Development of GIS-Based *Rumah Gadang* Tools as a Tourism Data Integrator for Halal Tourist Villages in West Sumatra, Indonesia

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Abstract— **Tourism is one of the economic pillars of countries, including Indonesia. However, the Covid-19 pandemic has significantly affected the global tourism industry. Nevertheless, the government has taken measures during this pandemic to prepare tourist villages to drive Indonesian tourism. West Sumatra, a province in Indonesia designated as a halal tourist destination, is actively developing halal tourist villages such as the Koto Baru. In this village, there are many Minangkabau traditional cultural houses called *Rumah Gadang* (RG). However, these houses are yet to attract tourists due to a lack of information dissemination about the uniqueness of the RG. Therefore, GIS-Based RG Tools (GRT) has been developed in web and mobile GIS (Android platform). This research reports on the development of GRT, which is intended to answer the challenges of developing tourist villages using ICT, namely the use of ICT is still limited to data collection and promotional media only, and there is no integrated tourism village management system with tourist attractions. The GRT was developed using a research and development methodology. Additionally, its development included using the waterfall method whereby PostgreSQL/PostGIS, Bootstrap, PHP, B4A, and JavaScript software were used to design and code GRT. After being programmed, the GRT was tested for functionality, and it was concluded that the app is appropriate and meets the needs of tourists during their pre-trips or visitations to tourist sites. Further research should focus on developing tourism app modules following the uniqueness of halal tourism villages.**

Keywords—**GIS; integrated tourist villages; Minangkabau; tourist attractions.**

I. INTRODUCTION

Tourism is considered one of the largest service industries in the world, which has contributed significantly to the economic growth of countries and formed a source of livelihood for many people [1]. Its development in the last few decades has shown fairly rapid growth [1], [2]. This development greatly impacts the country and society [3], [4]. According to Jus and Misrahi [5], before the pandemic, the percentage of jobs in the tourism industry sector was 10.6% of the 334 million jobs created worldwide. The industry also accounts for 10.4% of the global GDP (US$9.2 trillion).

Moreover, in 2019 international visitor spending was around US$1.7 trillion, with 27.4% of global service exports and 6.8% of total exports. However, the contribution of the tourism industry sector toward global economic growth has significantly decreased after the global Covid-19 pandemic. For instance, in 2020, this industrial sector suffered a loss of between US$4.5 to US$4.7 trillion. Furthermore, the global GDP contribution declined by 5.5%, leading to a loss of at least 62 million jobs, and the Indonesian tourism industry has not been spared either [6]-[10].

The Indonesian tourism industry was greatly affected due to the government's move to restrict regional and international travel [8], [9]. The government introduced the Large-Scale Social Restriction (LSSR) policy to help break the chain of Covid-19 spread in several regions in Indonesia. Its implementation stipulated that all schools, workplaces, and worship centers be carried out at home, while activities such as entertainment, tourism, and shopping centers were closed indefinitely [8], [9]. However, businesses offering essential services and goods were allowed to open but under strict health protocols.

The LSSR policy implementation by the government led to a significant decrease in the number of local and foreign tourists [10]. In 2020, the total number of foreign tourist arrivals to Indonesia fell to 4.02 million visits, which was a 75.03% decline compared to 2019. Additionally, the number of local tourists decreased by 61% compared to 2019. The pandemic threatened 13 million workers in the tourism sector

and 32.5 million people who indirectly depend on the tourism sector [10].

Along with the LSSR transition to the new normal, the tourism industry has also adapted by implementing social distance restrictions, capacity, and complying with health protocols, including cleanliness, health, safety, and environment [9]. It is presumed that by 2022, the Indonesian tourism industry will have recovered from the effects of the pandemic. Currently, the government is promoting tourism activities to revive the sector. According to Sandiago Uno (Minister of Tourism and Creative Economy), this pandemic is an opportunity for everyone to prepare everything needed to advance tourism and creative sectors. These preparations involve all sectors of the economy, including developing tourist destinations based on tourist villages and halal tourism [11], [12].

A village is a small settlement usually found in a rural setting [13]. It is generally larger than a "hamlet" but smaller than a "town." Some geographers define a village as an area having between 500 and 2,500 inhabitants. A tourist village is a rural location with special tourist attraction characteristics [14]. The development of these tourist villages has attracted much research [15], [16]. Also, it offers solutions to problems that exist in rural areas, including poverty, unskilled human resources, inadequate infrastructure, and job opportunities [17]. 12 benefits of developing a tourist village, including job creation, new business opportunities, opportunities for youth, rural tourism enhancing and revitalizing community pride, and preservation of rural culture and heritage [18]. The sustainability and many benefits accruing from tourist villages have drawn the attention of the Indonesian government.

