Study of permanent residential management in Tondo Village, Palu City

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ABSTRACT

Currently the regional government of Central Sulawesi Province through the Ministry of PUPR has built several permanent residential units (Huntap) for victims of the natural disaster on September 28 2018 that occurred in Palu City, one of which is located in Tondo Village, right behind the Tadulako University Campus. However, based on the results of the initial survey that had been carried out, there were still some things that were not given much attention, such as the provision of housing facilities and infrastructure as well as the shape of houses and their locations that did not respond to the topographic climatic conditions in Palu City. Based on the above premise, regarding the importance of permanent housing arrangement for victims of natural disasters, a problem can be formulated, namely "What is the concept of permanent housing arrangement in Tondo Village with a healthy shelter-based approach?"This study uses a rationalistic approach. The rationalistic approach is an approach that sees truth not solely from empirical conditions but also from argumentation as a part of thinking construction. To collect information and obtain data that is directly related to the research, a direct observation was carried out which included observation at the permanent residential location of Tondo Village which was the object of this study.The design concept carried out in the arrangement of permanent housing in Tondo Village is to formulate the concept of providing housing facilities and infrastructure. In addition to this, the model of residential buildings is also designed to be more attractive, so that it will be different from the appearance of permanent residential buildings that currently exist. The house design is maximized to be able to respond to the climate around a permanent residence, so as to be able to produce designs that guarantee the health of the residents of the house. The structural system used is no different from existing huntap building structural system, namely the simple healthy instant house structure system (RISHA.

1. Introduction

Two years after the natural disaster of 28 September 2018, which hit Central Sulawesi Province, especially Palu City and its surroundings, the Palu City Government has planned the construction of several permanent residences whose locations have been determined by the Central Sulawesi Provincial Government through the Governor's Decree Number: 369/516 / DIS. BMPR-G.ST/2018. These permanent shelters are intended for victims of natural disasters that have occurred. These permanent shelters are located in several locations, among others, 1) permanent dwellings located in Tondo Village; 2) permanent residence located in Talise Village; 3) permanent residence located in Kelurahan Duyu; and 4) permanent residence located in Balaroa Village.

Currently, the local government through the Ministry of PUPR has built several permanent residential units (Huntap) in several of the locations mentioned above. However, based on the results of the survey that has been carried out, there are still some things that have not been paid attention to, such as the provision of housing facilities and infrastructure as well as the shape of houses and their locations that do not respond to topographic climatic conditions in Palu City. By starting from the above premise, regarding the importance of permanent housing arrangement for victims of natural disasters, a problem can be formulated, namely "What is the concept of permanent housing arrangement in Kelurahan Tondo with a healthy shelter based approach?"

With the formulation of these problems, this research was conducted with the aim of answering the existing problems in the research question. The purpose of this research is to find out how the concept of permanent housing in Kelurahan Tondo uses a healthy housing-based approach. The scope of this research is to examine the permanent housing arrangement in Tondo Village with a healthy housing-based approach.

1.1. Home Overview

1.1.1. Definition of Home

A house is a building that functions as a place to live that is suitable for habitation, a means of fostering a family, a reflection of the dignity of its occupants as well as assets for its owner [1]. In a broad sense, a house is not only a (structural) building, but also a place of residence that meets the requirements of a decent life, seen from various aspects of community life [1]. Based on this definition, a residence can be interpreted as a place to live that has various functions for a proper place for human life. So in conclusion, the house is a building that has a function as a shelter and a place to rest.

1.1.2. Simple Healthy Home Concept

Healthy Simple House (Healthy Rs) is a house that is built using simple building materials and construction but still meets the minimum standard needs from the aspects of health, safety, and comfort, by considering and utilizing local potential including physical potential such as building materials, geology, and local climate as well as socio-cultural potential such as local architecture, and way of life [1]. The target of providing Simple Healthy Homes is for low income groups of people. In its implementation, the fulfillment of the provision of simple healthy houses still faces obstacles, in the form of low levels of community capacity, considering that the price of simple healthy houses still does not meet overall affordability. For this reason, it is necessary to provide an intermediate house design whose growth is directed to be Healthy Rs.

