

ARCHIVING TRADITIONAL HOUSES THROUGH DIGITAL SOCIAL MAPPING: AN INNOVATION APPROACH FOR LIVING HERITAGE CONSERVATION IN JAVA

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Abstract. Indonesia has various types of traditional houses, one of which is the most unique architectural work that is the Joglo Pencil (JP) house. It also has a meaning by reason of a symbol which defines as the development of culture and identity. The role of community in the conservation of cultural heritage buildings is very important. However, due to the pressure of urbanization, many heritage buildings transitioned into modern houses. The study area is the historic area of Kudus city, which previously had a significant influence on Islamic architecture due to its residential model. This study aims to provide a social mapping using GIS and primary survey involves community participation of living heritage. As a result, IT becomes the bridge between conservation needs and management patterns of structured organizations that connects all stakeholders. By innovation of digital social mapping, it will be a bridge for the participation of living heritage community with a more transparent and accountable conservation management. In this case, it is shown that Kudus has experienced cultural shifting and transition in traditional houses. The architectural design of the houses that was initially in JP has begun to disappear. The role of the community in social mapping is very decisive in providing data accuracy. Lacking in preservation and maintenance are the main factors, especially the minimum effort from local government. Therefore, active cooperation between cultural communities, communities, and the government is needed to be able to keep the existence of JP intact as a historical heritage building.

Keywords: traditional wooden house, living heritage, conservation, digital mapping.

Introduction

Sustainability of cultural values in the era of urbanization is one of the world's critical issues. One of which is related to the impact of urbanization on cultural conservation and local wisdom (Lang et al., 2016). The issue spurred discussion on the development of world civilization, which was assessed from the cultural and historical value of a nation (Salamak & Fross, 2016). Urbanization that erodes local cultural values needs to be an essential note (Lang et al., 2016). As it is known that in 2050 the concentration of more than 60% of the world's population is in urban areas (Organisation for Economic Co-operation and Development, 2014), which is why cultural change in the form of physical space is very vulnerable to occur.

It is important to safeguard culture from the strong influence of urbanization. The real problem arises, which has been becoming a central issue in cultural architecture, namely the preservation of buildings that have historical and local values (Wikantari, 2001). This issue is strength-

ened to be an essential spotlight in the world such as the management of historic buildings in Lithuania and Cyprus (Seduikyte et al., 2018), traditional housing in Italy (Resuli & Dervishi, 2015), cultural building in China (Shao et al., 2019), and heritage settlement in Indonesia and South Korea (Suprati et al., 2018). The case is also a problem in Asia, especially for developing countries like Indonesia.

The change in architectural values from traditional to modern is an evident fact, especially in one of the influential cultures in Indonesia, namely Java. Javanese civilization is one of the older civilizations and plays an important role in Indonesian culture. One of the advantages and uniqueness of Javanese culture is the architectural product that has a unique characteristic, which is the Joglo building. Joglo building had developed in Java with a many of variations, one of which is Joglo Pencil (JP) in Kudus city. It has a knock-down wooden frame structure using wooden pegs and has been proven as an earthquake resistant building. The building philosophy is associated to the social strata.

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In general, Javanese Joglo house is intended to be used for the aristocratic class and the type of JP is owned by the merchant class in the northern coastal of Java Island.

Maintaining the sustainability of the JP has been encouraged to be essential. Since urbanization, the existence of the JP has diminished and is feared to be extinct. This type of house is a milestone in the history of early Islam which also marks the Islamic teaching's development in Java. JP in Kudus were built from the 16th until the 20th century and according to the Indonesian law no 11 of 2010, they should be protected as the cultural heritage buildings, but in fact, the number of these buildings has decreased significantly due to urbanization. It is also due to the expensive construction and maintenance costs, which has put many JP to be up for sale (Sardjono, 2011). Preservation of JP as a work of local traditional architecture and cultural values of communities for future generations is a challenge for community and all stakeholders. Therefore, an appropriate method is needed, which combines digital information with documentation. Inventory through modern methods needs to be done in connection with the preservation of cultural heritage objects for the benefit of conservation, promotion, and education (Idham, 2018). For this reason, digital social mapping is essential for conservation efforts. With these problems, it is necessary to combine traditional communities with the concept of digital archiving in the form of maps, it is also crucial to build a scheme in conservation efforts by utilizing digital technology in the social mapping (Aliyah et al., 2017; Hossain & Barata, 2019).

Some previous research on the concept of preserving culture still uses conventional methods (Freitas, 2016). In the rapid change of urbanization era, innovation patterns should be applied in maintaining local values, one of which is the digital social mapping technique. It was able to provide new insights in effort to integrate digital mapping patterns with GIS-based information systems to map cultural sites. It becomes an essential when technology must be able to respond to global challenges, especially in maintaining and protecting the traces of the rich traditions of the past that have their significance for the civilization of a nation. As (Freitas, 2016) said, one form of preserving cultural values is to create useful data and track records so that historical values are well mapped. In line with this thought (Zoderer et al., 2016) tried to make innovation by mapping cultural-based tourism areas.

Furthermore, (Oikonomopoulou et al., 2017) assess history in the form of archaeology archives. These forms of research efforts have not yet utilized digital mapping models based on GIS. Several studies conducted by previous researchers on the uniqueness of the historic Kudus Kulon area have produced data about the JP from the floor plan, the appearance, and pieces that explore physical characteristics (Wikantari & Narumi, 2001). These studies have not provided a digital touch, especially in the process of digital social mapping for an inventory of JP using GIS that can develop spatial database, informing the location of buildings, historical settings, and current architectural conditions.

In contrast to previous studies, the focus of this research is to map the location of the JP with GIS as well as provide information on the architectural character, building conditions, and social dynamics that occur in maintaining the cultural value of the JP. It is an initiative to help the community in protecting cultural assets, especially the JP. The world of data storage has changed; the digital concept in Industry 4.0 has become a joint agreement in community activities. Proximity to the digital world with various internet of things (IoT) concepts is mandatory in all fields (Kim et al., 2017). The idea is juxtaposed with multiple needs, one of which is its use in supporting the preservation of local values. These technological advances have been widely used for local mapping values (Korpilo et al., 2018; Wirkus, 2015); however, applications in efforts to preserve historic buildings with local cultural values have not been widely implemented. Furthermore, research on GIS has indeed been done to display the economic potential and diversity of problems spatially (Nakayaman et al., 2017). However, the use of GIS to protect assets and culture has not been widely used.

This paper aims to provide a method of mapping that utilizes digital technology, which involves the living heritage community participation in the data collection and monitoring process. Besides that, this paper reviews the input and insights on the use of mapping technology to help preserve historic buildings as one of the innovations that connects local culture and digital technology. Through this media, the socialization and data collection of JP as one of the historical buildings can be facilitated. Furthermore, the developed GIS technology can answer problems and questions related to information location. It can help the local government, especially in city conservation efforts and development decision making related to historical sites in urban areas. Furthermore, this paper discusses the challenges of digital mapping and its application as a decision-making system for urban conservation policies to benefit urban communities and be able to provide accurate information as an urban conservation innovation.

1. Study area and methods

1.1. Study area

The research location is the Kudus Kulon area (Figure 1), known as the Kudus historic area (Wikantari, 2001). Formerly, this region was also known as Kudus Kulon (western part of Kudus), where Sunan Kudus carried out government duties and taught the teachings of Islam as the member of *Walisanga*. This area is also known as the distribution centre of the JP building. The four districts are as follows: Kerjasan, Damaran, Kauman, and Langgar Dalem. The Gelis River landscape separates Kudus to be two distinct regional characters, namely Kudus Kulon (western part of Kudus) which was originally developed by Sunan Kudus and the new developing area of Kudus Wetan (eastern part of Kudus).