Halal tourism is a tourism segment that provides services to Islamic tourists who travel according to Islamic teachings [19]. This makes them feel comfortable and safe in enjoying their travels. However, all tourists (Muslim and non-Muslim) can enjoy this type of tourism [20]. Moreover, the items that need consideration in this tourism segment include the availability of halal accommodation, food, and worship places [19]-[21]. Additionally, this segment has attracted several tourist countries in Asia, Europe, and the Middle East [22]. These countries are aware of a large Muslim population across the globe, which is second to Christians as the highest population among adherents of other religions in the world [23].

Various research about the development of tourist villages has been carried out within and abroad [15], [16]. There is an opportunity to continue research on tourist villages, especially Information and Communications Technology (ICT) adoption, to improve performance and tourist visits [17]. In this case, ICT is precisely the website used as a promotional medium [24]-[28]. With a website, far-away tourist spots can be known by people from different parts of the world. Moreover, tourists can access important information regarding the place before visiting [26]. However, ICT use is still largely at the information stage, and only small portions are at the interaction stage [29]. The use of ICT is still limited to data collection and media promotion [30]. There is no integrated tourism village management system, such as the integration of homestay management with tourist attractions

[30]. Therefore, ICT has not been implemented optimally and has not been understood by rural communities.

In 2016, Indonesia won 12 out of 16 awards at the World Halal Tourism Awards in Abu Dhabi. Consequently, several provinces have been designated as halal tourist destinations, including West Sumatra [31]. This region is majorly occupied by the Moslem Minangkabau ethnic, with traditional houses called RG, which symbolize togetherness, cooperation, democracy, and *kepenghuluan* identity [32]. One of the villages in this area is called Koto Baru, or *Saribu Rumah Gadang* Area (SRGA), South Solok, which was named the Most Popular Traditional Village of 2017 due to its rich culture [33]. It has many traditional houses, some of which allow tourists to experience the life of the indigenous people in the village [34]. However, due to the lack of information dissemination, this village is less crowded with tourists.

One form of ICT suitable for tourist villages development is the Geographic Information System (GIS) [35]-[37]. This GIS can manipulate, analyze and communicate geographic information visually in the form of maps to tourists [38]. Moreover, GIS can also be used to address the challenges of an integrated tourism village management system. GIS integrates different datasets for positioning, acquisition, analysis, and dissemination functions [39]. Spatial information can be used as an integrator of spatial-related cultural resources [40]. The GRT for the Koto Baru halal tourist village is being developed using web and mobile formats [35]-[40]. The GRT will integrate the RG as a homestay and tourist object with tourist attractions and support facilities. Moreover, the web form of GRT can be used by tourists during pre-trips, while its mobile form will be best applied when tourists arrive in the village.

II. MATERIAL AND METHOD

A. Research Area

The Koto Baru village, South Solok Regency, West Sumatra was used as the research location. Figure 1 shows a map of the Koto Baru location which is along the national road that connects the city of Padang with Jambi province.
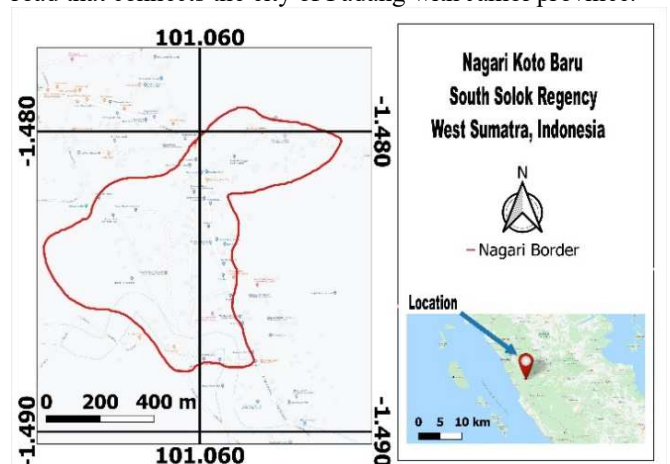

Fig. 1 Koto Baru Village, West Sumatra, Indonesia

The village is 125 km from Padang City, or a four-hour drive along the winding road, which crosses tea plantations, with beautiful views of the Kerinci mountain [33]. Moreover, the uniqueness of this village is its traditional houses, known

as the RG. About 125 old and artistic houses were built since the 1700s, of which ten are used as homestays [33]. The houses consist of various models, including 4, 5, and 6 pieces of *gonjong* or a pointed roof shape resembling a buffalo horn. Figure 2 shows the shape of the RG in the village.

