

WEB-GIS FOR SCHOOL DATA MANAGEMENT AND ASSESSMENT IN KLATEN REGENCY

**Rian Arif Hidayat¹, Ninik Agustin²,
Early Detrias³, Mochamad Taufiqurrochman Abdul Aziz Zein⁴**

Student¹, Lecturer^{2,4}, Full-Stack Developer³

Universitas Nahdlatul Ulama Al Ghazali Cilacap^{1,2,4}, PT. Rajut Ananda Hidup Mandiri³
rianarifh50@gmail.com¹, ninik.agustin@unugha.id², fdetrias@gmail.com³, zein@unugha.id⁴

Abstract

School location data in an area is typically only stored and presented in tabular or graphical form. Whereas school data is data that has a location point. Spatial presentation of data can provide broader information about an event or a feature that can facilitate drawing conclusions, for example using webGIS. WebGIS development in Klaten Regency has been implemented to display school data using licensed tools, but no development has been carried out using open source tools so that it is easy to customize. So, the development of a webGIS prototype is needed for the management and assessment of school data in Klaten Regency using open source tools. The system development methodology used is the waterfall model, with the phases of requirements analysis, design, implementation, and testing. The system was developed using the PHP language framework Code Igniter 4, MySQL database, front-end development in displaying maps using Leaflet.js and OpenStreetMap libraries. Spatial data of sub-district areas in the form of polygons is displayed using JSON and AJAX technology. School spatial data is displayed in the form of location point markers with school profile pop-ups. Functionality testing is carried out using the black box testing method resulting in all features functioning according to their functions.

Keyword: webGIS, Spatial Data, Open-source, School

Introduction

The locations of schools in an area are usually only stored and presented in the form of tables or graphical presentations. Meanwhile, school data is data that has a location point. School data is often presented as non-spatial data, which makes the management of school data processing not optimised. Spatial data has spatial information and non-spatial information. School data has spatial information in the form of coordinates of school location points, while non-spatial information occur as a school name, level, and number of students. Spatial data presentation can provide broader information about an event or a feature that can facilitate drawing conclusions (Agustin et al., 2023).

Spatial presentation of school data can be implemented by developing a web-based geographic information system (WebGIS). This is because WebGIS has the advantage of more

structured data management and easier data assessment. Data management that can be done includes storing data in a certain order, sorting data, and adding, changing data content, or deleting data. Simple data assessment includes selecting data and displaying the information contained in the data. With the spatial presentation of data, school data management can be conducted in a better structured and organised approach.

In the present day, information is served and shared quickly through the internet. The web is one of the platforms for sharing information via the internet that is accessed through a browser using any type of device, whether PC, laptop, tablet, or mobile. Web technology has the advantage of easy access and reliability, so it is also used to develop information systems. One of the types of information systems is a geographic information system that can visually present information by placing data on a map based on location coordinates. The development of Geographic Information Systems has been quite rapid in the last 10 years, both those developed based on open source or licensed (Shukla et al., 2021).

In Klaten Regency, an information system has been developed that contains WebGIS-based school data but still uses a spatial data processing application, ArcGIS Pro (Tiktana & Karen, 2021). This technology has limited features that can be built. WebGIS development using programming languages and databases provides freedom in building features. One of the programming languages used in web development is PHP. Some of the advantages of the PHP language include being open-source and having many dynamic libraries, easy to use, compatible for all OS, and has high security (Adam & Andolo, 2019; NV et al., 2023). For this reason, it is necessary to develop a prototype of a web-based geographic information system for school data management and assessment in Klaten Regency

Literature Review and Hypothesis Development

Web-based Geographic Information System (WebGIS)

Web-based Geographic Information System (webGIS) is a technology designed for displaying, processing, manipulating and analysing spatial data presented in a web interface. (Chumaidiyah et al., 2021; Lima et al., 2021; Lv et al., 2016). In line with the development of technology, webGIS developed a web architecture that has a map presentation layer in the browser, a web service in the business logic layer, and a database that has geographic data in the data layer. (Figure 1).