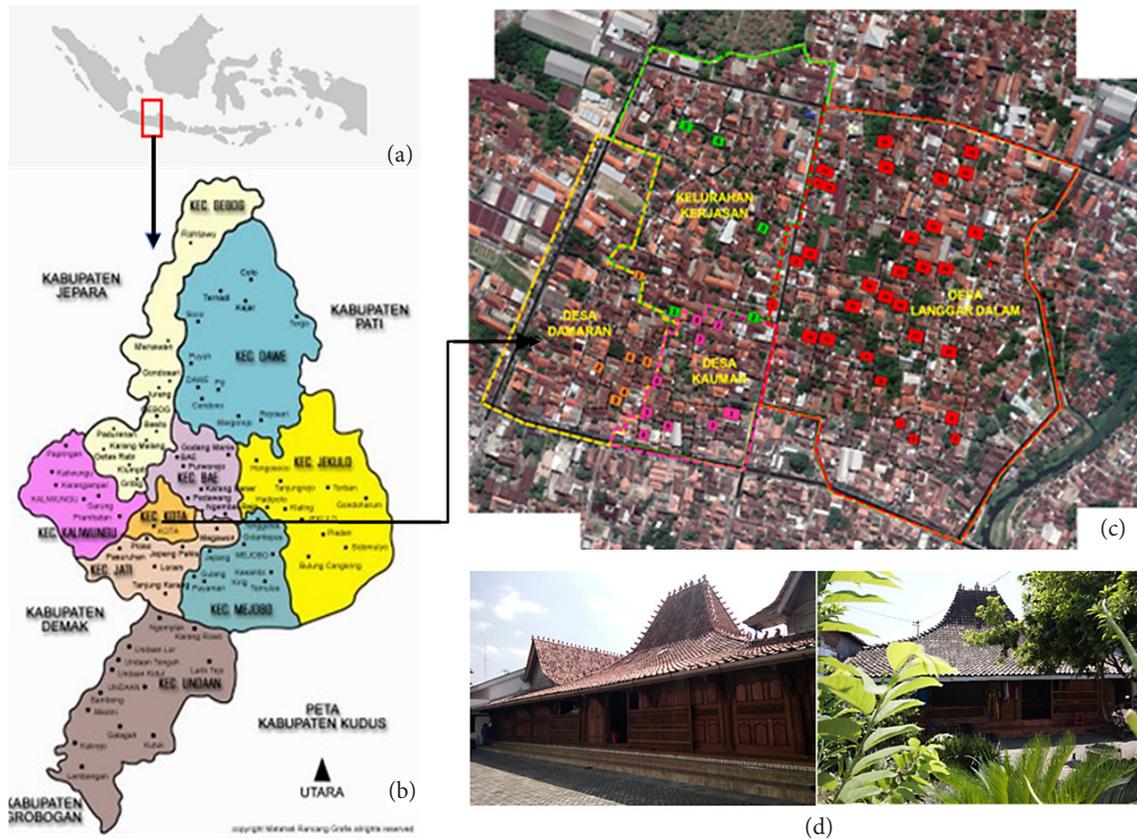


Figure 1. Kudus City as study area: (a) Indonesia map showing the location of Kudus City; (b) Magnification of Kudus City indicating the study area; (c) 4 District of study area; (d) Joglo Pencil – wooden traditional house in Kauman District (source: Data processing from GIS Map and private documentation)

1.2. Method

Current technological developments lead to accuracy in obtaining data, especially data when conducting field surveys. One use of technological progress is the geotagging method used to achieve the efficiency of JP Location. The geotagging process, as a geographical marker, can utilize the Global Positioning System (GPS) technology, which guarantees the accuracy and firmness of the location of OP. Geotagging itself is the process of adding metadata with geographical identification to a content (Harvey, 2014). The geotagging process comes from the Global Positioning System (GPS), which is based on the latitude and longitude coordinate model. Geotagging produces coordinates of the South Latitude (LS) and East Longitude (BT) at the point that has been observed in the field. In addition to providing coordinate points, geotagging can also produce distance content and place names along with textual and visual images (Harvey, 2014). As in Figure 3, which shows the content obtained from the survey results using geotagging. In addition to determining the coordinates of the district boundaries, physical evidence was also observed to mark district boundaries, such as landscapes in the form of rivers, hills, and forests, or artificial physical structures such as trenches, gates, roads, and bridges. Documentation is also done as a visual picture of proof of the existence of JP.

This geotagging method not only generates useful data, but more than that, geotagging can provide a picture of the problems at the district boundaries that collected through photos of the resulting location. It is in line with the opinion of (Brabyn & Mark, 2011), that location photos on markers or “tagging” can provide information from GIS to marker photos and vice versa, to give a clear picture of the location of landscapes on the ground. The finding of problems in the field becomes a continuation material in the discussion forum, but beforehand it is confirmed in advance to the local community when issues are found. The presence of local people much helped this field survey. In addition to geotagging, the location survey is also equipped with tracking. Tracking is done through a handheld GPS application that is useful for recording trips during a field survey. Monitoring can investigate the path taken to the location of the boundary point, if the road to the site is not detected in the digital map provided during the survey, then the recorded journey on this tracking can later be used as additional data in the digital map as presented in Figure 2 (de Vries, 2021; Sejati et al., 2020; Swafiyudeen et al., 2021). Other data that can be utilized in the form of road data are available during the survey, but not yet available on a digital platform.

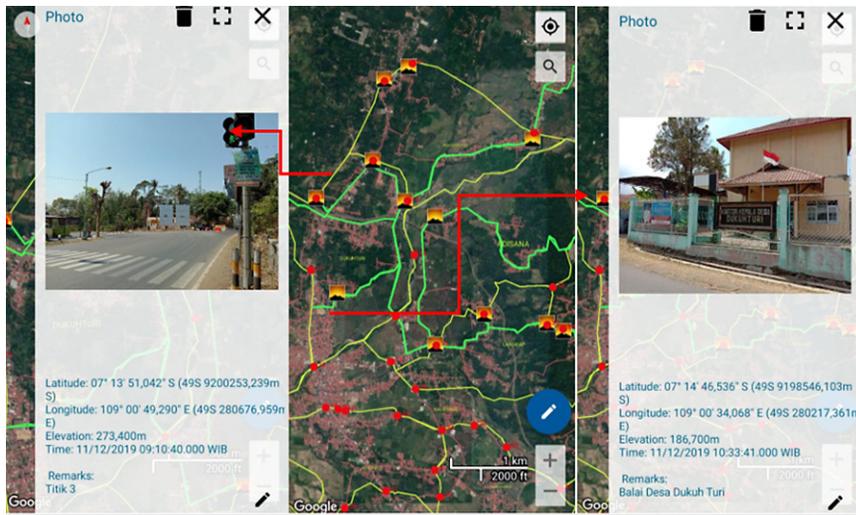


Figure 2. Digital mapping process (source: Data processing from Google Satellite and private documentation)

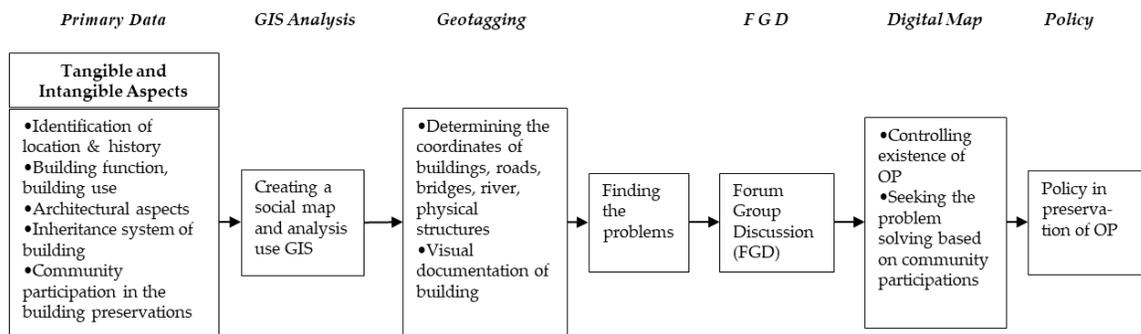


Figure 3. Diagram of roadmap study (source: Researcher’s analysis)

Participatory process

The social mapping process uses several approaches, such as using the SW Maps application (Figure 4) and QGIS for participatory mapping. Furthermore, to maximize data validation, FGDs are carried out. The first process is to provide training to the community, especially residents in the JP area to map in a participatory way using SW Maps. The first step is to make background settings with Google Satellite to make it easier to get to know the study area. Both project settings with the layer name JP the third, is to add detailed information according to the social characteristics of the people in the study area.

At the initial stage of socialization, the community was trained to understand SW maps as a survey tool, then the community was given guidelines to be able to use SW Maps correctly. From the survey results, it was found that the location points of JP as well as information related to the social conditions in the study area were obtained. The survey result points are converted into point layers that can be processed in QGIS. As a result, a map of the distribution of historic buildings such as JP becomes a database that can be accounted for its truth and validity. The database then becomes the basis for formulating policies related to the protection of historic buildings such as JP. More details can be seen in Figure 5.

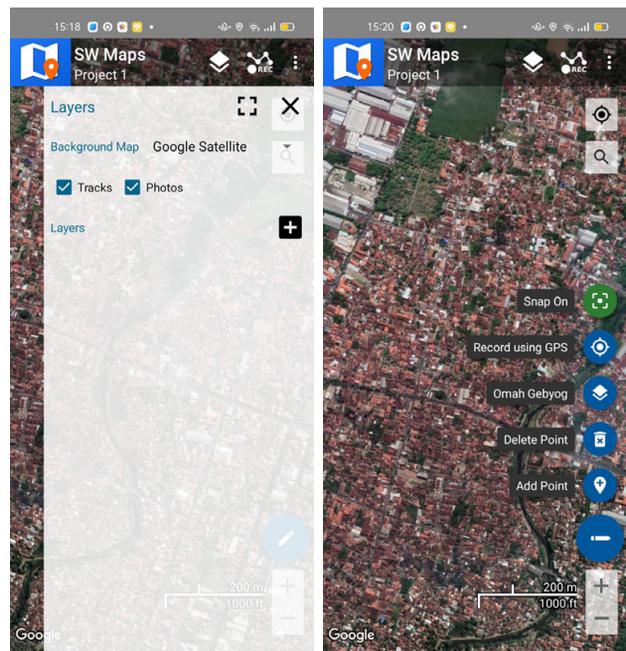


Figure 4. SW Maps as digital platform for participatory social mapping (source: Data processing from Google Satellite and private documentations)



Figure 5. Participatory mapping process: (1) Provide direction and socialization to the community regarding the use of SW Maps for mapping the Joglo Pencu’s house; (2) Setting SW Maps and how to use them for Data Collecting; (3) FGD for Data validation; (4) Results of participatory mapping for social mapping (source: Data processing from Google Satellite and private documentations)

1.3. Results and discussion

1.3.1. Urbanization and cultural shifting in Kudus Regency

Population growth is one indication of the flow of urbanization in a region. In the last five years, the Kudus City center experienced an increase in the population, wherein 2015 is populated by 96,981 people, to 99,581 people in 2019 (Figure 6a). When seen on average, the population growth in Kudus increased by 0.8% per year. In distribution, through social mapping, it was found that the most significant population density was Kota District (Kudus City), where the flow of urbanization was especially enormous there. It is shown in Figure 4c where the spatial distribution of population density is seen in the city center.