Rumah Sederhana is a place to live that is habitable and affordable for low and middle income people. The ideal plot area, in the sense that it meets the need for land area for a simple healthy building, both before and after it is developed. Broadly speaking, the calculation of the area of a residential building and the ideal area of a lot that meets the requirements of health, safety and building comfort are as follows: 1) The minimum space requirement according to the calculation with the Minimum Standard size 9 m2, or the threshold standard is 7.2 m2 per person. As a basic conception, the two calculations are still used while still considering the final form of the post-development house; and the module study for RIT and its growth to Rs Sehat-2, which is based on 3 M modules with a combination of land area and buildings, schematically it can be seen in Fig. 1 :

1.2. Housing Overview

1.2.1. Definition of Housing

According to S.M. Suparno and E. Marlina [2], housing is a group of houses that function as a residential or residential environment equipped with environmental infrastructure, namely the basic physical environment features, for example drinking water supply, garbage disposal, electricity, telephone, road, which allows a residential environment. function as it should.

Meanwhile, according to E. Budiharjo [3], housing is a building where humans live and carry out their lives, besides that the house is also a place where the socialization process takes place in an individual, introduced norms and customs that apply in a community. As a place for human life, it does not only involve technical and physical aspects but also social, economic and cultural aspects of its inhabitants.

Based on the two meanings above, it can be concluded that housing is a group of houses or other buildings built together as a single development.

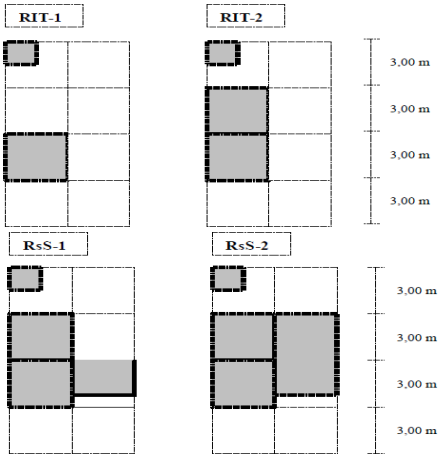

Fig. 1. The growth pattern of RIT towards a healthy house-2 on land conditions with high prices, with a minimum width of 6.00 m with an effective land area of 72 m2 and an ideal land area of 200 m2 [1]

1.2.2. Minimum service standards for housing in the regulation of the minister of public housing of theRepublic of Indonesia number 22 of 2008

Minimum Service Standards (SPM) are provisions concerning the type and quality of basic services which are mandatory regional affairs that are entitled to a minimum of every citizen [4]–[6]. The basic service in question is a type of public service that is fundamental and absolute to meet the needs of society in social, economic and government life.

The government provides services in the housing sector so that people are able to live in a livable and affordable house in a healthy and safe environment that is supported by infrastructure, facilities and public utilities (PSU). To provide these services, the government establishes SPM in the people's housing sector in provincial and district-city areas. The provincial and district / city governments carry out housing affairs services in accordance with the SPM in the public housing sector, which consists of the types of basic services, indicators, values and deadlines for achievement of 2009–2025. Types of basic services include livable and affordable housing, and a healthy and safe environment that is supported by infrastructure, facilities and utilities (PSU)

1.2.3. Settlement Environmental Infrastructure According to Indonesian National Standard Nomo 03- 1733 of 2004

In the National Standard Agency [7], several standards regarding environmental infrastructure for settlements are explained, including:

- Road Network

  The types of infrastructure and utilities on the road network that must be provided are determined according to the classification of residential roads, which are arranged based on the road hierarchy, road function and housing area / neighborhood class [8]. A good residential road must be able to provide a sense of security and comfort for the movement of pedestrians, cyclists and motorists. In addition, it must also be supported by the availability of road supporting infrastructure, such as pavement, sidewalks, drainage, landscaping, traffic signs, parking and others.

- Drainage Network

  Drainage network is infrastructure that functions to drain surface water to water receiving bodies and or to artificial infiltration buildings [9], which must be provided in residential areas in urban areas.