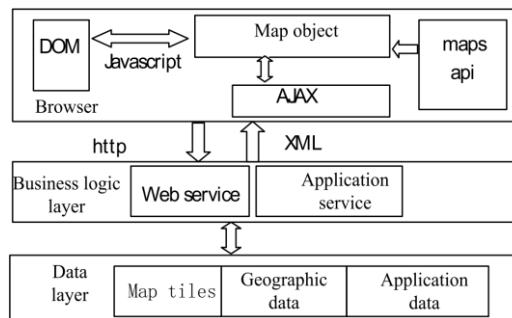


Figure 1. webGIS architechture (source : (He & Zhu, 2020))

WebGIS development in Indonesia has been used to provide solutions in various fields. In 2018, webGIS was developed to map schools and disaster mitigation (Ariyanti et al., 2018). In 2021, the application of web-based GIS has been carried out to address the distribution of clean water in Freshwater Fish Farms in South Bengkulu Regency (Yulfiperius et al., 2021). In 2022, a web-based GIS was developed to integrate the demographic and geographic data of each village in Tasikmalaya Regency (Rahmatulloh et al., 2022).

Display data on a web-based map

The main component of webGIS is the existence of a base map obtained from a web-based map service provider. Some platforms that have such services are Google Map (Gaikwad et al., 2021; Putra et al., 2020; Sari et al., 2019), Open Street Map (Smirnov & Kudinov, 2021; Soto & Alfaro, 2021), and Mapbox (Guan, 2023; Maulana & Kanai, 2021).

Together with the base map, specific spatial functions are needed that are utilised in the displays of spatial data, interaction of the map and the displayed spatial data, and further data processing. Therefore, there are many libraries available that can help organise spatial data in webGIS development. One of these libraries is *Leaflet.js* which is widely used by webGIS developers because it is easy to use, has complete basic features, and works lightl (Azaria & Momya, 2022; Nur Fazheera Algadri et al., 2021).

Research Methods

This research uses a waterfall model system development approach. Overall, the research method is shown in Figure 2 below.

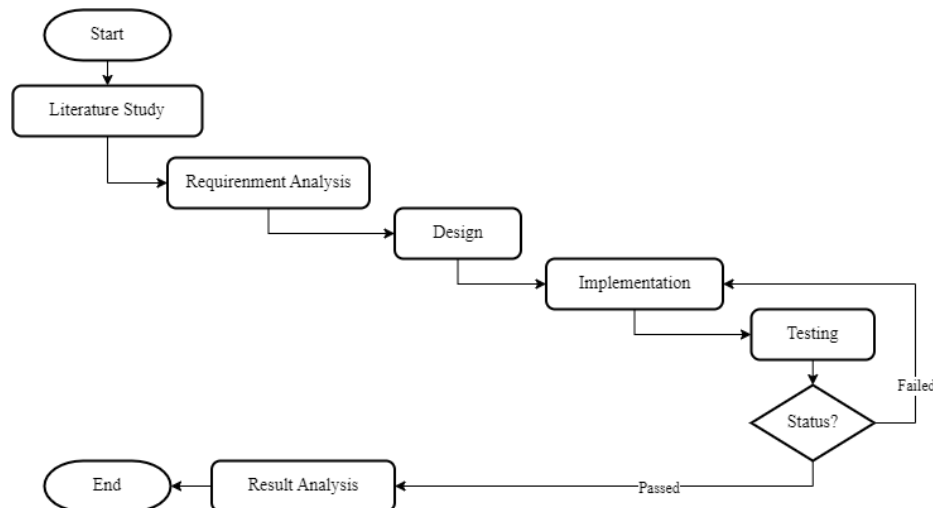


Figure 2. Research flowchart using waterfall model

Based on the figure above, the research stages begin with a literature study. Then proceed with the system development stage using the waterfall model (Pressman, 2010; Sommerville, 2016), with the following steps: requirements analysis, system design, implementation, and testing. Furthermore, the results of system development were analysed and concluded.

Requirement anaysis

The requirement analysis phase determines the specifications of the system to be developed. The system to be developed is a web-based geographic information system with the main feature of being able to create, read, update, and delete school data. The system has a dashboard view that displays a base map. The features on the dashboard page are the sub-district layer in the form of polygon data and school location point markers. The system is developed using HTML, CSS with Bootstrap framework, and JavaScript for Front-end development. While the PHP programming language Code Igniter Framework for Back-end development. The database used is MySQL. Leaflet.js and Open Street Map libraries are used to display the base map on the webGIS dashboard. The spatial data used is in polygon and point format. Polygon data is converted into JSON format to display the sub-district area. Then the point data is used to represent the school location marker.