The large urbanization flow in the city center also has an impact on the population around the Kudus Kulon. It has experienced a significant increase in population in line with the magnitude of urbanization in Kudus City.

The expansion began in 2015, which initially amounted to 5,253 people, increased to 5,441 people in 2019 (Figure 6b). It shows the population growth in the study area of 3% per year. This increase is quite high compared to the average growth rate in the center of the Kudus city of 0.8% per year.

The increase in population is an indication of the urge for urbanization. As stated by (McGee, 1971; Tian et al., 2017) that an increase in population can be a crucial indicator in the process of urbanization so that an increase in population will have an impact on houses, built-up areas, and demand for settlements. If seen by the growing trend, the process of the JP architectural shift is influenced by the emergence of modern dwellings to meet the increasing needs of the population. It shows that the change in the type of JP architecture is influenced by the existence of modern minimalist homes that are more affordable and attractive to the population.

The population that lives and survives in the city’s center, especially in Kudus historical areas, is decreasing

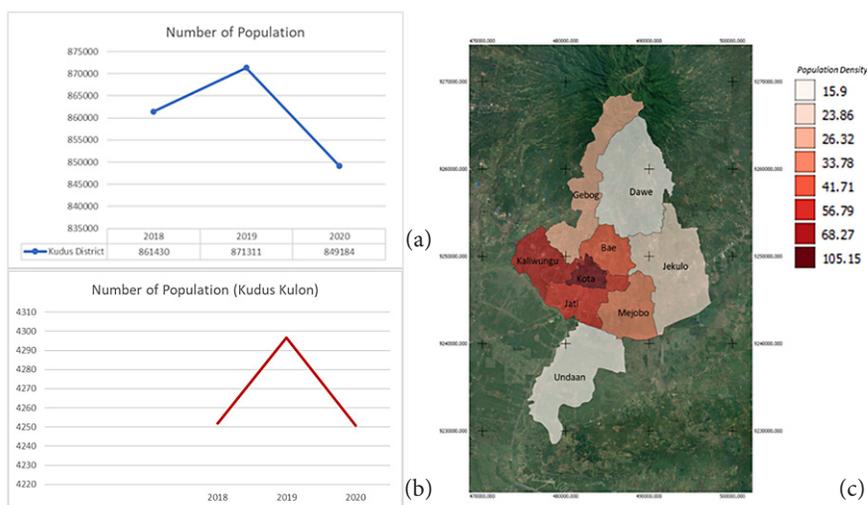


Figure 6. Population, urbanization and cultural shifting in Kudus Regency: (a) Population growth in Kudus City; (b) Population growth in Kudus Kulon Area; (c) Population density in Kudus Regency (source: Data processing from Badan Pusat Statistik, 2016)

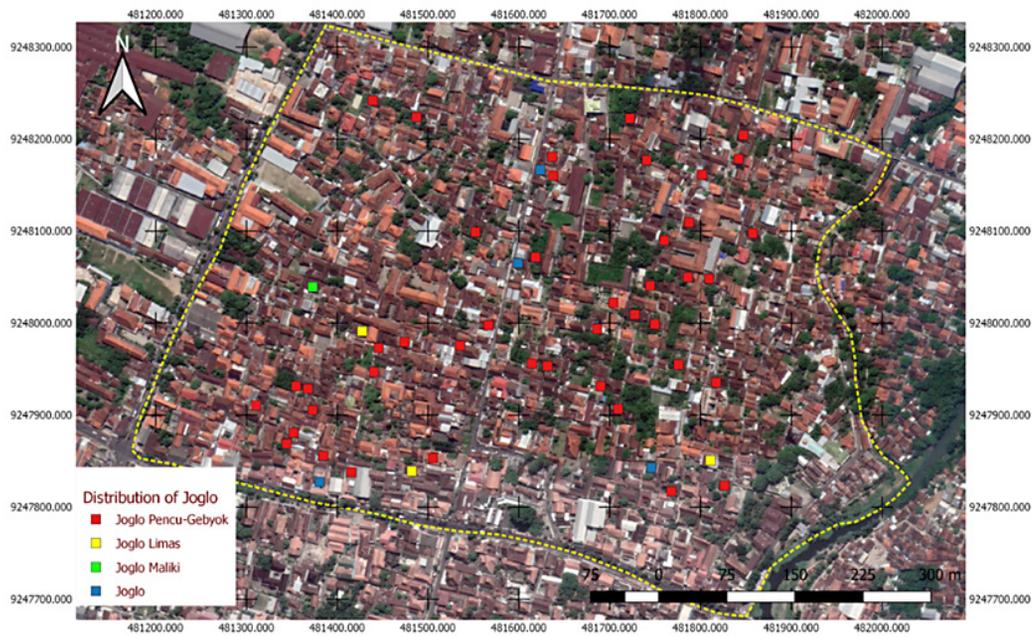
(Figure 6b). Based on the population data, there were 4.252 people in 2018, 4.297 people in 2019, but the population decreased so that it changed to 4.250 people in 2020. When described statistically, within 3 years the population decreased by 2%. The decrease of population is due to the increasing density of buildings and the low desire to stay and preserve cultural heritage. Some people move and leave their houses, which are cultural assets of the Kudus city such as JP, which impacts the condition of the house that are vulnerable to physical changes and function changes to the building that are experienced by the new house owners.

1.3.2. Spatial distribution of Joglo Pencu

This research succeeded in uncovering several facts related to JP. The facts are presented in the form of digital maps and show the spatial configuration and distribution of JP. The first fact is the distribution of JP which was found in only 51 houses out of 374 houses. It means that the number

of forms in modern houses dominates more than the JP. The second fact is that not all the JP still has their original function and structure. The truth is that out of 51 houses, 42 of them are still using *pencu* roofs shape, while 9 of them have changed. These findings show that the authenticity of JP began to decline in quality. From the mapping, it can also be seen that the location of the JP is quite widespread amid the dense housing with a modern architecture with various functions of the JP. Most of the functions of JP are as dwellings. However, some religious services were maintained in preserving the peculiarities of JP in the location of the cultural center of Kudus city (Figure 7).

Further facts from search results, not all building owners are identical to the residents of JP, and have changed ownerships. The function of JP is no more as a residence but as a place of business such as a rental house, warehouse, boarding school, or a museum. Meanwhile, out of 51-unit houses found at the study site, it is known that the descendant's occupants are 56%. This shows that the



(a)



(b)



(c)



(d)



(e)



(f)



(g)

Figure 7. Contain 4 different types: (a) Spatial distribution of Joglo Pencu (JP); (b), (c) Joglo Pencu type; (d) Joglo Maliki; (e), (f) Joglo Limas; (g) Joglo (source: Data processing from GIS Map and private documentation)

Kudus historic area has shown potential as a living heritage, where people and artifacts have been living together for generations. According to informants, the founder of the building has a successful entrepreneur’s background. It can make sense due to the expensive price for a unit JP completed with a traditional spatial-architectural forms, and whole carved wooden partition of *gebyog*, is around 520,000 USD price. Caring for wooden buildings with intricate carvings that are hundreds of years old is not easy, aside from requiring specific techniques, it also requires a large amount of money.

Over time, their business underwent a period of receding precisely at the beginning of the 20th to 1970. Meanwhile, the percentage of buildings in good condition is 39%. It illustrates that the occurrence of difficulties in building maintenance are mainly related to funding. Because of the costly maintenance of JP, only a few building owners are able to maintain it. As stated by one of the local respondents from Kauman village is as follows:

“To care for this JP, we need a lot of funds, and it is very hard to do with our economic condition. Once we received financial assistance, the amount was not enough for maintenance costs.”

Care funding assistance are given from the government, but not all houses are able to get it. Research in this area shows that 78% of the building’s function is still used as a residence. Some informants who still care for the JP explained that they actually love and like JP, but are often bumped into expensive maintenance costs. Meanwhile, Mr. Najib, the head of local foundation YM3SK told his reasons to take over the JP ownership JP in Kauman.

“Finally, the heir owner family agreed to hand it over to the foundation for the higher prize. The original JP type building, high quality only one left. It is all I can do due to continue caring for and preserve the cultural heritage of our parents.”