- Public utility needs, Clean water network some of the requirements, criteria and needs that must be met are:
    - Provision of clean water needs

      The housing environment must have sufficient clean water from a drinking water company orother sources in accordance with applicable regulations; and If there is a city water supply system or an environmental clean water supply system, then eachhouse has the right to have a house connection or a yard connection.
        - Provision of clean water networks
        - There must be a city or neighborhood network up to house connections
        - Pipes buried in the ground using PVC, GIP or fiber glass pipes; and
        - Unprotected above ground pipe using GIP
        - Provision of public faucets (One public faucet is provided for 250 users, maximum service radius of 100 meters, Minimum capacity for public faucets is 30 liters / person / day; and the size and construction of public faucets is in accordance with SNI 03-2399-1991regarding the planning procedures for public mck buildings.
        - Provision of fire hydrants (For commercial areas the distance between fire taps is 100 meters, For residential areas the maximum distance between taps is 200 meters, The minimum distance from the curb is 3.00 meters, If it is not possible to make a tap, fire wells are required; and, Fire hydrant planning refers to SNI 03-1745-1989 concerning the procedure forinstalling a hydrant system for prevention of fire hazards in houses and buildings).
- Wastewater network

  The types of planning elements in the wastewater network that must be provided in urban housing environments are septic tanks [10], infiltration areas and wastewater piping networks.
- Solid waste network

  The types of planning elements that should be provided are trash carts; trash bin; temporary disposal place(TPS); and landfills (TPA).
- Electrical network

  Some of the requirements, criteria and needs that must be met are ; provision of electrical power needs, provision of electricity networks, provision of facilities and infrastructure for electricity networks.

1.3. Settlement Patterns

According to A.R. Wiraprama & Zakaria [11], that the distribution pattern of settlements is strongly influenced by land conditions, water management, topography, and the availability of natural resources in a particular village. There are three patterns of settlement in relation to the landscape, which are as follows:

1.3.1. Linear Settlement Patterns

The linear pattern of residential settlements is said to be linear / elongated if the houses are built to form a long lined pattern. The longitudinal pattern is generally found in residential areas along rivers, roads, or coastlines.

1.3.2. Centralized Settlement Patterns

This settlement pattern is clustered to form small and diffuse units [12]. The centralized pattern is a pattern of residential settlements in which the houses are built at one point. Centralized patterns are generally found in residential areas in villages located in mountainous areas [13].

1.3.3. Scattered Settlement Patterns

The settlement pattern is scattered in highland areas or volcanic areas and areas that are less fertile. In a scattered pattern, residents' houses are built on wide areas and dry land that are spread out and slightly apart from each other. The scattered pattern is generally found in large areas with dry soil. This pattern can be formed when residents try to live near a source of water, especially groundwater, so that houses are built at points that have good water sources.

2. Method

This study uses a rationalistic approach. The rationalistic approach is an approach that sees the truth notsolely from empirical conditions but also argumentation as a part of thinking construction [14]. To collect information and obtain data that is directly related to research, a direct observation is carried out which includes observation activities at a predetermined location. This activity aims to obtain a complete picture of the concept of permanent housing arrangements for victims of natural disasters based on healthy housing. The method of obtaining data is by observation using digital cameras and drone**s.** After all the data is collected, the data analysis stage will be carried out. Data analysis will be carried out in a descriptive qualitative manner by explaining the meaning of each data macro and micro. So that later you will find an architecturally appropriate concept in the arrangement of permanent housing for victims of natural disasters located in Tondo Village.

3. Results and Discussion

3.1. Macro Review

3.1.1. Site Condition

The site is located in Tondo Village, right behind the Tadulako University Campus as show in Fig. 2. The site area is ± 9 Ha or ± 90,000 m2, which is in the planning area that has been determined by the local government of Palu City and is a relatively safe location from natural disasters. This location is land that has been designated as a housing location for victims of natural disasters by the local government through the Decree (SK) of the Central Sulawesi governor Number: 369/516 / DIS.BMPR-G.ST / 2018. The selection of this site area was assumed to meet the current development planning deficiency, namely 300 permanent residential units.

