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# POST-OCCUPANCY EVALUATION OF PAGERJURANG PERMANENT HOUSING AFTER THE MERAPI VOLCANIC ERUPTION

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**Abstract.** Merapi Volcano erupted in 2010 and a community-based relocation of the destroyed area was implemented step by step in 2011, 2012, and 2013. This study, therefore, employed the Post-Occupancy Evaluation (POE) Method to investigate the ability of the new (permanent) housing model in Pagerjurang Kepuharjo Village, Yogyakarta to make its residents feel at home more than the old one and to determine the residents' responses to their life after 10 years of living in the new model. Questionnaires were used to collect responses from 24 families and the results showed the residents became comfortable after 2 years of living in the new (permanent) housing due to the fulfillment of the post-disaster basic needs and do not wish to be back and live in their old houses. They were also reported to have felt satisfied with the new facilities such as the well-designed infrastructure including clean water, sanitation, electricity, streets, and evacuation routes as well as the well-designed layout with the houses built together (*gotong-royong*) to ensure more efficiency in terms of design. The model was also supported by the Government in terms of housing cost subsidy. In conclusion, the new community-based (permanent) housing has the ability to create a homey atmosphere and helps to ease the post-eruption recovery.

**Keywords:** POE, Pagerjurang, post-disaster, housing, relocation.

## Introduction

Major disasters usually generate several needs and these include housing support for the affected population. For example, when mast disasters hit and destroyed numerous homes, housing support became a challenging task for post-disaster recovery efforts (Fu et al., 2013). Housing is usually the most affected sector in any catastrophic events and millions of houses have been destroyed due to natural and man-induced disasters from earthquakes, cyclones to floods, storms and fire accidents, landslides, and volcanic eruptions (Tipple, 2005).

Relocation is one of the long-term strategies in any disaster management plan and this does not mean a new land and house is provided but by rebuilding displaced lives. It is, however, very challenging to implement these programs to a satisfactory level in any circumstance (Sangasumana, 2018). Moreover, relocation is part of the disaster cycle which is classified under the recovery phase which serves as a key to mitigate and prepare for the next disaster by applying structural and non-structural measures. It is expected to be implemented where there is better access to infrastructure, community services, social networks, and not disaster-prone. The quality of the houses and infrastructure constructed during this process, however, influence vulnerability to the next disaster (Sangasumana, 2018).

Merapi is one of the 77 most active volcanoes in the world (Alexandria, 2015) and according to the data issued by the Operational Control Centre of the National Disaster Management Agency (BNPB) on 12 December 2010, it caused 277 deaths with 2,682 houses heavily damaged in the region of Yogyakarta, a financial loss of Rp.3.62 billion ($402,2 million), 17.27% or Rp.626.65 million ($69,6 million) of which was associated with the housing sector. The post-eruption rehabilitation to restore housing was recorded to have required Rp.247.15 million ($27,4 million) with the relocation model implemented step by step for 3 years including 2011, 2012, and 2013. This was recorded by BNPB (2011) to have covered (a) housing restoration – by considering the safety relocation policy – which is based on mitigation and disaster risk reduction-based spatial layout and design, (b) public infrastructure restoration to support community's mobility and regional

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economy including vital infrastructure for disaster preparedness, (c) social life recovery, (d) community empowerment-based economy recovery, (e) government and environment recovery as well as the disaster risk reduction.

Pagerjurang Permanent Housing is one of the Merapi post-eruption relocations set up by the Government and REKOMPAK (Rehabilitasi dan Rekonstruksi Masyarakat dan Permukiman Berbasis Komunitas/Community-Based People and Housing Rehabilitation and Reconstruction) to fulfill the need of the eruption victims. The Permanent Housing is set in Kepuharjo Village, Cangkringan District, Sleman Regency on a land area of 66.000 $m^2$ which used to be the ground for the village treasury. It is one of the 18 Permanent Housings spread over 7 villages in the Regency as shown in Figure 1.