Fig. 2 The RG in the Koto Baru traditional village

B. Steps for Conducting Research

The research methodology used is research and development, while the waterfall method was used for software development. Furthermore, the research stages include literature review, survey, system analysis, data collection, system design, coding, testing, and maintenance as illustrated in Figure 3.
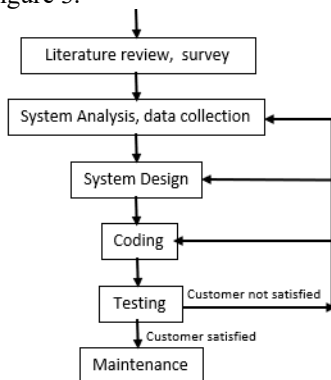

Fig. 3 Research stages

The first activity for this research was about literature review concerning halal tourism villages, followed by a survey, system analysis, and data collection. The survey's main output involves determining tourist objects, attractions, and support facilities from the Koto Baru village. From the survey, it was found that the cultural value of the RG building makes the village unique, and this attracts tourists. Other tourist attractions include eating *bajamba* complete with *petatah petitih* simulation, having lunch together with banana leaf mats, learning to cook special dishes, enjoying fine arts such as *tampuruang*, *piriang*, and *silek luncua* dance. The available support tourist facilities include places of worship/mosques, restaurants, small industries, and souvenir shops.

System analysis involves defining the functional system, including the search for RG as a tourist object and homestay, tourist attractions based on the date of activity, and tourist support facilities around the traditional house, as well as solving the challenges of an integrated homestay management

system with tourist attractions. The following are the system functionalities:

1. Tourists can search for RG using its radius, name, ethnic name, category, and facilities. The information displayed is as follows:
   - List of RG.
   - The location.
   - Detailed information about RG, including name, address, ethnic name, year built, last year of renovation, category, facilities, description, and photos.
   - Detailed information on RG.
2. Tourists can search for tourism activities held by date. The information displayed is as follows:
   - List of tourism activities.
   - The location of the RG where tourism activities are located.
   - Detailed information about tourism activities, including name, place, date, status, and person in charge.
3. Tourists can search for tourist-supporting facilities such as places of worship, restaurants, small industries, and souvenir shops around the RG. The information displayed is as follows:
   - List of tourist support facilities.
   - Location of tourist support facilities.
   - Detailed information about tourist support facilities.

The next activity involves tourism data collection in Koto Baru village. The data collected are as follows:

1. Attribute Data

Attribute data is collected directly from the field; hence, data involving RG, restaurants, mosques, small industries, and souvenir shops were collected for the system development. The data collected from the RG consisted of attribute data such as the owner's name, ethnicity, address, construction year, renovation year, category of RG (homestay or not), facilities owned, and telephone contact numbers. Furthermore, the attribute involving the mosque data comprised the mosque's name and address. The data for the restaurant included name, address, and operation hours, while that for the small industry involved the industry name, address, owner's name, and telephone contact number. Souvenir shop data comprised the store name attribute data, owner's name, hours of operation, and telephone contact number.

2. Spatial Data

This type involved collecting data directly from the field using a mobile phone with GPS. The spatial data collected for system development included geographic data of Koto Baru village, such as geometric data of RG, mosques, restaurants, small industries, and souvenir shops. It consisted of raster and vector data whereby the raster data was obtained from the aerial photo of Koto Baru village from google maps used as a base in the digitization of the village. The vector data generated from the digitization process involved the geometric data of the RG in the polygons form. The restaurants, mosques, small industries, and souvenir shops are all in the points form. Figure 4 shows the process of adding spatial data and mosque attributes.

After completing the analysis phase, the technology architecture, user interface, database, and process design were arranged. Figures 5-7 show the shape of web and mobile GIS's main user interface design. The entity-relationship diagram (ERD) of the database design can be seen in Figure 8.