Design

The system design phase used the Unified Model Language (UML) because the system will be developed using the object-based PHP language framework (Imanuel et al., 2022; Sastypratiwi & Yulianti, 2019). The system design is described using use case diagrams, activity diagrams, state diagrams and sequence diagrams

a) *Use case*

Below is Figure 3 which shows the use case diagram. This use case diagram shows that there are two roles in the system to be developed, namely admin and user. The figure shows the access rights of each role. Admins can access the admin page, add school data, add school location markers, view the list of schools, and delete school data. Meanwhile, users have access to open the dashboard, view the list of schools and data for each school.

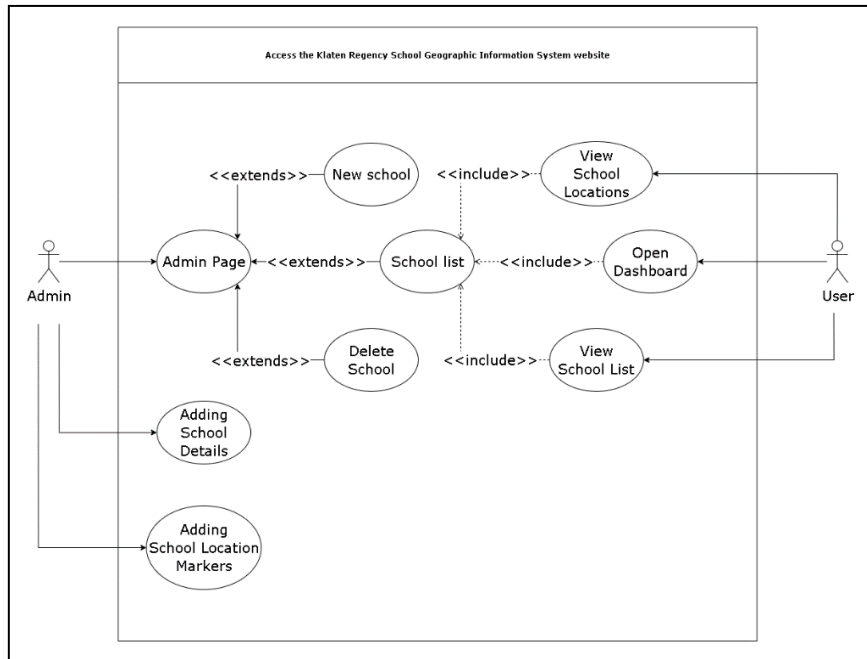


Figure 3. Use case diagram shows access of admin and user

b) *Activity Diagram*

The design of the school object control flow that will be created is shown in Figure 4 below. One of the selected school data has add, edit, and delete features. Each feature will appear on a new page. Each feature has validation before the changes are executed. Changes to field contents in the add and edit features will end with a save step. Meanwhile, record changes in the delete feature will end with a delete step.

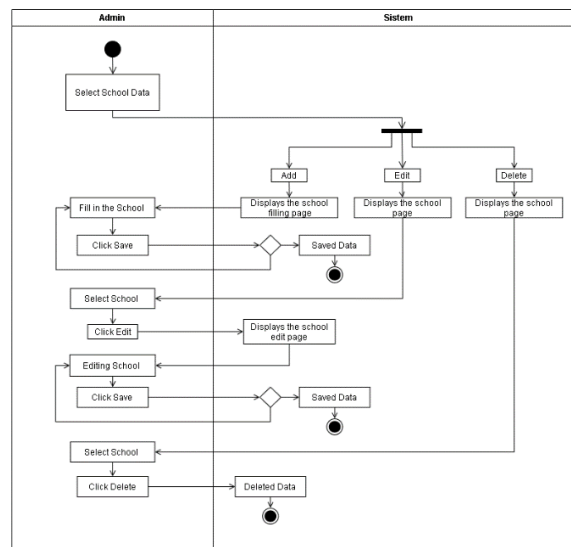
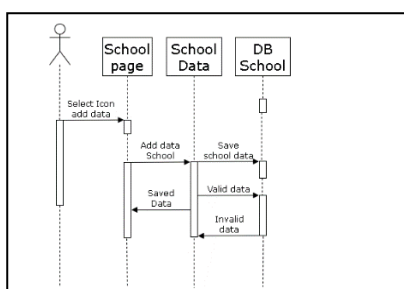