The Pagerjurang Permanent Housing is 650 m above the sea level in elevation and 9.7 km away from the Summit of mt. Merapi (BPBD Sleman, 2010). The total number of houses built was 301 for 301 patriarchs from 4 villages including Kaliadem, Umbulharjo, Petung, and Manggong. The facilities provided by the Government are cattle cage, a multipurpose building, houses, a place of worship, and a sports field as shown in Figures 2, 3, 4, 5, and 6 respectively.

There were 87.5% permanent buildings and almost all the streets were in good condition before the disaster. The people living on the slope of Mount Merapi are of Javanese culture with a unique social condition such that despite the often occurrence of volcanic eruptions, they feel comfortable living in the area. This was probably due to the fertility in the area as well as the bond among them.

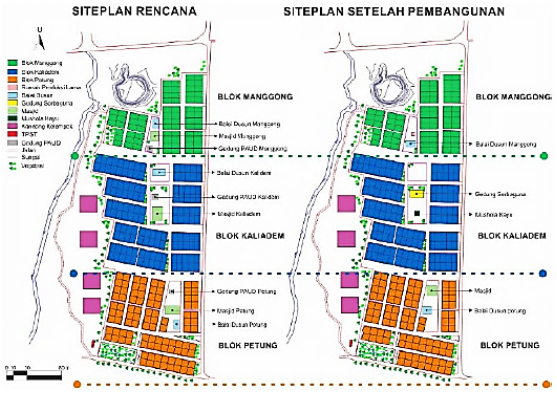



Figure 1. Siteplan housing

Figure 2. Cattle cage

Figure 3. Multipurpose building

Figure 4. Houses

Figure 5. Place of worship

Figure 6. Sports field

The community is ethnically and religiously homogeneous with the majority of the residents being Muslims and Javanese farmers living in a system called *gotong-royong* or work-together, especially while fixing up and rebuilding the damaged houses (RDTR, 2011).

Community involvement in post-disaster recovery activities is based on the values and norms of mutual cooperation which is a helping behavior usually conducted for free. This spirit of cooperation is characterized by the presence of local social groups according to the community needs which reflects their enthusiasm and willingness to prepare for disasters. Moreover, several traditional, cultural, and spiritual values are integrated into the community behavior of those living around Mount Merapi and this contributes to their ability to overcome disaster problems. The repeated eruptions experienced in the area make them have high resilience and independence. The value of mutual help and cooperation is still being preserved in the community and reflected daily in the joint activities of cultivating agricultural land, planting rice, and harvest time. Furthermore, it is also seen as a social capital containing the values of independence, solidarity, collective awareness, and social responsibility encouraging the realization of joint action. This further led to the formation of local social groups such as the Community Social Workers (PSM), Youth Organizations, Social Organizations, and Cadets of Disaster Preparedness with membership from local. They are usually trained and facilitated by the Ministry of Social Affairs and the local Social Service. (Gunawan, 2014). Social capital contributes positively to the development of disaster-resistant communities even though its existence is not realized in social life. The values and norms in joint activities have also been reported to be based on togetherness, mutual assistance, care, and karmic legal mechanisms (Tohani & Wibawa, 2019).

The integration of cultural approach to disaster management has been proved to be significant in a community with members having less knowledge on reducing the risk of a disaster (Haraty & Utabera, 2018). This approach has been reported to be effective in post-disaster reconstruction practices (Aliakbarlou et al., 2018) contrary to the ineffectiveness often associated with management of post-disaster housing reconstruction (Bilau & Witt, 2016). Meanwhile, the "REKOMPAK" (*Kementerian Pekerjaan Umum*/Ministry of General Affairs) was recorded to have provided aids for relocation in a system called "Growing House Development and *Gotong-Royong* Community Empowerment" to the tune of 30 million Rupiahs for each house (Pemerintah Provinsi Daerah Istimewa Yogyakarta, 2011). In contrast, a functional performance measurement evaluates the fitness of a building for the purpose it was constructed with due consideration for user activities. Some of the aspects evaluated include space management, interior, and exterior finishes, proximity to other facilities, and human factors (Zhang & Barret, 2010).