Furthermore, Bootstrap is used to design the GRT user interface, while PostgreSQL/PostGIS is used for databases, and PHP, Basic4Android, and JavaScript are used for process programming. GRT testing was carried out using the black-box testing method, which aimed to check the performance of the GRT to ensure every feature ran as expected. Moreover, the data used for this test was from Koto Baru village.
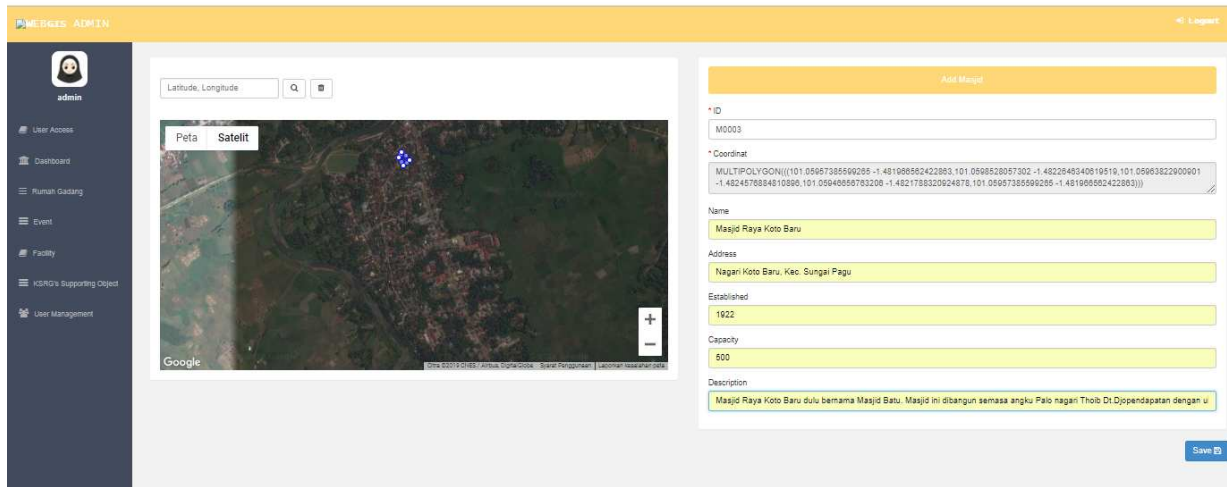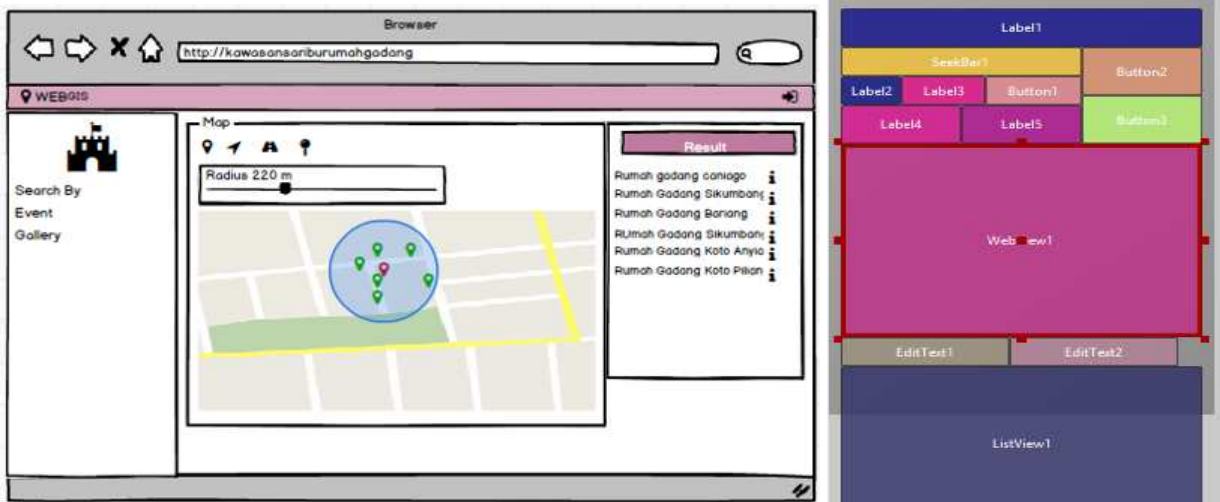