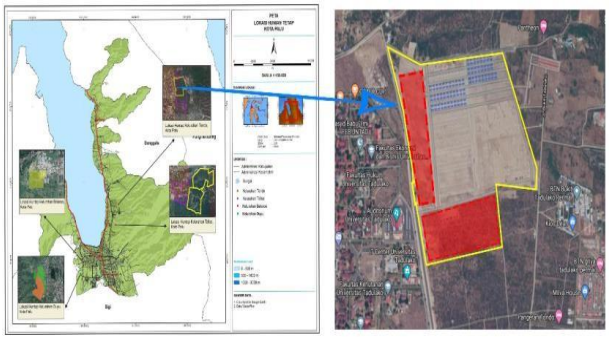

Fig. 2. Site of Research Location

The current description of the site is, among others, in the north there is empty land belonging to the community, in the south there is empty land belonging to the community, in the east there are permanent residential houses that existed before the current permanent residential development, and the west is bordered by the main road and the University campus Tadulako as show in Fig. 3.

The need for housing / housing in planning for housing victims of natural disasters can be calculated using the standard of the Ministry of Public Housing number 403 / KPTS / M / 2002, which is 9 m2 for 1 resident, so that for 1 unit of house with a capacity of 4 people, the area is obtained. 1 house unit of 9 m2 x4 people = 36 m2. Based on the results of surveys and measurements, the land for development planningis ± 9 Ha or ± 90,000 m2. Based on the area of land, for 1 residential unit, if you use the Basic Building Coefficient (KDB) of 60:40. Based on the above calculation, for an area

of ± 9 hectares, a housing area of ± 36,000 m2 or around 300 housing units can be made. With a green open area of 54,000 m2.

Based on the analysis of the needs for the number of occupancy and land area above, if it is assumed that each family head (KK) consists of 4 people, then the number of residents in the planning location willbe 1,200 people. Need for Number of Permanent Shelter show as Fig. 4.

Fig. 3. Conditions around the Site Plan

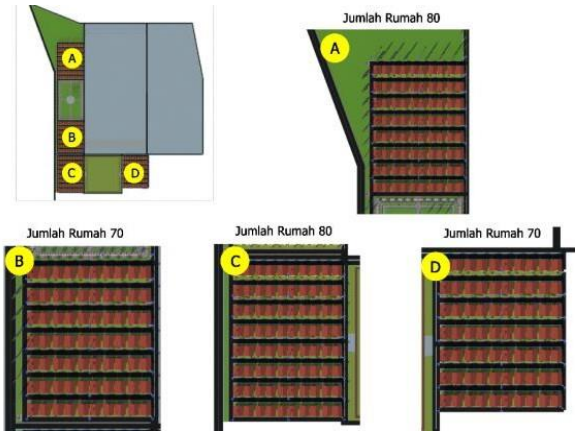

Fig. 4. Need for Number of PermanentShelter. (Source: Analysis Results, 2020)

3.1.2. The Concept of Achievement Towards the Site

Determination of achievement on the site aims to obtain entry and exit directions on the site, in order to make it easier for users to achieve. Reach to the site via the main road on the west side. The means of transportation used to reach the location include city transportation, private vehicles, two-wheeled vehicles, trucks and buses. The basic considerations in achieving the site are:

- The main achievement on the trail is the primary road behind the Untad campus, with a roadwidth of ± 8 meters with a speed limit of 30 km / hour.
- Ease and efficient achievement

3.1.3. The Concept Of Residential Arrangement Patterns And Residential Models

The house arrangement pattern is arranged linearly following the road network pattern of the residential neighborhood [15], [16]. With the shape of the house using the Simple Healthy Instant House (RISHA) construction.Housing planning for victims of natural disasters in Tondo village uses a symmetrical house shape. This isin accordance with the requirements for an earthquake-resistant house model which is an alternative consideration in the design to reduce the risk of disasters from earthquakes, where the residential model still pays attention to health including lighting, ventilation and sanitation. This living house model follows the requirements for building earthquake-resistant

houses based on the Technical Guidelines for Earthquake Resistant Houses and Buildings by the Directorate General of Human Settlements of the Ministry of Public Works. Linear / longitudinal settlement pattern as show in Fig. 5.