1.4. The result of mapping

1.4.1. Typology of Joglo Pencu based on spatial layout

In general the JP’s spatial layout includes (1) the core of main building called *dalem*, which is used for sleeping and private activities. The main building consist of *jogosatru* (guest room), *senthong* (bed room), *gedhongan* (praying room) *jogan* (space in the front of *gedhogan*); *pawon* is a building on the right side or left side of *dalem* or even both sides which functioned as kitchen; (2) *Latar* (courtyard), which is used for outdoor socialization with neighbours. Sometimes the ground is covered with *kerakal* (gravel) a local material which is easily can be found in the Gelis River. In row type houses which are close to the courtyard, the houses are connected one another to form a corridor/ passageways for neighbouring passer-by’s; (3) complementary buildings are used to accommodate service and economic activities. It consists of *pekiwan* (wells and bathrooms), and *sisir* which has a function for multipurpose room, or storage.

The result of mapping can be seen in Figure 8 which were shown that 36% of the building layouts have one kitchen, 18% for buildings with two kitchens, 18% buildings without kitchen and other categories were 14% each. This research shows that the majority of 72% of the buildings are in the original plan, where the floor plan is an important asset in the preservation of cultural heritage buildings. In accordance to Sardjono (2011) point of view that the main building of JP, despite their authenticity, shows a tendency to change due to them being traded. The orientation of the JP building still faces the south of cosmology direction, which is considered to be sacred (Suprapti et al., 2020), but does not apply to new buildings. From the spatial layout can be seen the changing level of this heritage building, which is related to its vulnerability. This mapping shows that IT facilitates community participation in preserving local cultural values, especially JP buildings.

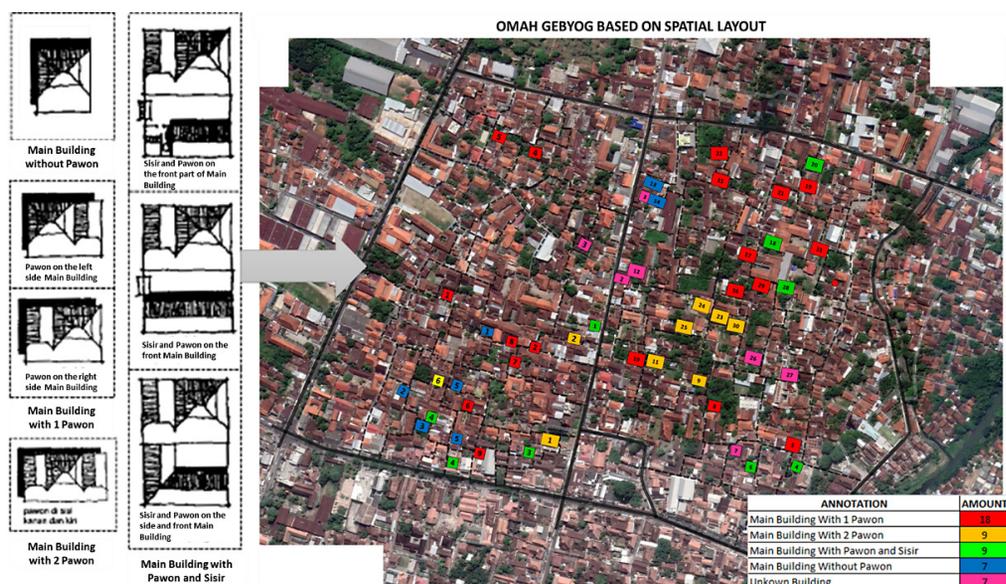


Figure 8. Mapping of Joglo Pencu (JP) based on spatial layout (source: Suprapti et al., 2020)

1.4.2. Typology of Joglo Pencu based on usability

The mapping result as seen in Figure 9 shows that the majority or 78% of JP are used for their authentic function as residence, 10% are used for stalls, shops, and storages, and 8% are also used as a museum (Suprpti et al., 2020). The finding is inline to Paulios stated that indicates the strong potential of living heritage settlements, where building owners throughout history have used, cared for, and preserved JP privately and sustainably (Poulios, 2014). There is also an indication of the adaptive reuse of the JP building to meet the needs as an effort maintaining its continuity. The use of IT for JP mapping promotes a strong community participation role in conservation through a living heritage approach.

1.4.3. Typology of Joglo Pencu based on ownership

JP's house traditionally is the highest achievement of a dwelling house. Suprpti et al. (2020) categorizes building ownership with regard to the openness of a lifestyle that is implemented in the form of a house. These include (1) Single-JP (*Rumah Tunggal*) and In Row-JP (*Rumah Deret*) which reflects their openness and the Enclosed-JP (*Rumah Kilungan*) which reflects high privacy. Figure 10 below is the mapping result shows that the Single-JP is 54% and are mostly used for residential houses, a small part for warehousing and Islamic boarding schools; the Row-JP is 32% and are mostly used for residential houses; and the Enclosed-JP is 14% which are fenced by a high brick wall around the building and have better quality *gebyog*, are

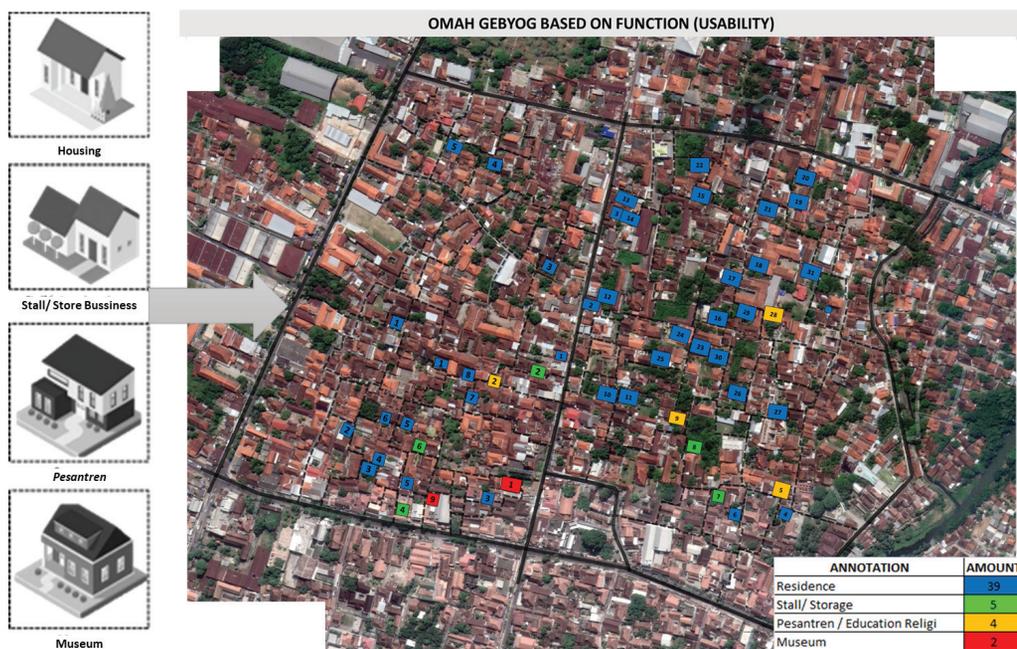


Figure 9. Distribution of Joglo Pencu (JP) based on usability (source: Suprpti et al., 2020)

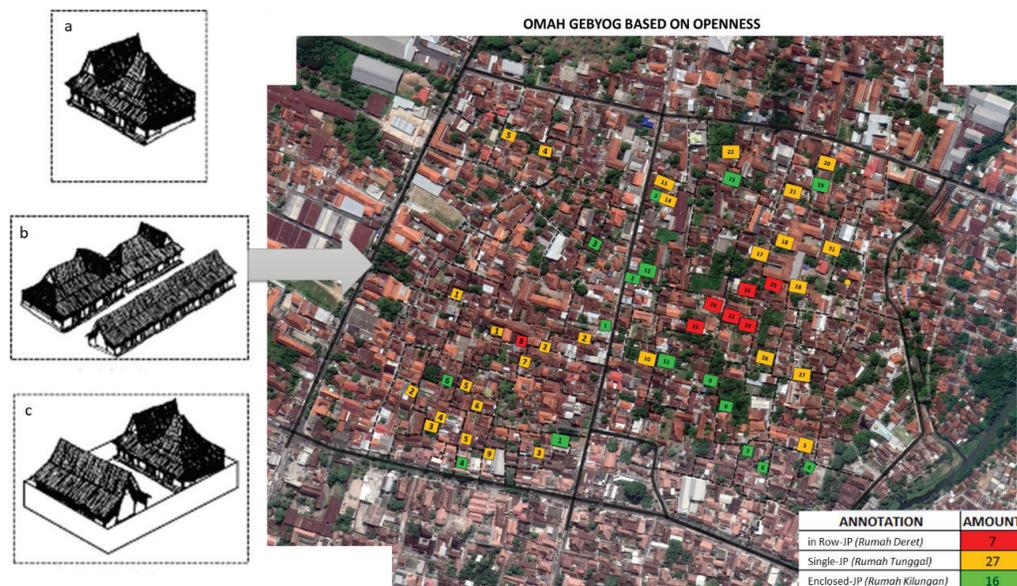


Figure 10. Distribution of Joglo Pencu (JP) based on spatial layout. Left side: (a) Single-JP (*Rumah Tunggal*); (b) in Row-JP (*Rumah Deret*); (c) Enclosed-JP (*Rumah Kilungan*) (source: Suprpti et al., 2020)

mostly used for business houses, residences and museums. This mapping means the social implications where the Single-JP category and the Row-JP have a high level of social openness and solidarity compared to the more Enclosed-JP. Compared to the Single-JP and the Row-JP, the Enclosed-JP has a high quality *gebyog* along with potential cultural values, but in other side related to its vulnerability. The results of this mapping as seen in Figure 10 that the quality of the Enclosed-JP's houses is decreasing in number and is facing the threat of extinction due to being traded. The efforts of building owners in maintaining and preserving JP are mostly done privately.