Fig. 4 The process of adding data and mosque attributes

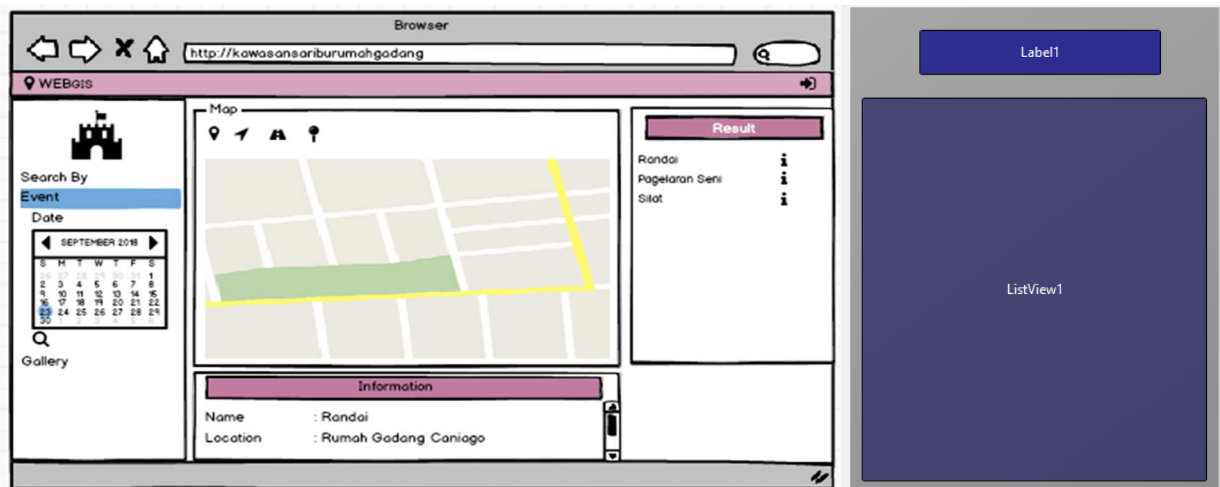Fig. 5 The design of the search page for the RG around the tourist position

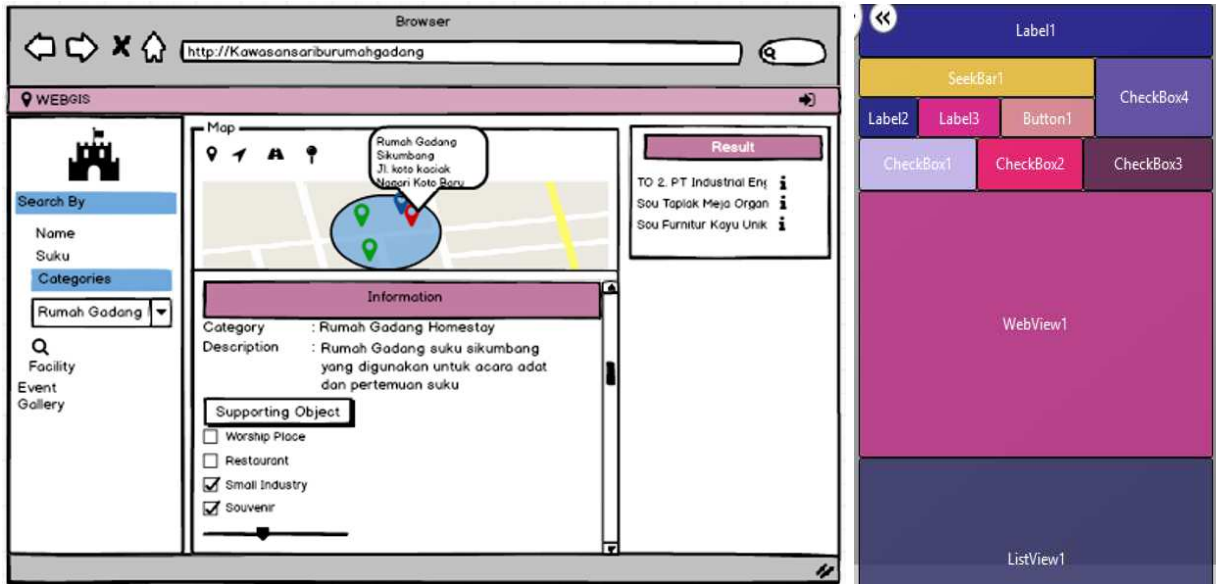Fig. 6 Design of a tourism activity search page by date