It is very interesting to discuss the successful handling of the Merapi volcanic eruption in Yogyakarta based on the short emergency response period of just one month. This was supported by the community's ability to inhabit disaster-prone areas and understanding of the socialized warning signs through the community leaders and government institutions. The compliance with the rules has been discovered to be a critical success factor in disaster management and it is possible to use the success recorded as an example for other regions, especially the role of community and government cooperation in tackling post-disaster challenges. The Merapi volcanic eruption case was comprehensive due to the interrelationships between nature, social aspect, and culture with the post-disaster management implemented using a community participation approach. This involved the combination of the government and community efforts to restore social, economic, and cultural conditions.

## 1. Methodology

Post-Occupancy Evaluation (POE) Method was applied in this study. This method is usually used to re-examine an assisted as well as inhabited building or community using a more specific process for systematic collection, analysis, and comparison of data (Amoah, 2016). It focuses on developing performance and design evaluations by considering non-technical factors with the possibility of influencing the design and development of facilities.

The concept of Post-Occupancy Evaluation (POE) has attracted much attention in recent years from researchers and research bodies. It has been reported that residential buildings development, by both corporate and government, is expected to be initiated with an understanding of the PO determinants (Aliyu Ahmad, 2016). POE is a tool and system which allows facility managers to systematically identify and evaluate critical aspects of building performance to ensure it meets the intended goals and needs of users after it has been occupied for a period (Eke et al., 2013). It also encompasses an expansive range of processes and activities to systematically evaluate the performance of a building after its handover (Tookaloo & Smith, 2015). Traditionally, building performance knowledge has been passed down through generations of construction specialists with the exhaustive tacit understanding of a client's cultural, social, operational, technical, and economic parameters (Grath, 2011).

A questionnaire is a survey instrument in the form of a series of questions provided to obtain data (Mathers, 2016) and, in this case, it was used to obtain information on the houses the Pagerjurang Permanent Housing residents have been living. The results were intended to determine their opinions on the housing and facilities condition, people's involvement, and their satisfaction. The POE was implemented in 5 stages including the entry and initial data collection, designing the research, collecting data, analyzing data, and presenting the information. This methodology is associated with the descriptive statistics which involve the provision of simple summaries on the sample and observations made quantitatively through statistics or visually using simple-to-understand graphs.

The questionnaires were analyzed using Excel Program and the results are expected to be used as a guide for future development and indirectly to improve further design and performance of the building (Khair et al., 2015). Moreover, several human needs models were required to be accommodated in the design process (Iba, 2016) while the benchmark criteria to compare the quality of finish, services, and performance of the facilities are provided by the POE (Hassabain, 2016) in order to offer guidance for future improvements (Tookaloo & Smith, 2015).

## 2. Discussion

The data obtained from the 24 family respondents showed the majority were housewives with 81% of the people in the Pagerjurang community observed to be from Kaliadem and Petung villages, 14% from Manggong village, and the remaining 5% from Umbulharjo village. The major reason for their relocation was because they had no other place to live as shown in Figure 7.

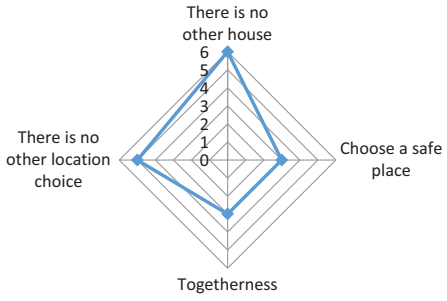


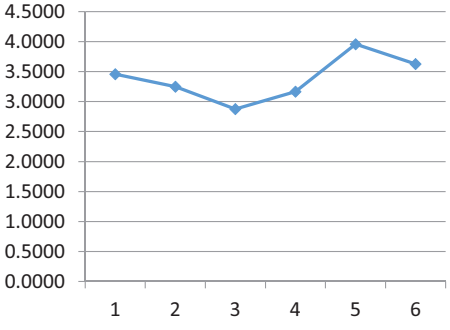

Figure 7. Residents' reason for relocation

Several tables and curves processed from the opinions of the 24 respondents were discussed. The horizontal axis shows the level of respondent satisfaction with the greater magnitude recorded at higher numbers while the vertical axis indicates the questions. The following conclusions were, therefore, drawn based on the results in one table and curve.