JP tradition as “inheritance” allows this house to be distributed to several descendants. Based on this tradition, JP can be divided into parts such as the *dalem* (main building), *pawon* (kitchen building), and *sisir* (working place building), so each heirs will get each parts. It will threat the existence of JP due to the persuasion of billions rupiah from antique object lovers (Hamidi et al., 2015). As the owner of the building, they are also direct descendants of the building's founders, which is possible to the fourth to the seventh generation earlier. Over time, the tangible and intangible aspects have been integrated and have a reciprocal relationship between the two; this is the character of living heritage (Poulios, 2014). Living heritage is a challenge for the development of heritage sustainability, which is a community-based approach (de Caro & Wijesuriya, 2012; Poulios, 2014). Besides, this situation allows the preservation of the sense of place that will maintain sustainability between tangible and intangible aspects (Tan et al., 2018). The intensity of social relations between communities is quite high, because the majority of residents have a good kinship relationship in a social and religious group. They arrange routine activities in social-religious meetings once per week at resident's house in a rotational system. But, preservation efforts are constrained by economics and heir problems.

1.5. The native living heritage of *Gusjigang* community and Joglo Pencil development

Gusjigang is a philosophy of the Kudus Kulon people, derived from the acronym of the word “*gus*” which means good, “*ji*” which means competent in Quran, and “*gang*” which means patience in trading as well as entrepreneur. The *Gusjigang* philosophy is the educational character from Sunan Kudus which was practiced by the Kudus Kulon people in their everyday life (Said, 2013). From the Ismaya's study in 2013, this character has been understood by people for generations of 1980 and earlier (Ismaya, 2013). This character is the liquid of social capital and has the local wisdom values related to moral responsibility of religious aspects, interest in continuing learning of social aspects, and hardworking as well as independent in economics (Maharromiyati & Suyahmo, 2016). *Gusjigang* is a tradition of devout Muslims as well as the tradition of trade and industry economics, and is a phenomenon that has been supporting the economy of Kudus community for

its rapid growth (Ihsan, 2017). The history records the development of Kudus City very closely to trading activities (Sumintarsih et al., 2016). Two of the founding figures of Kudus were Sunan Kudus and The Ling Sing (came along with Cheng Ho's expedition in 15th century) to organize the foundations of the Kudus City with social religious (Islamic) policy and economic activities of entrepreneurs. The two figures became Row Model for the Kudus community (Said, 2013). The Kudus economy began to rise with the opening of the nation's foreign trade through Gelis River. Along with the time passage, they also developed the typical trade commodity of Kudus, such as the traditional snack of Jenang (traditional sticky rice snack), Kretek (cigarettes), as well as embroideries and confection. In the period of 1970–2000 there was a decline in Kudus trading due to economic policies that lacked the support of people's trades. During the heyday of the Kudus economy, many JP buildings were established, supported by carpentry techniques inherited by The Ling Sing and Sunan Kudus, the material supply of the best quality of teak wood from the forest of Blora Regency, as well as support by the financial capability of the *Gusjigang* community. The acculturation of Islamic culture, Buddhism, Hinduism, Javanese, Chinese, and European that are visible from the spatial layout of the JP house and ornament showed harmonization and tolerance. The success of the JP house overwhelms the trend of home living among the *Gusjigang* community at the time, and has bridged the architectural tastes with economic success and social tolerance. JP sustainability supported by the community of *Gusjigang* with a cultural reserve cannot be separated from each other. This is a form of living heritage (Ndoro & Wijesuriya, 2015), which naturally performs activities designing, building, caring and nurturing, as well as living together the JP. For hundreds of years, various problems related to the care and maintenance of JP are solved in a natural way, such as the treatment of teak materials with traditional formula consisting of bath water tobacco, replacing wood material with a new wood or with bricks, or changing precarious roof with zinc. The case of *Gusjigang* and JP in Kudus Kulon shows a form of natural living heritage that independently make efforts to preserve and care.

1.6. Social participatory in JP preservation

From the results of the social mapping, several forms of community organization participation in the management of NOG have been found. The first fact is the involvement of YM3SK, one of those who care about tangible and intangible assets for JP. This NGO was established in the 1980s by the administrators of the Kudus Mosque-Tomb of Sunan Kudus, currently led by Mr. Nadjib Hassan. The Foundation has the responsibility to maintain the care, Tombs and the Tower of Menara, which was founded by Sunan Kudus in 956 H or 1549, as well as cultural and religious traditions that existed for pilgrims, as well as the surrounding community.

At present day, the foundation has two representative units of JP. One unit is located in Jl. Sunan Kudus, received

from a YM3SK administrator. This building was put back down and underwent maintenance by replacing some damaged wood materials and cost around 7,143 USD. The most recent building, owned in 2017, is from the complete JP category from architectural spatial planning and quality of JP in original conditions purchased from heirs for 585, 800 USD. Both buildings will be functioned as museums. Furthermore, related to building maintenance, Mr. Najib also said:

“Maintenance of the OP in normal conditions is carried out routinely once a year. It took especially, for wooden walls OP are carried out using herbs that can clean and be able to ward off termite attacks, consisting of natural materials such as clove flowers, tobacco leaves, and castor fruit. However, due to expensive maintenance costs, not all building has a routine maintenance.”

The role of NGOs in protecting and preserving the JP is outstanding in potential (Figure 11). It is because of the place attachment factors caused by place identity, place dependence, and place bonding factors (Goussous & Al-Hammadi, 2018). However, there are still weaknesses where the efforts made have not been integrated with the community and other stakeholders. In addition, the role of academics and researchers on JP also continues to develop. Academics and universities have a significant interest in the JP in the Kudus Kulon area. They work in research and community service in buildings, as well as historic areas, both in the historic district of cultural preservation. Researchers from within and outside the country have conducted research, and the results are published through publication media, social media, and other digital information media. According to YM3SK, several universities are involved from within the country and also foreign investigators are interested in developing science in the region. This is in line with the vision and mission of the UNESCO World Heritage. For this reason, the more stakeholders involved in each stage of preservation, the better for conservation efforts (Absalyamov, 2015).

Furthermore, the presence of private sectors also colors the spirit of guarding JP. Some private companies through CSR programs, established the Oasis Garden introduced

JP as one of their collections, the Jenang (traditional food) Museum, also introduced the JP house as main building. The participation of these companies is still focused on the objectives of establishing activities that promote JP to the public. The use of social media in order to expand its business objects helps introduce and promote JP. Private sectors play an essential role in the era of digital platforms, especially in spreading public and private issues (Galani et al., 2019). Aside from that, the participation of private and public actors is needed actively through the entire preservation process (Absalyamov, 2015; Achig-Balarezo et al., 2017).

Looking deeper, the efforts made by the government also support the preservation of JP. Through the Office of Tourism, among others, is the establishment of this JP building as an object of cultural heritage in 2009. For this reason, a UN reduction of 50% is granted. A maintenance assistance fund has also been launched to the owners of JP, although the amount is insufficient. Nevertheless, the sale of JP continues to this day, without the Government being able to control it. In 1998, the total number of completed JP was 64 units, but there were only 56 units in 2009 (Sohirin, 2019). At this time, only one unit remains in the complete and original category. The building was just taken over by YM3SK in 2017.

The importance of community participation in the conservation of heritage buildings was conveyed by (Firmansyah & Fadlilah, 2016). The role of community participation is also suspected of having an essential contribution to sustainable cultural heritage management and urban development (Husnéin, 2017; Ferretti & Gandino, 2018; Li et al., 2020). Community participation is needed at all stages of the process. Starting from the identification stage, through programming to the execution stage requiring the role of intensive community participation (Oevermann et al., 2016). Some weaknesses of the management of JP in the Kudus Kulon historic area are related to the limitations of human resources and personnel, budget limitations, and the absence of an integrated management system between various stakeholders in an organization. However, the management of cultural heritage is an economic potential (Amit-Cohen & Sofer, 2016) that can be developed to improve the welfare of citizens.