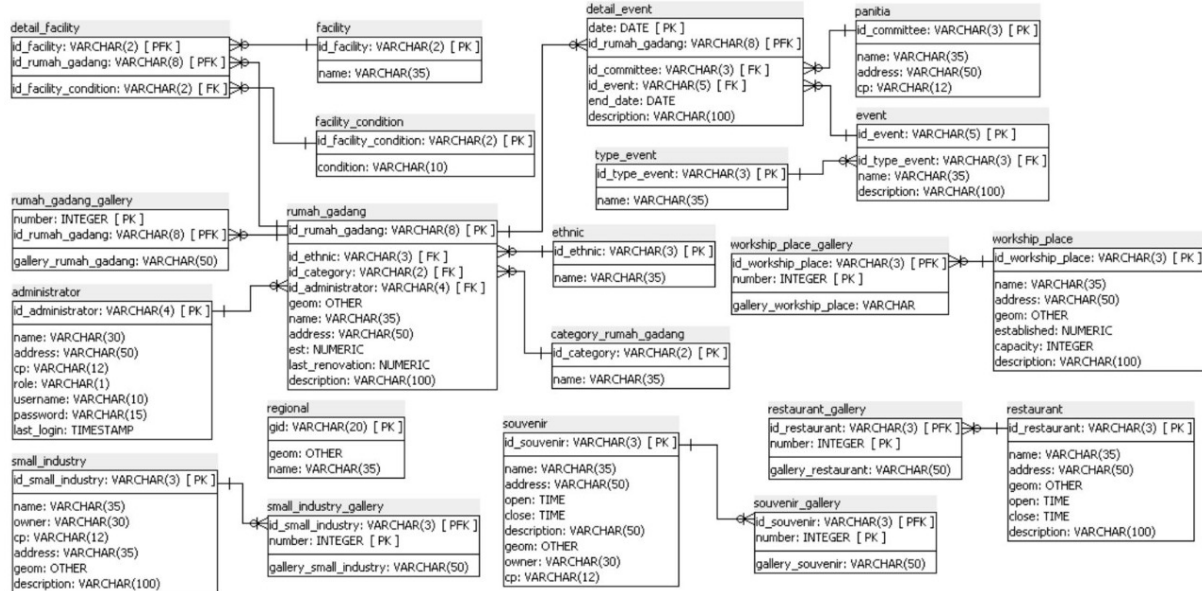Fig. 7 The design of the search page for supporting tourism facilities

Fig. 8 ERD GRT

III. RESULT AND DISCUSSION

GRT for the halal tourist village in Koto Baru was successfully programmed and developed using PHP, B4A, and JavaScript. It has also succeeded in integrating the RG management as a homestay and a tourist object with tourist attractions and tourist support facilities. Bootstrap was used to build the user interface, while PostgreSQL/PostGIS helped build the database. PostgreSQL is a free and open-source software database, while PostGIS is a spatial database extender for PostgreSQL object-relational databases. Additionally, Google Maps was used as the base, while the PostGIS spatial function and the Google Maps API integrated the RG, tourist attractions, and support facilities.

After the GRT was programmed, it was tested using the Koto Baru village tourism data. The following tests were carried out with the examiner's position at the coordinate point (101.0598625, 1.4818065). Furthermore, the three main

functions of the GRT were tested, including the search for RG as a tourist object and a homestay, tourist attractions based on the activity date, and tourist support facilities around. Figure 9 demonstrates the search output for RG as a tourist object center about 500 meters away from the examiner's position in the web GIS form and the mobile GIS form. Meanwhile, Figures 10-12 present the search results for RG by category (homestay), tourist attractions by activity date, and tourist support facilities. The test results showed that the GRT had been developed appropriately, with its system functioning properly with all the needs during pre-trips or at tourist sites.

Figure 10 shows the search results for RG homestays in the Koto Baru village. Subsequently, Figure 11 illustrates the house where art performances were held in April and May 2019. Figure 12 exhibits the restaurant facilities around the Fifaldi Datuak Sultan Nanchodo's RG with coordinates (101.058886260962, -1.48513714264909). Figure 11 is also the output resulting from integrating the traditional house with

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tourist attractions. This integration was carried out on the database by relating the RG table with the event table.

Furthermore, Figure 12 is the output resulting from the integration of traditional houses with tourism support facilities, which is carried out on a spatial database (PostGIS) using several spatial operations involving the commands select … from … where, st_x, st_y, st_centroid, point, st_distance_sphere, and st_geomfromtext. Therefore, the GRT has shown the ability to integrate RG, tourist attractions, and supporting facilities. The GRT has addressed the problem of managing homestays integrated with tourist attractions and support facilities.
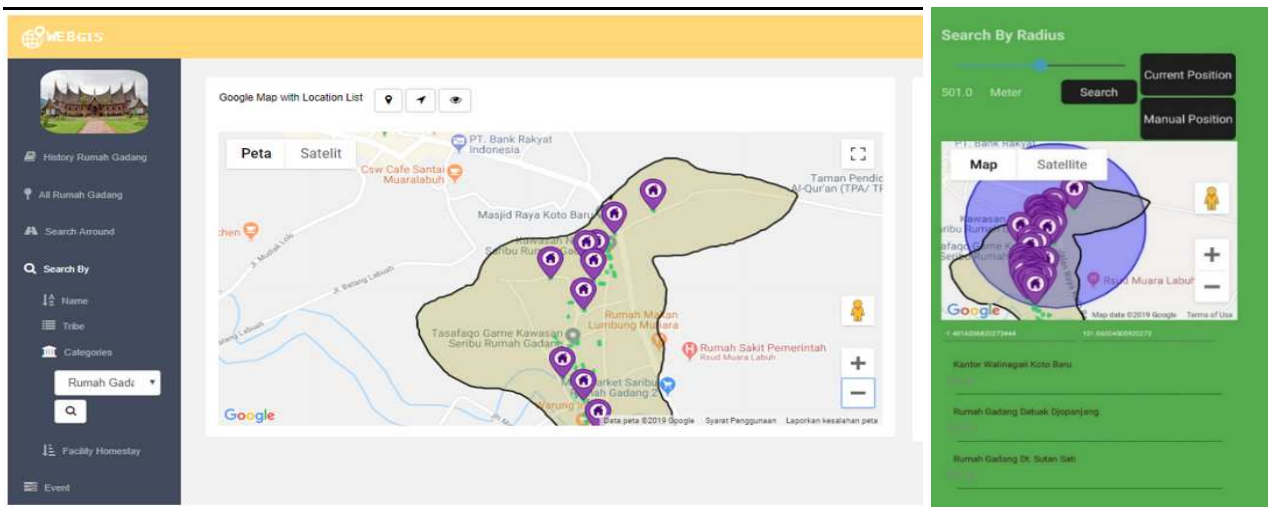