*a. Residents' reason for living a comfortable life*

The curve in Table 1 shows the highest level of satisfaction was in number 5 and this means the residents live a comfortable life because their post-disaster basic needs are fulfilled.

Table 1. Residents' reason for living a comfortable life

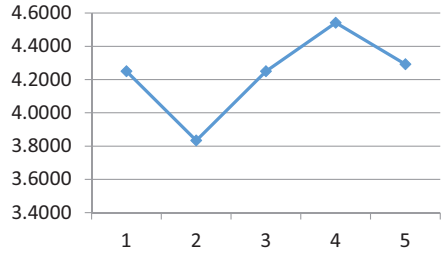



| | | | | | | |
|---|---|---|---|---|---|---|
| | 3.45 | 3.25 | 2.87 | 3.16 | 3.95 | 3.62 |
| Pearson Correlation | 0.70 | 0.82 | 0.68 | 0.78 | 0.73 | 0.63 |
| t Value | 4.69 | 6.90 | 4.41 | 5.95 | 5.14 | 3.82 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **valid** | **valid** | **valid** |
| Valid Number | 6 | | | | | |

*b. Level of satisfaction with the facilities*

The curve in Table 2 shows the highest level of satisfaction was in number 4 and this means the respondents are satisfied with the facilities provided including the place of worship and multipurpose building to support their routine activities. Meanwhile, additional facilities were developed by some of the residents in their houses after the REKOMPAK Program has been completed.

Table 2. Degree of satisfaction with the housing facilities

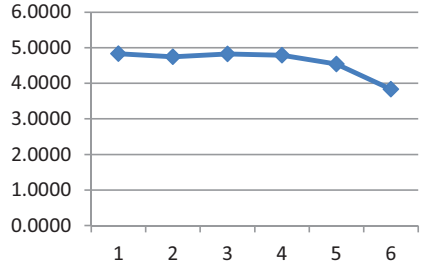



| | | | | | |
|---|---|---|---|---|---|
| | 4.25 | 3.83 | 4.25 | 4.54 | 4.29 |
| Pearson Correlation | 0.59 | 0.50 | 0.64 | 0.67 | 0.59 |
| t Value | 3.50 | 2.75 | 3.94 | 4.32 | 3.43 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **valid** | **Valid** |
| Valid Number | 5 | | | | |

*c. Level of satisfaction with the infrastructure facilities*

The curve in Table 3 shows the highest level of satisfaction was in number 4 and this means the infrastructure facilities such as water and waste management, electricity, streets, and evacuation route are well-designed to the satisfaction of the residents.

Table 3. Degree of satisfaction with the housing infrastructures

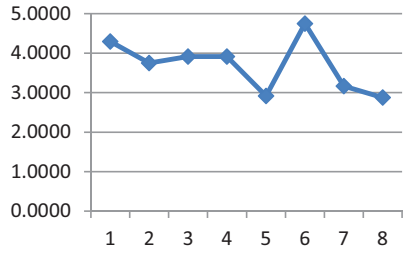



| | | | | | | |
|---|---|---|---|---|---|---|
| Pearson Correlation | 0.48 | 0.42 | 0.56 | 0.57 | 0.40 | 0.48 |
| t Value | 0.79 | 0.66 | 0.96 | 0.98 | 0.62 | 0.77 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | invalid | invalid | invalid | invalid | invalid | invalid |
| Valid Number | 0 | | | | | |

*d. Level of satisfaction with residential and environmental layout*

The curve in Table 4 shows the highest level of satisfaction was recorded in number and this indicates the residents feel comfortable living in Pagerjurang due to the good layout of the new housing, the creation of a similar atmosphere to their previous houses, and the urban environment.