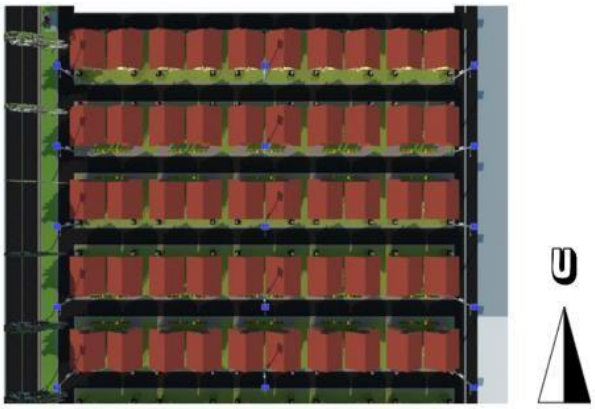

Fig. 5. Linear / longitudinal settlement pattern(Source: Analysis Results, 2020)

3.1.4. Road Network Arrangement Concept

Creating a network of environmental roads designed to follow residential patterns to give a flexibleimpression. The environmental road network that will be provided consists of 2 road classes, namely:

- Neighborhood road network I with a width of 4 meters with a shoulder of 0.5 m, as the connecting axis between neighborhood roads II, using asphalt pavement.
- Neighborhood road network II with a width of 3.5 meters with a shoulder of 0.5 m, as access foreach dwelling, using asphalt pavement.

The road width considerations to be made are as follows:

- As a road for four-wheeled vehicles that can be passed by 2 4-wheeled vehicles and / or if one ofthem is used as parking, other vehicles can still pass it.
- As a way for vehicles needed in an emergency, including fire engines and ambulances [17].

3.1.5. Drainage Network Arrangement Concept

The drainage system planning for permanent housing in Tondo is as follows:

- The drainage system used at the planning site is a closed drainage system
- A road shoulder with a cross-sectional width of 50 cm can be used for a closed drainage system, so that the top of the drainage can be used as a pedestrian area, placement of electric poles, public utility networks and other infrastructure networks.
- The use of closed channel drainage, using fabricated drainage construction materials (U-ditch).
- The cover for drainage uses precast concrete modules which in addition to functioning as a pedestrian place, also makes it easier to control the cleanliness of the drainage in the housing environment.
- Every drainage turn and channel distance of 10 meters is made a control basin to make it easierfor the manager to control

3.1.6. Clean Water Supply Concept

The need for clean water at the residential planning location for victims of natural disasters in Tondo is strongly influenced by the number of people, so the more people there are, the greater the water use will be. Water needs per person per day according to SNI 19-6728.1-2002 concerning the Compilation of the Resource Balance are listed as 150 liters / person / day in a city with a population of 1 million. Referringto the SNI, the standard used for water needs is 150 liters / person / day.

As previously known, the number of dwellings planned to be built is 300 units, assuming that each unitis occupied by 4 people. So that the need for drinking water / clean water must serve 1,200 people. Based on this, the need for drinking water / clean water for the residential environment of victims of natural disasters reaches 180,000 liters of water / day. Therefore, each dwelling provides a water reservoir in the form of a reservoir with a capacity of 2,000 liters with the assumption that 1 water reservoir is used as a backup for daily water use. The water supply system in the residential environment uses water from PDAM.

Then the water is channeled to the residents' settlements through the installed PDAM pipes. Furthermore, in each house there is a water meter, which functions to measure the amount of water that flows and is spent by other clean water customers. The flowed water is then stored in each house reservoir, which is placed on the reservoir tower. And will be used for daily needs

3.1.7. Environmental Sanitation Network Concept

Planning a sanitation network in the shelter of victims of this natural disaster for wastewater management.In a septic tank [18], organic waste is separated between its solid form and its liquid form, then the separated wastewater is flowed into an infiltration well. Infiltration well is a soil and water conservation technique which has the main principle of expanding the absorption area so that the surface runoff is reduced optimally.

The benefits that can be obtained by making this infiltration well are as follows:

- Reduces runoff and prevents standing water.
- Maintaining groundwater levels and increasing groundwater supplies
- Prevent land subsidence or subsidence as a result of excessive groundwater extraction
- Reducing the concentration of groundwater pollution

For household waste, such as used washing water and water sinks, it will go through the control tub. The control tub is a kind of hollow tub that receives dirty water from the bathroom sewer and passes it to the public drain (city sewer). The function of this control tub is so that when dirt deposits occur, we can control and clean it easily. Control tub is made of cast concrete, the top is equipped with iron handles for easy opening and closing. Concept of Sanitation / Waste Management as show in Fig. 6.