Figure 11. Focus group discussion with local NGO in JP location (source: Private documentation)

1.7. The preservation of Joglo Pencu living heritage is threatened by cost

However, the decline of Kudus trading in the late 20th century has a significant impact on JP. It is estimated that since 1950 there is no longer a new JP building that is established in Kudus Kulon, and the community of *Gusjigang* encountered the difficulties of treatment high cost of JP. During this time, the population in the research area in the service sector domination amounted to 45.5%, and businessmen as well as merchant sectors amounted to 27, 8% (Badan Pusat Statistik, 2016). The Data still shows the dominance of people's livelihoods in the entrepreneur's sector and trading, but the condition of economic ability has been very different. The second is the cultural system of JP building inheritance influenced by Java and Islam traditions, allowing JP to be divided into a number of homeowners' heirs. Parts of such buildings (*dalem*, *pawon*, *sisir*) are handed over to each heir, respectively. So that one building can be owned by several people. As a result of this condition, the building integrity is threatened by ownership change due to sales. From interviews with informants, it was known that the most vulnerable parts of the building disappearing in a row are *sisir*, *pawon*, and *dalem*. This mapping shows the completeness of the building covers 14% of the main building (*dalem*) without *pawon*, 50% of buildings with *pawon*, as well as 18% of the main building (*dalem*) with *pawon* and *sisir*. From the mapping, it can be concluded that 82% of JP building found still intact, consists of *dalem* which is equipped with one or two *pawon* and/or *sisir*. Along with the changing conditions of the Kudus Kulon economy, these two things make a constraint for the preservation of JP. Almost all owners (98%) convey financial difficulties to care for JP, it's the result of reduction in the amount, completeness of the building parts, and degradation of the JP quality in which 20% of the buildings in poorly maintained include damage between 50% to 75% (Figure 12).

1.8. Integration of GIS and heritage preservation in urban scale

In line with the global issue of cultural heritage preservation, the efforts and initiatives delivered in the Social Mapping study of OP are one of the concrete steps of innovation. It is in line with the thoughts of Oikonomopoulou

et al. (2017) that an innovative approach needs to be taken to support the preservation of ideas and ideas of historical objects. However, the study findings are slightly different from the results of Oikonomopoulou et al. (2017). In this case, IT becomes one of the bridges between preservation needs and management patterns and structured organizations that connect the government, cultural organizations, and society. They work as the objects and subjects of preservation of cultural buildings, while previous findings prioritize preservation efforts in strategic support planning for sustainable development in Greece. In line with this, the use of IT for the preservation of JP has shown progress in protection and promotion that brings newness to the social structure of the community, especially in Kudus Regency and traditional Javanese communities that are thick with culture in the form of historic buildings.

Furthermore, Kudus City with high population density (Badan Pusat Statistik, 2016) continues to increase 0.8% each year, which has an impact on cultural acculturation so that it is vulnerable to cultural changes, especially in the style and architecture of buildings. This cross-culture has resulted in a very rapid change and dynamics so that a good and useful preservation pattern must be applied. It is in line with the thought of Ward and Ravlin (2017), where cross-culture is very influential on culture. In this case, the building of JP, which is shifted to a modern form so that the structure of JP has initially been a characteristic of vernacular architecture from Kudus, has now transformed into rare items that must be guarded. Meanwhile, housing demolition continues to occur as a result of urban growth that demands changes in the function of buildings, especially in the main lines in Kudus, which have changed from residential to commercial services. By the experience of Han et al. (Cheng & Han, 2016) where conflicts in the regional culture have the power to drive change, so there is a need for efforts such as preservation through the latest technology as successfully carried out in this study.

From the mapping and compilation of the database produced in the preservation innovation of JP, the *Gusjigang* community, NGO, and the government was able to identify the needs for building protection in the form of property rights, remedial measures, and maintenance at a particular scale and period quickly. It is following several facts that were successfully shown from the results of

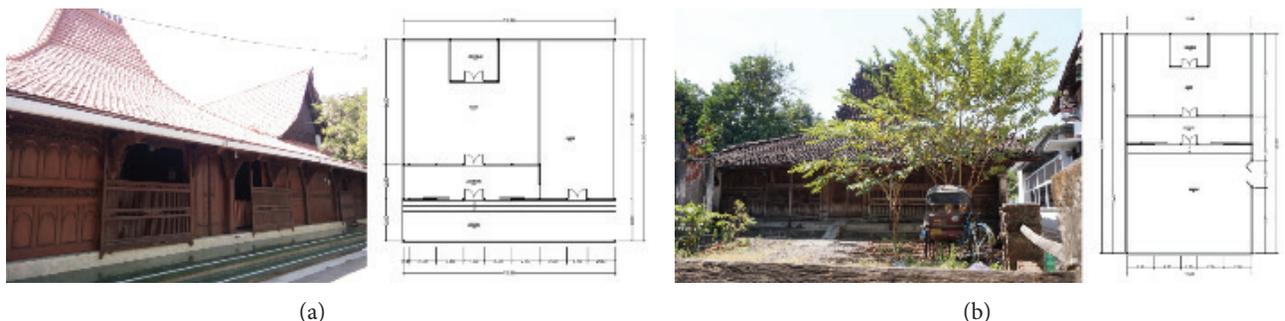


Figure 12. Condition of JP: (a) The condition of JP that very well maintained; (b) The condition of JP that poorly maintained, the teakwood wall condition is faded and porous, also the roof has been partially damaged and hollow (source: Private documentation)

this study. First, the JP building still stands even though the number is now limited. It is in accordance with the aspect of visibility where culture will undoubtedly show its identity though urbanization and cross-cultural urges are extensive (Ward & Ravlin, 2017; Idham, 2018; Plevoets & Sowińska-Heim, 2018; Kamalipour & Dovey, 2019; Kiruthiga & Thirumaran, 2019; Suprapti et al., 2019). However, its existence needs attention so that its sustainability as one of the characteristics of the region can be maintained.

The second fact is public participation that can help maintain and monitor buildings through IT technology. Ease of accessing information in the form of architecture and spatial data and good location information can support the efforts of various generations to move, supporting the wholeness of JP. It is in line with Bugs et al. (2010), which prioritizes IT technology on the basis of GIS to make improvements from an urban action plan based on community participation. It is quite useful because the mapping of JP also utilizes GIS technology, which can be combined with spatial planning and development plans to get a clear picture of the potential and problems of the management of JP. Other evidence is the amount of active participation from the government and the community in the FGD. Regarding the preservation system of JP, it can be seen from the enthusiasm of participants and the formulation of ideas that developed in the discussion. It shows that community initiatives are a new force in maintaining a heritage site. The vernacular transformation that continues to occur will have an impact and influence in a living heritage community so that the efforts and innovations of the community are very beneficial for preservation in the long run. This fact is slightly different from the findings from Plevoets and Sowińska-Heim (2018), where the adaptive reuse concept is carried out to bridge the influence of the vernacular transformation. Still, in this study of JP, the perspective of change is narrowed so that the JP must show the vernacular style and authenticity of its architecture in an effort to confirm the identity of the region.

The third fact, the concept of GIS, which is carried out in the study of JP is more focused on monitoring and evaluating the existence of the JP and mapping the presence of the JP in one of the regional identities. In contrast, some previous studies prioritize aspects of Archaeology and spatial history that presents the transformation and spatial-temporal process of a historic site (De Caro & Wijesuriya, 2012; Hamidi et al., 2015; Tan et al., 2018). But, this study offers a different perspective to bridging knowledge between generations in recognizing JP, the philosophy of buildings, and other efforts in preservation. In compiling the JP database, several elements inform maintenance and funding efforts. This shows the monitoring function of the JP GIS that was built. Besides, the owner's data and changes are an effort to evaluate ownership, making it easier for policymakers to follow up on the preservation of JP.

The fourth fact is the results of the investigation of JP shows that the influence of the development of Islam in the Kudus City is still thick and still maintained. This position is in line with the study of Shao et al. (2019), and Suprapti et al. (2018), where investigation and modification are needed. Similar to Hossain and Barata (2019), who successfully demonstrated interpretative mapping in Bangladesh where cultural heritage mapping succeeded in showing the existence of a historic settlement. However, the context of JP investigation is the existence of buildings.

Other facts show that the running of cultural mapping as a tool in seeing the dynamics and sustainability of history is quite successful (Aliyah et al., 2017; Freitas, 2016; Hamidi et al., 2015; Zoderer et al., 2016; Suprapti et al., 2020). As stated by (Freitas, 2016), that cultural mapping is a useful tool to see a continuum from a past course. This study of JP also adopted a top-down effort (government policy). It conveyed ideas of change in the form of bottom-up (preservation ideas and ideas from the community and community). Efforts to unite preservation actions both top-down and bottom-up have been realized and bridged by social mapping with GIS. The community can provide input and advice related to the protection of JP and also get complete information on the existence of JP as the regional identity. The combined action of the two sides of this policy is predicted to be useful, considering that this is an initiative that has emerged from both parties in the hope that the meeting can take place in virtual spaces (GIS) in discussing the existence of the JP. This function is in line with expectations from the study of Seduikyte et al. (2018), where the most important of the efforts of preservation and protection of history, especially historic buildings is the process of knowledge transfer that must be the primary goal. Thus, whatever the medium, knowledge transfer takes precedence over mere beautification and dependence on technology alone.

This idea is in line with the study of van der Hoeven (2019) where social media contributions combined with historical sites and IT advancements can make a region or building remain in the watch of the wider community. It is a new force where crowdsource and IT are able to provide fresh air to maintain the integrity of culture. However, structured and planned actions will work better if the three concepts succeed in running well from IT and mapping with GIS, top-down and bottom-up approaches, and crowdsource from social media can coincide in a spirit to give birth to policies in support of JP.