Fig. 9 The location of RG around the test coordinates (101.0598625, 1.4818065)
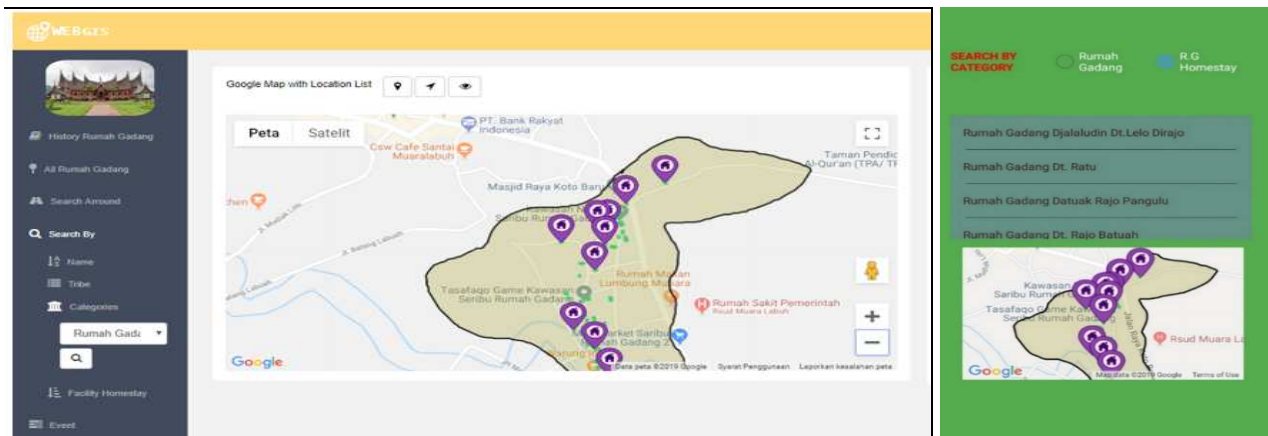