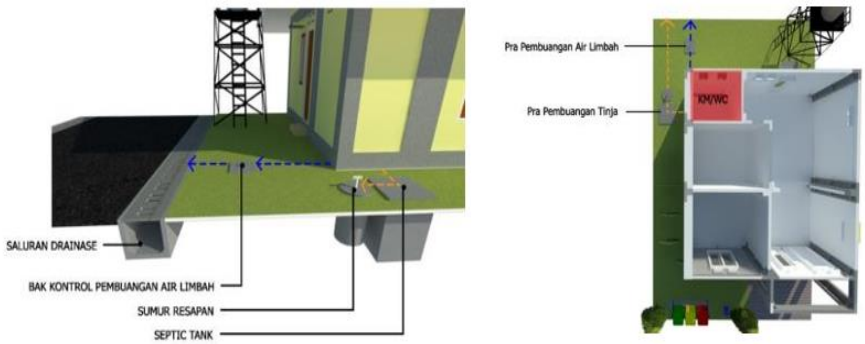

Fig. 6. Concept of Sanitation / Waste Management (Source: Analysis Results, 2020)

3.1.8. Solid Waste Concept

The concept of solid waste in the permanent residence of victims of natural disasters [19] in Tondo is a transportation system from the trash cans of each house, then disposed of to a temporary garbage dump (TPS). Then the garbage will be transported by garbage officers using a garbage collection truck provided by the City Sanitation Service, which is then immediately taken to the final disposal site (TPA) in Kawatuna.

3.1.9. The Concept of Providing Electric Networks

The types of planning elements in the electricity network that must be provided in the housing environment of victims of natural disasters in Tondo Village, include the need for electricity and electricity networks. Basically, the housing environment is obliged to obtain electricity supply services

from the State Electricity Company (PLN). Which has been required that each household unit (KK) gets a minimum service with a subsidy of 900 VA. In addition to the above, for the procurement of Public Street Lighting (PJU) in residential areas it is planned to use a solar panel lighting system. This is done as an effort to save energy.

- Environmental Support Facility Concept.

  To support activities in a residential area, it is necessary to provide supporting facilities in the form of an environmental park which functions as a community recreation space. Based on the standard of green open space provision, for an area of green open space for housing with a population of 1,200 people, the open space at the planning location is placed in the middle of a residential area. Environmental parks can be used as children's playgrounds, they must be planned and built so as to ensure the safety of the children who use them, besides that they can function as places for recreation and communication betweenresidents. In addition to providing open space, a fire protection facility in the form of a hydrant is providedin the housing area of victims of natural disasters in Tondo. Concept of green open space facilities and fire protection as show in Fig. 7.

Fig. 7. Concept of green open space facilities and fire protection(Source: Analysis Results, 2020)

3.2. Micro Review

3.2.1. Space Requirements And Space Amount

The need for space in the dwelling remains adjusted to the number of actors, namely, father, mother, and child, with the assumption that the perpetrator is 4 people. So that you get the area of 1 house unit of 9 m2 x 4 people = 36 m2. The following is a table of space requirements, actors, and the amount of space in permanent housing in Tondo Village. Space Requirements as show in Fig. 8.

No.	Nama Ruang	Pelaku	Perhitungan	Besaran (m^2)	Standar
1.	Kamar Tidur	* Anak	2,00 x 3,00	6,00 m^2	Asumsi
2.	Kamar Tidur Utama	* Ibu * Ayah	2,50 x 3,00	7,50 m^2	Asumsi
3.	Ruang Tamu/ Keluarga	* Ayah * Ibu * Anak * Tamu	3,00 x 3,00	9,00 m^2	Asumsi
4.	Ruang Dapur & Ruang Makan	* Ayah * Ibu * Anak	3,00 x 3,50	10,5 m^2	Asumsi
5.	KM/WC	* Ayah * Ibu * Anak	1,50 x 2,50	3,75 m^2	Asumsi

Fig. 8. Space Requirements, Actors, and Amount of Permanent Occupancy Space

Based on the calculation figure above, a fixed residential plan design is then carried out as shown in Fig. 9.