Finally, the sense of place of a historical building cannot be lost when an area becomes attractive in social media or the area's value. This sense of place must be maintained to show that the monitoring and evaluation function is still running (Savić, 2017). If the sense of place is lost, so the values contained in the JP are also disappeared. For this reason, community engagement is needed to unite the preservation efforts, both integration, and action, in the field so that through this study, concrete steps can be arranged and implemented according to the right direction and purpose.

Conclusions

This study succeeded in making a breakthrough in social mapping with digital technology to promote the aim of introducing and inviting the community to preserve JP in Kudus City, mainly in the cultural areas of the Kudus City. This social mapping succeeded in uncovering various facts, including the character of architecture, the value of socio culture, and the character of the living heritage community that shifted so that it influenced the preservation efforts of JP, especially in terms of ownership and care.

The research shows that there is an inseparable relationship between the *Gusjigang* community and the JP sustainability. This study also managed to bridge the preservation problem of the *Gusjigang* community that has been done naturally with other stakeholders especially with the local government. With a technological innovation approach is expected preservation of cultural heritage in the living heritage area can have a wider perspective, not just to preserve the historical monuments but also communities that live together in it.

With the success of this study, the function of GIS as a decision support system is proven by its ability to describe and inform in detail about the JP condition, so that it can bridge the interests of preservation with government policy and establish various networks between the government, NGOs, and related stakeholders. Social mapping as the bridging of the government top down policy and bottom-up preservation rules from the living heritage community is a digital knowledge transfer. Further studies in broader scope are needed to elevate the conservation of JP. It is essential to develop the theoretical framework for enriching the theory of urban heritage and architecture for JP preservation. Finally, this study has shown that mediating various aspects of conservation can be bridged with increasingly evolving technology.

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References

- Absalyamov, T. (2015). Tatarstan model of public-private partnership in the field of cultural heritage preservation. *Procedia - Social and Behavioral Sciences*, 188, 214–217. <https://doi.org/10.1016/j.sbspro.2015.03.375>
- Achig-Balarezo, M. C., Vázquez, L., Barsallo, M. G., Briones, J. C., & Amaya, J. (2017). Strategies for the management of built heritage linked to maintenance and monitoring. Case study of the san roque neighborhood, Cuenca, Ecuador. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-2/W5, 755–761. <https://doi.org/10.5194/isprs-archives-XLII-2-W5-755-2017>
- Aliyah, I., Setioko, B., & Pradoto, W. (2017). Spatial flexibility in cultural mapping of traditional market area in Surakarta (A case study of Pasar Gede in Surakarta). *City, Culture and Society*, 10, 41–51. <https://doi.org/10.1016/j.ccs.2017.05.004>
- Amit-Cohen, I., & Sofer, M. (2016). Cultural heritage and its economic potential in rural society: The case of the kibbutzim in Israel. *Land Use Policy*, 57, 368–376. <https://doi.org/10.1016/j.landusepol.2016.05.031>
- Badan Pusat Statistik. (2016). *Kabupaten Kudus Dalam Angka 2016*. <https://kuduskab.bps.go.id/publication/2016/07/15/ac004f0390d934671fa19e9a/kabupaten-kudus-dalam-angka-2016.html>
- Brabyn, L., & Mark, D. M. (2011). Using viewsheds, GIS, and a landscape classification to tag landscape photographs. *Applied Geography*, 31(3), 1115–1122. <https://doi.org/10.1016/j.apgeog.2011.03.003>
- Bugs, G., Granell, C., Fonts, O., Huerta, J., & Painho, M. (2010). An assessment of Public Participation GIS and Web 2.0 technologies in urban planning practice in Canela, Brazil. *Cities*, 27(3), 172–181. <https://doi.org/10.1016/j.cities.2009.11.008>
- Cheng, G., & Han, J. (2016). A survey on object detection in optical remote sensing images. *ISPRS Journal of Photogrammetry and Remote Sensing*, 117, 11–28. <https://doi.org/10.1016/j.isprsjprs.2016.03.014>
- de Caro, S., & Wijesuriya, G. (2012). Engaging communities: Approaches to capacity building. In *Involving communities in world heritage conservation—concepts and actions in Asia* (pp. 48–55). ICOMOS-Korea.
- de Vries, W. T. (2021). Trends in the adoption of new geospatial technologies for spatial planning and land management in 2021. *Geoplanning: Journal of Geomatics and Planning*, 8(2), 85–98. <https://doi.org/10.14710/geoplanning.8.2.85-98>
- Ferretti, V., & Gandino, E. (2018). Co-designing the solution space for rural regeneration in a new World Heritage site: A Choice Experiments approach. *European Journal of Operational Research*, 268(3), 1077–1091. <https://doi.org/10.1016/j.ejor.2017.10.003>
- Firmansyah, F., & Fadlilah, K. U. (2016). Improvement of involvement society in the context of smart community for cultural heritage preservation in Singosari. *Procedia - Social and Behavioral Sciences*, 227, 503–506. <https://doi.org/10.1016/j.sbspro.2016.06.107>
- Freitas, R. (2016). Cultural mapping as a development tool. *City, Culture and Society*, 7(1), 9–16. <https://doi.org/10.1016/j.ccs.2015.10.002>
- Galani, A., Mason, R., & Rex, B. (2019). Dialogues and heritages in the digital public sphere. In *European heritage, dialogue and digital practices*. Routledge. <https://doi.org/10.4324/9780429053511-9>
- Goussous, J. S., & Al-Hammadi, N. A. (2018). Place attachment assessment of a heritage place: A case study of the Roman amphitheater in downtown Amman, Jordan. *Frontiers of Architectural Research*, 7(1), 1–10. <https://doi.org/10.1016/j.foar.2017.12.001>
- Hamidi, H., Setijonegoro, F. N., Fujitriartanto, Sa'id, A., Harioso, Huda, Hardiyanto, A., Waluyanto, B., Lubis, I. S. G., Setiawan, D., Prayitno, H., & Mu'arofah, A. F. (2015). *Indeks Desa Membangun: Kementerian Desa, Pembangunan Daerah Tertinggal dan Transmigrasi*. Jakarta Selatan.
- Harvey, K. (2014). Geotagging. In *Encyclopedia of social media and politics*. Sage. <https://doi.org/10.4135/9781452244723.n230>
- Hossain, S., & Barata, F. T. (2019). Interpretative mapping in cultural heritage context: Looking at the historic settlement of

