improved sanitation facilities. The continued use of open pits in urban areas further highlights gaps in sanitation provision.

These findings underscore the importance of expanding access to improved drinking water and sanitation facilities, particularly in underserved regions such as Papua. The association between schooling and housing conditions also supports considering education alongside infrastructure provision in efforts to improve housing

habitability. However, the estimated relationships should be interpreted as associations rather than evidence of causal effects.

### *Limitations and Further Studies*

This study focused on two out of the four criteria for habitable housing established by the Central Statistics Agency: access to improved drinking water sources and sanitation facilities. Further research is required to analyze all four criteria for habitable housing at the regional level. By doing so, comprehensive analysis results can be generated, leading to more comprehensive policy recommendations aimed at reducing uninhabitable housing in Indonesia. Additionally, the research findings indicate that years of schooling and informal labor contribute to reducing uninhabitable housing. Both factors are associated with income, suggesting that household welfare affects the reduction of uninhabitable housing. Further analysis is necessary to assess uninhabitable housing based on household welfare, aiming to offer more targeted policy recommendations.

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