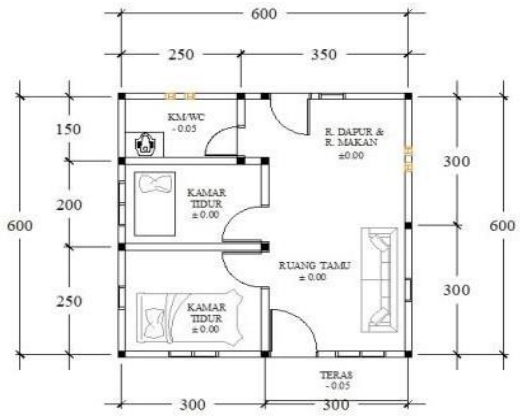

Fig. 9. Permanent residential plans in Tondo Village(Source: Analysis Results, 2020)

3.2.2. Structure Concept

The concept of structure in permanent housing (huntap) which is the object of this study, uses the technology of the Simple Healthy Instant House (RISHA) structure, with the development of a more attractive form, compared to the existing form of huntap buildings. The RISHA construction process does not require cement and bricks, but rather combines concrete panels with bolts. Its main structural material is reinforced concrete, a mixture of sand, cement and gravel. While on the floor, the construction used is attic beams and wooden planks or multiblocks. This RISHA construction was developed since 2004 by theresearch and development agency of the Research and Development Center for Housing and Settlements (Puslitbang Perkim) of the Ministry of PUPR. Risha as a form of engineering knock down technologyused in permanent residential buildings is in accordance with the Kepmen Kimpraswil No. 403 / KPTS /M / 2002 regarding technical guidelines for healthy simple homes.

3.2.3. Form Concept

The form of a permanent residential house in Tondo Village which is the object of this study uses a Subtractive transformation (reduction) indicated by a reduction in the mass composition with a box shape. This is done in order to find a house shape that is more attractive and in accordance with the environmental conditions around the house. Shape Transformation at RISHA's House as show in Fig. 10.

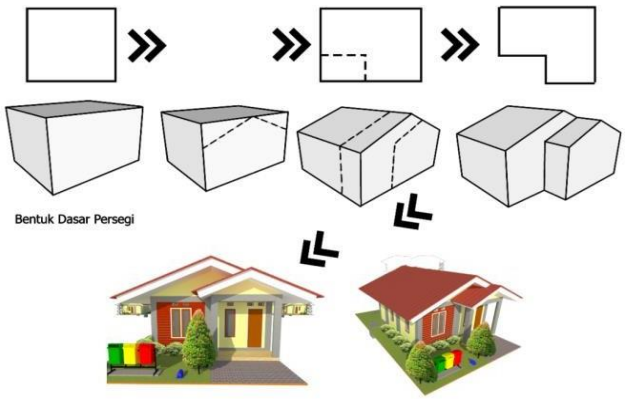

Fig. 10. Shape Transformation at RISHA's House(Source: Analysis Results, 2020)

Declarations

Author contribution. All authors contributed equally to the main contributor to this paper. All authors read and approved the final paper.
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Conflict of interest. The authors declare no conflict of interest.
Additional information. No additional information is available for this paper.

References

[1] "Decree of the Minister of Human Settlements and Regional Infrastructure of the Republic of Indonesia Number: 403/KPTS/M/2002 Date: 02 December 2002 concerning Technical Guidelines for Building Healthy Simple Homes (Rs Sehat)." [Online]. Available at: https://pustaka.pu.go.id/biblio/keputusan-menteri-permukiman-dan-prasarana-wilayah-republik-indonesia-nomor-403kptsm2002-tanggal-02-desember-2002-tentang-pedoman-teknik-pembangunan-rumah-sederhana-sehat-rs-sehat/54329.

[2] G. Broadbent, *Eco-Architecture II*. p. 368, 2008. [Online]. Available at: https://www.witpress.com/books/978-1-84564-119-1.

[3] "Housing planning and development - Surrey County Council."[Online]. Available at: https://www.surreycc.gov.uk/community/housing/planning-and-development.

[4] M. A. Kuddus, E. Tynan, and E. McBryde, "Urbanization: A problem for the rich and the poor?," *Public Health Rev.*, vol. 41, no. 1, pp. 1–4, Jan. 2020, doi: 10.1186/S40985-019-0116-0/METRICS.