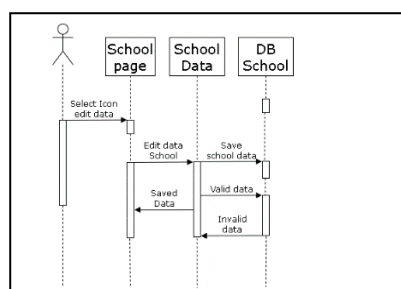
Figure 4. Activity diagram of Klaten regency WebGIS

c) Sequence Diagram

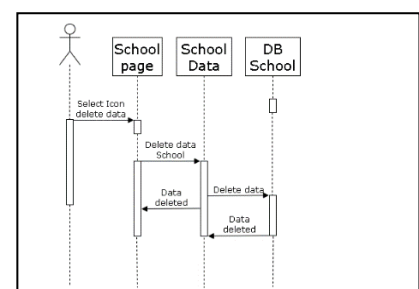
The sequence diagram design below shows the sequence that is executed in the add feature (figure a), edit feature (figure b), and delete feature (figure c). The admin role executes the add feature by selecting (clicking) the add data icon on the school page. Next, when the add data page appears, the admin inputs new data. The data that has been entered is validated and forwarded to the school database (DB) and stored in the database. After the new data is saved, the system will display the school page again. If the data is invalid, the system will return to the add school data display. The edit feature has the same sequence as the add feature, except that it does not add new records to the database. The delete feature also has almost the same sequence as the previous two features but the data validation does not bring up a new page. After the delete validation is executed, the system will return to the school page.



(a)



(b)



(c)

Figure 5. Sequence diagram of Klaten regency WebGIS

d) State Diagram

Next, the design in state diagram is shown in Figure 6 below. Users can access the webGIS through the admin page, then add school data including location data. Admin can also delete school data from the admin page.

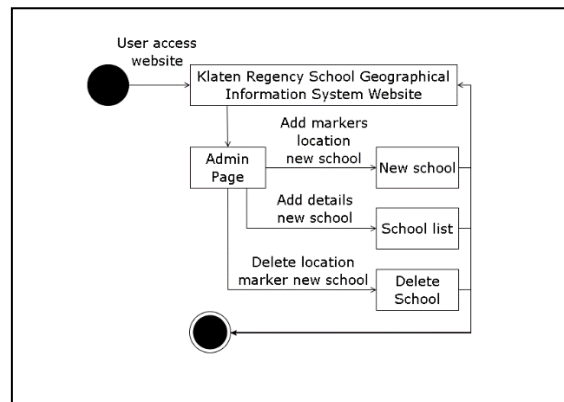


Figure 6. State diagram of Klaten regency WebGIS

Implementation

The Implementation phase begins with applying the design to the database. Next, implementing the programme code with the Model View Controller (MVC) concept using the "Code Igniter 4" framework. The system was developed with three models, namely KabupatenModel, KecamatanModel, and SekolahModel. The base map from "OpenStreetMap" is displayed on the dashboard using the "L.map" function from the Leaflet.js library. Sub-district development is done by creating create, read, update, and delete features using the MVC concept. The sub-district polygon data in JSON format is called using AJAX techniques, the functions "getData", "L.geoJson", "JSON.stringify", and "JSON.parse". The next step, developing school features with the same concept as the development of sub-district features. The last step, the development of markers and the feature of clicking on markers at school points is done using the Leaflet library with the functions "onEachFeature" and "L.marker".

Testing

The testing stage is carried out using black box testing. this method is used to test the functionality of the system. If the results are successful, then proceed to the analysis stage, if it fails, then return to the system implementation stage. Furthermore, the results analysis stage aims to discuss the results of system development in detail.

Discussion

The results of the system design implementation as the dashboard, sub-district, and school pages are shown in the following figure. The dashboard page (Figure 7) displays the Kecamatan and Sekolah menu sidebar, a map display with polygons of sub-districts in Klaten Regency and school location points, and district statistical data on the right side.