Table 4. Degree of residents' satisfaction with the layout and environment of the housing



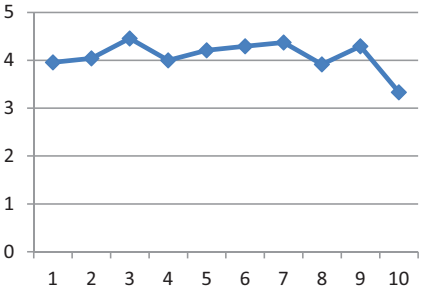

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 4.29 | 3.75 | 3.91 | 3.91 | 2.91 | 4.75 | 3.16 | 2.87 |
| Pearson Correlation | 0.48 | 0.59 | 0.82 | 0.30 | 0.72 | 0.50 | 0.55 | 0.17 |
| t Value | 2.60 | 3.47 | 6.73 | 1.52 | 5.00 | 2.71 | 3.13 | 0.83 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **invalid** | **valid** | **valid** | **valid** | **invalid** |
| Valid Number | 6 | | | | | | | |

*e. Level of residents involvement in settlement and mutual cooperation planning*

The curve in Table 5 shows the highest level of satisfaction was in number 3 and this indicates a high number of validations with a relatively constant level of satisfaction. It also means the respondents felt helped by mutual cooperation since the residents were involved in the processes of planning and designing and they all agreed to the development plan. The experts or architects listen to their ideas during the design process and those willing to develop their houses were required to obtain a building permit from the Government. Moreover, they also helped one another during construction using the *gotong royong* system to save building cost.

Mutual cooperation was also implemented in the maintenance of settlement infrastructure with the people discovered to have repaired damaged evacuation roads, public toilets, and prepared public kitchen equipment.

Table 5. Degree of residents' involvement in planning the housing and doing "Gotong royong"

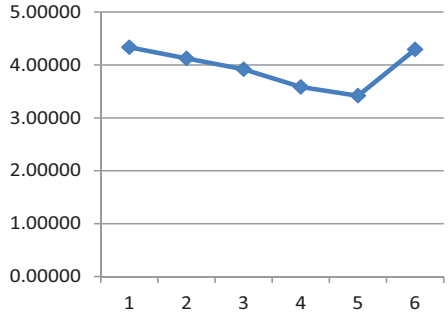



| | | | | | |
|---|---|---|---|---|---|
| | 3.95 | 4.04 | 4.45 | 4.00 | 4.20 |
| Pearson Correlation | 0.61 | 0.78 | 0.35 | 0.17 | 0.73 |
| t Value | 3.63 | 5.97 | 1.75 | 0.84 | 5.11 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **invalid** | **valid** |
| | 4.29 | 4.37 | 3.916 | 4.291 | 3.33 |
| Pearson Correlation | 0.82 | 0.71 | 0.48 | 0.55 | 0.48 |
| t Value | 6.80 | 4.80 | 2.59 | 3.09 | 2.60 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **valid** | **valid** |
| Valid Number | 9 | | | | |

*f. Level of residents' welfare change or the economy*

The curve in Table 6 shows the highest level of satisfaction was in number 1 and this means the government supported the residents' economic growth by providing each family with some cattle for them to make a living. This is expected to increase their prosperity compared to their condition before relocation.

Table 6. Degree of change in the residents' prosperity

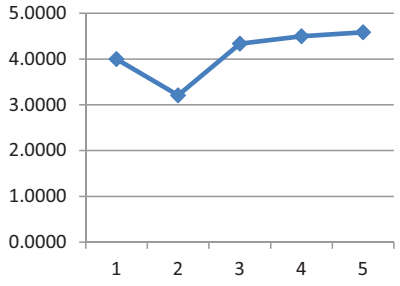



| | | | | | | |
|---|---|---|---|---|---|---|
| | 4.33 | 4.12 | 3.91 | 3.58 | 3.41 | 4.291 |
| Pearson Correlation | 0.57 | 0.78 | 0.89 | 0.60 | 0.79 | 0.15 |
| t Value | 3.31 | 5.95 | 9.38 | 3.53 | 6.05 | 0.72 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **valid** | **valid** | **invalid** |
| Valid Number | 5 | | | | | |

*g. Disaster preparedness level*

The information provided in the curve of Table 7 shows the highest level of satisfaction to be in number 5 and this means the residents believe the possible natural threats are lava eruptions and tremors. However, in case they eventually occur, the village chief is expected to instruct the residents to follow the guidelines in the early warning system in order to evacuate themselves to a safer place.