[5] S. Samion and Y. Darma, "Minimum Service Standards for Basic Education in Border Region," *J. Educ. Teach. Learn.*, vol. 3, no. 1, pp. 104–112, 2018, doi: 10.26737/jetl.v3i1.554.

[6] H. Yusuf and A. Rahman, "Minimum Standard Of Services For Social Functioning Of The Neglected Elderly Received Social Service From Social Welfare Institution : Notes From The Field," in *International Conference on Social Work*, 2020, no. March, pp. 59–65, [Online]. Available: https://jurnal.umj.ac.id/index.php/ICSW2019/article/view/6879.

[7] "Regulation of the State Minister for Public Housing Number: 22/PERMEN/M/2008 concerning Minimum Service Standards for Public Housing in Provincial and Regency/City Regions."[Online]. Available at: https://pustaka.pu.go.id/biblio/peraturan-menteri-negara-perumahan-rakyat-nomor-22permenm2008-tentang-standar-pelayanan-minimal-bidang-perumahan-rakyat-daerah-provinsi-dan-daerah-kabupatenkota/E768K.

[8] M. Schlecht and R. Meyer, *Site selection and feasibility analysis for concentrating solar power systems*. Woodhead Publishing, pp. 99-125, 2021, doi: 10.1016/B978-0-12-819970-1.00015-3.

[9] R. Yusuf, "Study of Urban Drainage Network Performance in Maximum Discharge Storage in the City of Bandung," *KnE Soc. Sci.*, vol. 3, no. 12, p. 711, Mar. 2019, doi: 10.18502/KSS.V3I12.4143.

[10] "Wastewater Network Optimization | Xylem US." [Online]. Available at: https://www.xylem.com/en-us/products--services/decision-intelligence-solutions/solutions/s/wastewater-network-optimization/.

[11] "SNI 03-1733-2004 Procedures for planning residential environments in urban areas". *NAWASIS – National Water and Sanitation Information Services*. [Online]. Available at: https://www.nawasis.org/portal/digilib/read/sni-03-1733-2004-tata-cara-perencanaan-lingkungan-perumahan-di-perkotaan/51450.

[12] E. B. S, A. Antariksa, and S. Surjono, "Pola Permukiman Desa Petungsewu Kecamatan Dau, Kabupaten Malang," *J. Tata Kota dan Drh.*, vol. 4, no. 2, pp. 101–110, 2012. Available at: https://tatakota.ub.ac.id/index.php/tatakota/article/view/143.

[13] N. Li and S. Jiang, "Study on Spatial Pattern of Rural Settlements in Wuling Mountainous Area Based on GIS," *Wirel. Pers. Commun.*, vol. 102, no. 4, pp. 2745–2757, Oct. 2018, doi: 10.1007/s11277-018-5300-x.

[14] A. R. Wiraprama and A. W. Purwantiasning, "Kajian Pola Permukiman Dusun Ngibikan Yogyakarta Dikaitkan Dengan Perilaku Masyarakatnya," *NALARs*, vol. 13, no. 1, Jan. 2014. [Online]. Available at: https://jurnal.umj.ac.id/index.php/nalars/article/view/383.

[15] "Models of Residential Density and Their Impact on Planning: A Historical and Contemporary Analysis."[Online]. Available at: https://www.jstor.org/stable/44403628.

[16] E. G. Irwin and N. E. Bockstael, "Interacting Agents, Spatial Externalities and the Evolution of Residential Land Use Patterns," in *The Economics of Land Use*, Routledge, 2017, pp. 359–382, doi: 10.4324/9781315240114-23.

[17] H. Hsiao, J. Chang, and P. Simeonov, "Preventing Emergency Vehicle Crashes: Status and Challenges of Human Factors Issues," *Hum. Factors*, vol. 60, no. 7, p. 1048, Nov. 2018, doi: 10.1177/0018720818786132.

[18] "Septic and Onsite Wastewater Systems." [Online]. Available at: https://www.cdc.gov/disasters/foodwater/septic.html.

[19] "Criteria for the Definition of Solid Waste and Solid and Hazardous Waste Exclusions | US EPA." [Online]. Available at: https://www.epa.gov/hw/criteria-definition-solid-waste-and-solid-and-hazardous-waste-exclusions.