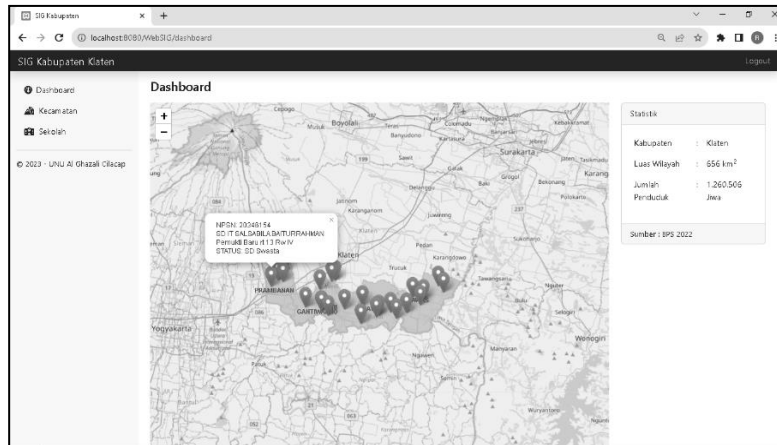


Figure 7. The webGIS dashboard view of the Klaten Regency shows a base map with district polygons and school marker points

When the kecamatan menu on the sidebar is clicked, the Kecamatan Page will appear (Figure 8a). When the add data feature is executed, a new blank form will appear (Figure 8b) to input new data. Likewise, the edit data feature will display a form page that has been filled with sub-district data that has previously been inputted. Next, the admin can edit the contents of the field, then click save if they want to update the data, and click cancel if they want to cancel the data changes.

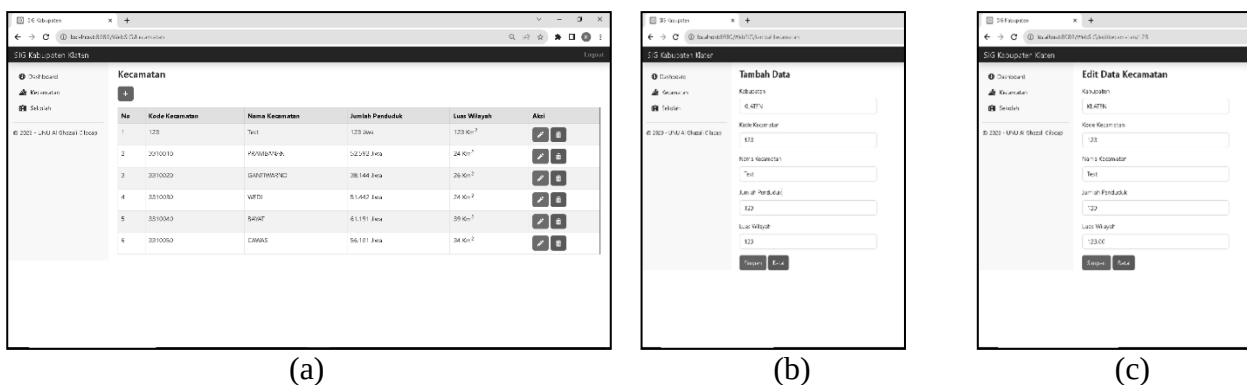


Figure 8. District feature display: (a) district list, (b) district data add feature, (c) district data edit feature

Next, the school page can be displayed through the school menu on the sidebar. The school menu features add data, edit data, and delete data. Next, the school page can be displayed through the school menu on the sidebar. The school menu features add data, edit data, and delete data. The following in Figure 9 presents the display of the function of adding school data, editing school data and recapping school data which displays the edit and delete menus.