Table 7. Degree of disaster alertness

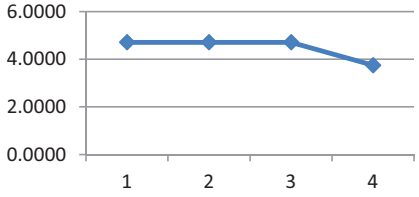


| | | | | | |
|---|---|---|---|---|---|
| | 4.00 | 3.20 | 4.33 | 4.50 | 4.58 |
| Pearson Correlation | 0.42 | 0.28 | 0.03 | 0.53 | 0.57 |
| t Value | 2.22 | 1.37 | 0.16 | 2.94 | 3.29 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **invalid** | **invalid** | **valid** | **valid** |
| Valid Number | 3 | | | | |

*h. Level of program sustainability*

The curve used to represent the information in Table 8 shows the highest levels of satisfaction were in numbers 1, 2, and 3 and these indicate the stability of the respondents' appreciation towards the program's sustainability. The relocation program was considered successful due to the collaboration between the government and residents and they wish it is reimplemented in future occurrences.

Table 8. Residents' expectation for the program's sustainability




| | | | | |
|---|---|---|---|---|
| | 4.70 | 4.70 | 4.70 | 3.75 |
| Pearson Correlation | 0.75 | 0.43 | 0.50 | 0.84 |
| t Value | 5.43 | 2.28 | 2.74 | 7.38 |
| t Table | 1.73 | 1.73 | 1.73 | 1.73 |
| Explanation | **valid** | **valid** | **valid** | **valid** |
| Valid Number | 4 | | | |

The successful implementation of the government programs as indicated by the level of respondents' satisfaction in Tables 1–8 is inseparable from the role of REKOMPAK which involved coordinating with the government to distribute the aid. It was also involved in the discussions with the architect team in designing the house layout but the collaboration was eventually successful due to the community cooperation.

## Conclusions

The results obtained are stated as follow:

1. The residents feel comfortable because their post-disaster needs are fulfilled.
2. The residents feel comfortable living in the new (permanent) housing and do not wish to return to their old houses. They feel satisfied with the new (permanent) housing facilities.
3. The residents develop additional facilities after the relocation program was completed.
4. According to the residents, the infrastructure such as clean water, sanitation, electricity, streets, and evacuation routes was well-designed.
5. The residents feel comfortable living in the new (permanent) housing because it has a good spatial layout as well as due to their involvement in the relocation process.
6. The location was selected based on the agreement of all residents and the government's building permit was obtained.
7. The residents built the new housing collaboratively to ensure efficiency based on the blueprint and were supported by the Government in terms of building cost subsidy.
8. The new community-based housing model created a homey feel and helped the post-disaster recovery process.
9. The concept of community-based development facilitated by REKOMPAK works efficiently and integrates community needs with government programs.
10. Mutual cooperation is a collective awareness and a form of social solidarity conducted for the benefits of the residents. It involved people from different villages and varying initiatives making efforts to mobilize available resources through joint action. This was associated with the level of understanding amongst them, the physical environment in the form of Mount Merapi slopes, and their social environment – agrarian communities.
11. The successful handling of the Mount Merapi post-disaster eruption is evidence of serious government efforts as well as accountability for international agreements on disaster risk reduction.

## Recommendation

It is recommended that local governments, planning authorities, and architects provide continuous support and assistance on socio-cultural and economic activities while responding to future post-disaster programs to ensure readiness in case of other disasters. Furthermore, the community is advised to continue mutual cooperation in order to accelerate post-disaster handling.

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