- Khan Jahan in Bangladesh. *Journal of Cultural Heritage*, 39, 297–304. <https://doi.org/10.1016/j.culher.2018.09.011>
- Husnén, A. (2017). The evolving role of modern urbanistic heritage in shaping sustainable public realm: The case of Abu Dhabi. *International Review for Spatial Planning and Sustainable Development*, 5(3), 5–24. https://doi.org/10.14246/irpspd.5.3_5
- Idham, N. C. (2018). Javanese vernacular architecture and environmental synchronization based on the regional diversity of Joglo and Limasan. *Frontiers of Architectural Research*, 7(3), 317–333. <https://doi.org/10.1016/j.foar.2018.06.006>
- Ihsan, M. (2017). Gusjigang; karakter kemandirian masyarakat kudu menghadapi industrialisasi. *Iqtishadia: Jurnal Kajian Ekonomi dan Bisnis Islam*, 10(2), 153–183. <https://doi.org/10.21043/iqtishadia.v10i2.2862>
- Ismaya, E. I. (2013). Falsafah gusjigang sebagai modal sosial membangun masyarakat kudu yang sejahtera. In *Disajikan dalam Seminar Internasional Ikatan Sarjana Geografi Indonesia di UGM*. Universitas Gajah Mada.
- Kamalipour, H., & Dovey, K. (2019). Mapping the visibility of informal settlements. *Habitat International*, 85, 63–75. <https://doi.org/10.1016/j.habitatint.2019.01.002>
- Kim, T.-h., Ramos, C., & Mohammed, S. (2017). Smart city and IoT. *Future Generation Computer Systems*, 76, 159–162. <https://doi.org/10.1016/j.future.2017.03.034>
- Kiruthiga, K., & Thirumaran, K. (2019). Effects of urbanization on historical heritage buildings in Kumbakonam, Tamilnadu, India. *Frontiers of Architectural Research*, 8(1), 94–105. <https://doi.org/10.1016/j.foar.2018.09.002>
- Korpilo, S., Virtanen, T., Saukkonen, T., & Lehvavirta, S. (2018). More than A to B: Understanding and managing visitor spatial behaviour in urban forests using public participation GIS. *Journal of Environmental Management*, 207, 124–133. <https://doi.org/10.1016/j.jenvman.2017.11.020>
- Lang, W., Chen, T., & Li, X. (2016). A new style of urbanization in China: Transformation of urban rural communities. *Habitat International*, 55, 1–9. <https://doi.org/10.1016/j.habitatint.2015.10.009>
- Li, J., Krishnamurthy, S., Roders, A. P., & van Wesemael, P. (2020). Community participation in cultural heritage management: A systematic literature review comparing Chinese and international practices. *Cities*, 96, 102476. <https://doi.org/10.1016/j.cities.2019.102476>
- Maharromiyati, M., & Suyahmo, S. (2016). Pewarisan nilai falsafah budaya lokal Gusjigang sebagai modal sosial di pondok pesantren entrepreneur Al Mawaddah Kudus. *Journal of Educational Social Studies*, 5(2), 163–172.
- McGee, T. G. (1971). *The urbanization process in the Third World: Explorations in search of a theory*. G. Bell & Sons, Ltd.
- Nakayama, Y., Nakamura, K., Saito, H., & Fukumoto, R. (2017). A web GIS framework for participatory sensing service: An open source-based implementation. *Geosciences*, 7(2), 22. <https://doi.org/10.3390/geosciences7020022>
- Ndoro, W., & Wijesuriya, G. (2015). Heritage management and conservation: From colonization to globalization. In L. Meskell (Ed.), *Global heritage: A reader*. John Wiley & Sons, Inc.
- Oevermann, H., Degenkolb, J., Dießler, A., Kargeb, S., & Ulrike Peltz, U. (2016). Participation in the reuse of industrial heritage sites: The case of Oberschöneweide, Berlin. *International Journal of Heritage Studies*, 22(1), 43–58. <https://doi.org/10.1080/13527258.2015.1083460>
- Oikonomopoulou, E., Delegou, E. T., Sayas, J., & Moropolou, A. (2017). An innovative approach to the protection of cultural heritage: The case of cultural routes in Chios Island, Greece. *Journal of Archaeological Science: Reports*, 14, 742–757. <https://doi.org/10.1016/j.jasrep.2016.09.006>
- Organisation for Economic Co-operation and Development. (2014). *Urban population growth*. <https://doi.org/10.1787/8d1e7da0-en>
- Plevoets, B., & Sowińska-Heim, J. (2018). Community initiatives as a catalyst for regeneration of heritage sites: Vernacular transformation and its influence on the formal adaptive reuse practice. *Cities*, 78, 128–139. <https://doi.org/10.1016/j.cities.2018.02.007>
- Poulios, I. (2014). Discussing strategy in heritage conservation: living heritage approach as an example of strategic innovation. *Journal of Cultural Heritage Management and Sustainable Development*, 4(1), 16–34. <https://doi.org/10.1108/JCHMSD-10-2012-0048>
- Resuli, P., & Dervishi, S. (2015). Thermal performance of cultural heritage Italian housing in Albania. *Energy Procedia*, 78, 753–758. <https://doi.org/10.1016/j.egypro.2015.11.087>
- Said, N. (2013). Gusjigang dan kesinambungan budaya Sunan Kudus: relevansinya bagi pendidikan islam berbasis local genius. *Jurnal Penelitian Islam Empirik*, 6(2), 117–138.
- Salamak, M., & Fross, K. (2016). Bridges in urban planning and architectural culture. *Procedia Engineering*, 161, 207–212. <https://doi.org/10.1016/j.proeng.2016.08.530>
- Sardjono, A. B. (2011). Respon rumah tradisional kudu terhadap iklim tropis. *MODUL*, 11(1), 7–16.
- Savić, J. (2017). Sense(s) of the city: Cultural mapping in Porto, Portugal. *City, Culture and Society*, 11, 12–19. <https://doi.org/10.1016/j.ccs.2017.08.001>
- Seduikyte, L., Grazuleviciute-Vileniske, I., Kvasova, O., & Strainskaite, E. (2018). Knowledge transfer in sustainable management of heritage buildings. Case of Lithuania and Cyprus. *Sustainable Cities and Society*, 40, 66–74. <https://doi.org/10.1016/j.scs.2018.03.013>
- Sejati, A. W., Buchori, I., Rudiarto, I., Silver, C., & Sulisty, K. (2020). Open-source web GIS framework in monitoring urban land use planning: Participatory solutions for developing countries. *Journal of Urban and Regional Analysis*, 12(1), 19–34. <https://doi.org/10.37043/JURA.2020.12.1.2>
- Shao, M., Li, L., Chen, W., & Liu, J. (2019). Investigation and modification of two kinds of Chinese traditional lime in cultural building relics. *Journal of Cultural Heritage*, 36, 118–127. <https://doi.org/10.1016/j.culher.2018.02.018>
- Sohirin, S. (2019). *KLANGENAN: Kampung Seni Lerep: Belajar Sambil Berkarya*. <https://koran.tempo.co/read/berita-utama-jateng/168550/klangenankampung-seni-lerepbelajar-sambil-berkarya?read=true>
- Sumintarsih, S., Ariani, C., & Munawaroh, S. (2016). *Gusjigang: etos kerja dan perilaku ekonomi pedagang kudu*. Balai Pelestarian Nilai Budaya (BPNB).
- Suprapti, A., Kim, S., Pandelaki, E. E., & Firmandhani, S. W. (2018). A spatial dialogue of heritage village between Kauman in Semarang and Seochon in Seoul toward preservation development. *Journal of Architecture and Urbanism*, 42(1), 16–23. <https://doi.org/10.3846/jau.2018.1478>
- Suprapti, A., Sarjono, A. B., Indriastjario, I., & Pandelaki, E. E. (2019). The spatial concepts of cultural heritage village toward a tourism development: A case study of Kadilangu Demak Indonesia. *Journal of Architecture and Urbanism*, 43(1), 36–46. <https://doi.org/10.3846/jau.2019.6057>
- Suprapti, A., Sejati, A. W., Sardjono, A. B., Pandelaki, E. E., Malik, A., & Huwaida, N. M. (2020). Toward sustainable preservation of cultural heritage buildings: A combination of digi-

- tal mapping and architectural mapping for Omah Pencu in the historic area of Kudus Kulon. *TEKNIK*, 41(3), 201–211. <https://doi.org/10.14710/teknik.v41i3.27922>
- Swafiyudeen, B., Sa'i, U. I., Bala, A., Abubakar, A. Z., Musa, A. A., & Shehu, N. (2021). Modelling Precipitable Water Vapour (PWV) over Nigeria from ground-based GNSS. *Geoplanning: Journal of Geomatics and Planning*, 8(1), 41–50. <https://doi.org/10.14710/geoplanning.8.1.41-50>
- Tan, S.-K., Tan, S.-H., Kok, Y.-S., & Choon, S.-W. (2018). Sense of place and sustainability of intangible cultural heritage – The case of George Town and Melaka. *Tourism Management*, 67, 376–387. <https://doi.org/10.1016/j.tourman.2018.02.012>
- Tian, L., Ge, B., & Li, Y. (2017). Impacts of state-led and bottom-up urbanization on land use change in the peri-urban areas of Shanghai: Planned growth or uncontrolled sprawl? *Cities*, 60(Part B), 476–486. <https://doi.org/10.1016/j.cities.2016.01.002>
- van der Hoeven, A. (2019). Historic urban landscapes on social media: The contributions of online narrative practices to urban heritage conservation. *City, Culture and Society*, 17, 61–68. <https://doi.org/10.1016/j.ccs.2018.12.001>
- Ward, A.-K., & Ravlin, E. C. (2017). Building influence as an outsider: A theoretical approach to cross-cultural impression management. *Human Resource Management Review*, 27(3), 491–506. <https://doi.org/10.1016/j.hrmr.2016.12.013>
- Wikantari, R. R. (2001). *The sustainability of historic environment composed of wooden traditional houses in the city of Java* [Doctoral dissertation]. Osaka University.
- Wikantari, R. R., & Narumi, K. (2001). Prospect of public alley and shared-passage in the historic area of Kudus, Indonesia, based on the residents' evaluation. *Journal of Architecture and Planning (Transactions of AIJ)*, 66(545), 197–205. https://doi.org/10.3130/aija.66.197_2
- Wirkus, L. (2015). An open source WebGIS application for civic education on peace and conflict. *ISPRS International Journal of Geo-Information*, 4(2), 1013–1032. <https://doi.org/10.3390/ijgi4021013>
- Zoderer, B. M., Tasser, E., Erb, K.-H., Lupo Stanghellini, P. S., & Tappeiner, U. (2016). Identifying and mapping the tourists' perception of cultural ecosystem services: A case study from an Alpine region. *Land Use Policy*, 56, 251–261. <https://doi.org/10.1016/j.landusepol.2016.05.004>

Glossary

1. Dalem: The main building of *Joglo Pencu* is a place to facilitate a daily life of family-like sleeping, eating, dining, etc.
2. Gadri: Dining room
3. Gandhok: Complementary building located near side the main building (*dalem*)
4. Gebyog: Ornamental carved wooden wall
5. Gedhongan: The central bedroom
6. Gusjigang: The name of Kudus Kulon community, which has meant
7. Jogan: Hall in the front of *Senthong* (bedroom)
8. Joglo Pencu: The traditional roof shape of higher and slightly tapered upwards
9. Jogosatru: Guestroom
10. Latar: Open yard
11. Limasan: Pyramid roof covers Pawon maligi building
12. Pawon: Building for Kitchen
13. Pekiwan: Well, toilet
14. Pesantren: Islamic traditional boarding school
15. Senthong: Bedroom
16. Sisir: Workplace