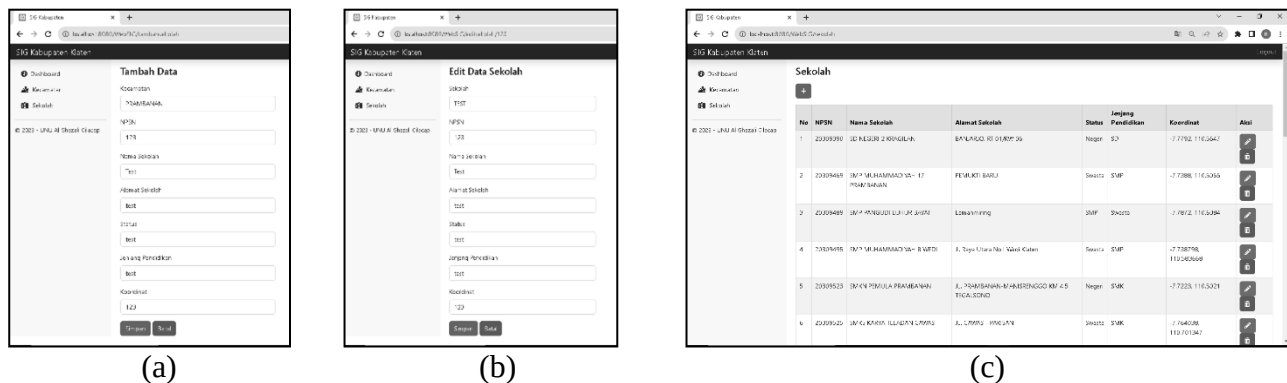


Figure 9. School feature display: (a) school data list, (b) school data add feature, (c) school data edit feature

System function testing with the blackbox method is conducted based on objects created at the system development phase and run based on the system design. The following Table 1 shows the results of system testing.

Table 1. Result of functional blackbox testing

Object	Features tested	Action	Status
Kabupaten	Dashboard	Display a base map with sub-district polygons and school marker points	Passed
	District polygon click feature	The selected sub-district polygon has a different colour, and the sub-district data is displayed.	Passed
	School marker click feature	School data pop-up appears above the selected school marker	Passed
Kecamatan	District page	Displays a list of sub-districts in the form of a table consisting of fields "no", "sub-district code", "sub-district name", "population", "area", "action".	Passed
	Add feature	The inputted data matches the criteria. After selecting save, the web returns to the District page and shows that there is new data that has been inputted in the sub-district list. A new polygon appears on the dashboard	Passed
		When click cancel, Return to District page	Passed
	Edit feature	Click the edit data icon, the system redirects to the edit data page, after the data content has been changed, click save. The system redirects to the District page and the data	Passed

Object	Features tested	Action	Status
Sekolah	Delete feature	content has changed.	
		When cancel clicked, Return to District page	Passed
		Click the delete icon on one of the selected sub-districts, a delete data validation pop up appears, click ok, the data that was previously selected has been deleted.	Passed
		When click the cancel button, the pop-up disappears. No data change occurs	Passed
	School Page	Displays a list of schools as a table that consists of fields "no", "NPSN", "school name", "school address", "status", "education level", "coordinates", "action".	Passed
	Add feature	The data entered is in accordance with the criteria. After selecting save, the web returns to the School page and shows that there is new data that has been inputted in the school list.	Passed
		A new marker appears on the dashboard	
	Edit feature	When cancel is clicked, return to School page	Passed
		Click the edit data icon, the system redirects to the edit data page, after the data content has been changed, click save.	Passed
		The system redirects to the School page and the data content has changed.	Passed
	Delete feature	When cancel is clicked, the system returns to the School page	Passed
		Click the delete icon on one of the selected schools, a delete data validation pop up appears, click ok, the data that was previously selected has been deleted.	Passed

Based on the test results above, all functions in the dashboard were successfully tested with all results having a passed status. This system can be used as a school data management in Klaten District, including if it will conduct an assessment of the attribute data in it. This platform can be used to enhance the webGIS system that has been developed by Tiktana & Karen (2021) y adding school data attributes, addresses, school status and so on. WebGIS development without using software such as QGIS and ARCGIS has its own advantages including;

1. Interactivity can be improved by maximising the front end (such as the use of CSS).
2. Improved performance by maximising the back end (e.g. the use of optimised algorithms to improve accuracy and performance)
3. Adaptive to AI, big data, IoT technologies that can be integrated in webGIS
4. Security of data can be further improved through optimised layered protection

Conclusion

The webGIS system for school data management and assessment has been built using HTML, CSS with Bootstrap framework, and JavaScript for the Front-end. While the PHP programming language Code Igniter Framework for Back-end. The database used is MySQL. Leaflet.js and Open Street Map libraries are used to display the base map on the webGIS dashboard. The spatial data used is in the form of polygons and points. Polygon data is converted in JSON format to display sub-districts and point data to represent school location markers. The results of black box testing show that all webGIS functions run according to their functions.

Suggestions for further research improvement are the availability of special GIS functions that are developed according to the needs of the region. Optimisation of the front end and back end can be adjusted to the functions developed.

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