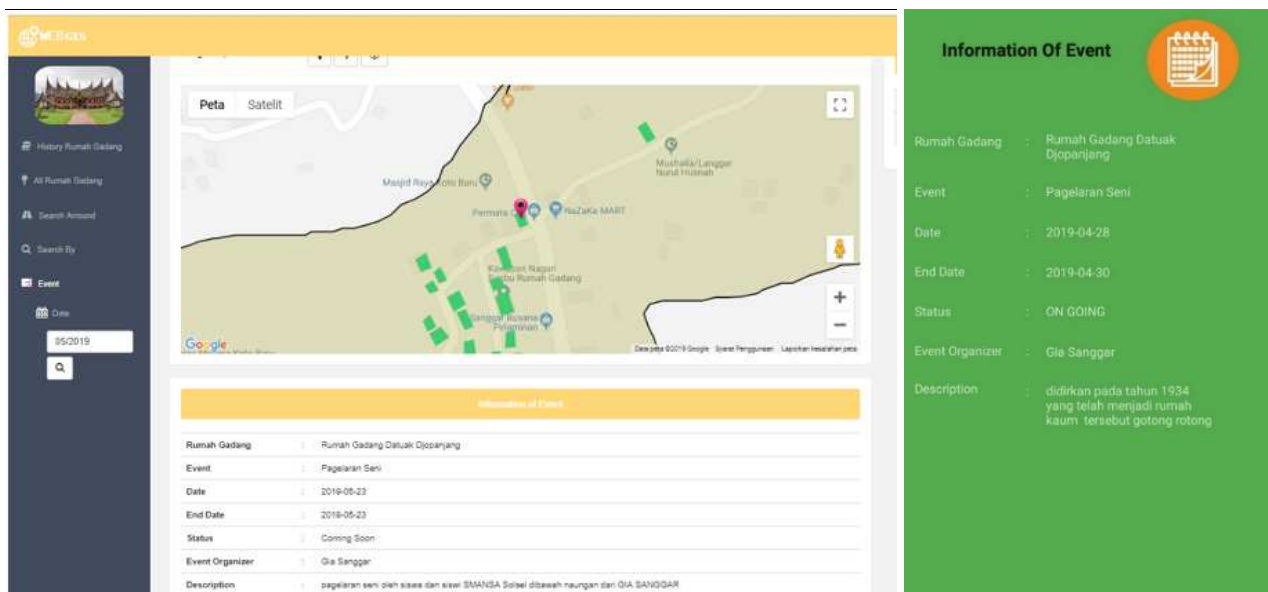Fig. 10 RG that functions as a homestay

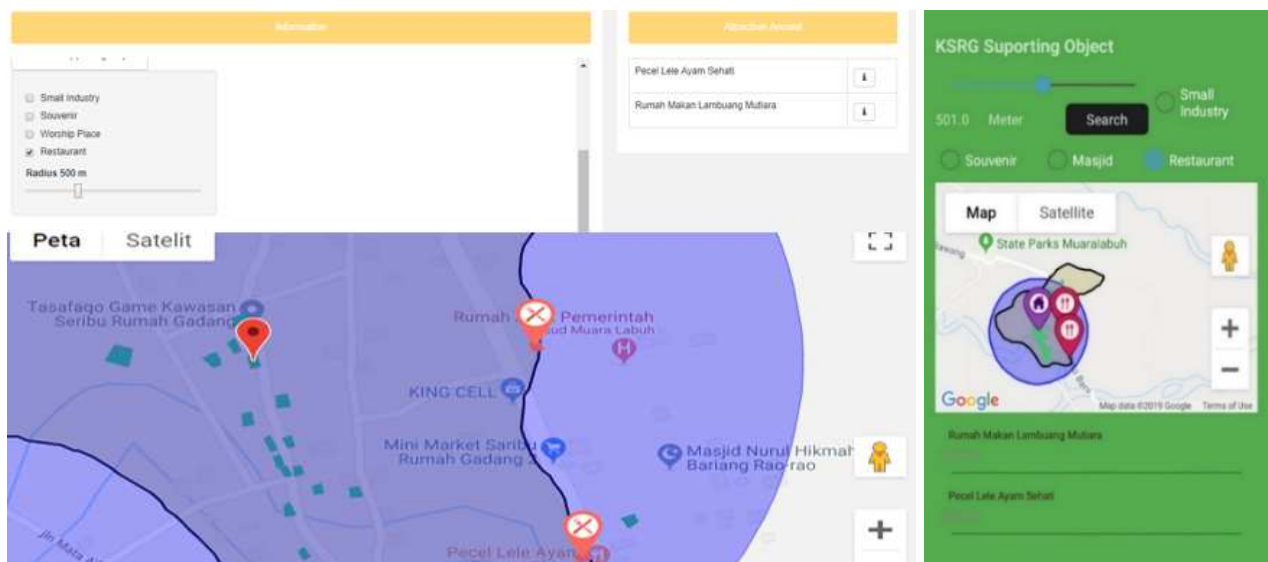Fig. 11 RG where art performances were held in April and May 2019

Fig. 12 Facilities/objects that support tourism: Restaurants around the Fifaldi Datuak Sutan Nanchodo's RG

IV. CONCLUSION

GRT for the halal tourism village in Koto Baru was successfully developed using a research and development method. The main research was software development, preceded by a literature review and survey work to determine the needs of the system being built. From the analysis, the system's function solved the challenges by developing tools for integrating RG with tourist attractions and supporting tourism. The system integration design was carried out through ERD design and PostgreSQL database with PostGIS spatial extension. The integration included the management of RG, which functions as a tourist object, a homestay with tourist attractions and support facilities.

Furthermore, the GRT user interface was designed using Bootstrap. The GRT programming was then implemented using PHP, B4A, and JavaScript, while Google Maps was used as the base map. After the GRT had been programmed, it was tested to check its functionality using Koto Baru village tourism data. The test results indicated that the developed GRT had a functional system integrating all needs for the pre-trips and at tourist sites. Further research should focus on developing tourism app modules following the uniqueness of halal tourism villages.

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