Design of Integrated Database on Mobile Information System: A Study of Yogyakarta Smart City App

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Abstract. An integration database is a database which acts as the data store for multiple applications and thus integrates data across these applications (in contrast to an Application Database). An integration database needs a schema that takes all its client applications into account. The benefit of the schema that sharing data among applications does not require an extra layer of integration services on the applications. Any changes to data made in a single application are made available to all applications at the time of database commit - thus keeping the applications' data use better synchronized. This study aims to design and build an integrated database that can be used by various applications in a mobile device based system platforms with the based on smart city system. The built-in database can be used by various applications, whether used together or separately. The design and development of the database are emphasized on the flexibility, security, and completeness of attributes that can be used together by various applications to be built. The method used in this study is to choose of the appropriate database logical structure (patterns of data) and to build the relational-database models (Design Databases). Test the resulting design with some prototype apps and analyze system performance with test data. The integrated database can be utilized both of the admin and the user in an integral and comprehensive platform. This system can help admin, manager, and operator in managing the application easily and efficiently. This Android-based app is built based on a dynamic client-server where data is extracted from an external database MySQL. So if there is a change of data in the database, then the data on Android applications will also change. This Android app assists users in searching of Yogyakarta (as smart city) related information, especially in culture, government, hotels, and transportation.

1. Introduction

The development of increasingly complex applications requires an increasingly complex database design as well. The database is one of the decisive factors in the power and success of the application. The factor of normalization, nonduplication, and optimization of memory usage become the main factor in database design [1]. If the designed database does not meet the above requirements, it will be fatal; process errors can occur, programming logic errors, output errors generated, and excessive memory usage resulting in economic wastage, especially if the application requires large amounts of data. The database technology develops more rapidly. If the first data is limited to text and images, then the current data already includes more kinds, such as imagery, genomics, heart rate and so forth. An integrated database is a database that acts as a data store for multiple applications, resulting in data integrity between applications [2]. An integrated database requires a scheme that can unify all user needs into a
database design. The result of this scheme is a more general (general) or complex database design or both because it must incorporate bounded contexts if each application is built separately. The advantage of sharing data between applications is that it does not require an extra layer of application integration services. Any changes to data performed on an application will automatically change all the data in other applications so that synchronization is easy to do. The integrated database contains information collected from more than one data source. In the process of combining different data sources, individual data elements often need to be altered or synced to represent a consistent or standard context. This transformation must be done without loss of data integrity and interpretation. Combining data from multiple sources increases statistical power to identify important relationships between data elements.

An integrated database is used by research institutes, pharmaceutical companies, and regulatory agencies during clinical development and post-marketing surveillance. Integrated databases have been used for years, but in recent years, the use of integrated databases has evolved beyond classical applications to clinical trial data to incorporate applications into imagery, genomics, and other digital data. More advances in data storage, agency software applications, and information standardization efforts have affected the construction and use of integrated databases [3–4].

Information Systems are the key to success in Enterprise systems. Integration can replace functionally oriented, impacting the cost of infrastructure support [5]. Currently, the integration of an information system is a necessity, more important than ever, because in a large institution there are many separate applications, which require a lot of costs, a long time in syncing information between applications [5]. According to Pichler [6], data integration is a combination of multiple heterogeneous data sources that display data through virtual similarities and global schemes. Mapping the (local) data source to the target (global) scheme, so the global scheme as a view and locale is also a view with a strong connection to the data query. Sutanta [7] creates an integrated database model for population systems by utilizing Indonesian Resident’s ID Number (NIK). The design is made so that the primary key values that have been previously defined and used in each database can still be used. Gal [8] performs a systematic analysis of process properties and stabilizes the criteria for evaluating the quality of matching algorithms by using mapping attributes between heterogeneous schemas. Nurnawati [9] developed location-based mobile applications to present healthcare location information in Yogyakarta. The information provided is among others the locations of hospitals, clinics, pharmacies, and specific regional locations presented on the digital map feature. The application is also developed based on Android. The app is intended for people and migrants using Android mobile device. This app presents the closest Health Service detection feature of the user's location using the Google Map i.e. location distance, location route along with photos and a short information. Nurnawati [10] succeeded in developing a database integration model for GIS application prototypes that can be applied to mobile device. Applications in this study have been tested on 4 (four) types of information, namely transportation, tourism, hotels, and government offices. This research succeeded in implementing database usage for several applications at once. The objective of this study is to design an integrated database used by the application package i.e. an application that integrates multiple GIS applications on Android-based mobile hardware where it can be accessed and used freely by users.

According to Yang and Hsu [11], Location Based Service (LBS) is a service that reacts actively to position entity changes to be able to detect the location of the object and provide services according to the location of the known object. The LBS works on “Mobile Positioning” technology. This service is an application that depends on a particular location and is also defined as an information service by utilizing technology to know the position of something. The Positioning System technology on LBS facilitates users to obtain location information according to their needs. The LBS has similar technology category as like as Geographic Information System (GIS), and Global Positioning System (GPS) application, known as geospatial technology. This technology consists of devices for collecting, storing, analyzing and distributing data by the needs of users of the earth coordinate system. This service becomes very important for users because it can connect with geographic location information to the location of its users. The LBS application is the result of a merger of three technologies: New Information and Communication Technologies (NICTS), the Internet, and GIS using spatial databases.
This LBS technology consists of devices used to collect, store, analyze and distribute data and information based on the real-time geographic coordinate system. Identification of user coordinates allows LBS applications to provide services for mobile device users.

2. Experimental Setup

2.1. Domain of study
The scope of the study includes data on tourist objects, transportation, hotels and lodging, government offices, and education in the Daerah Istimewa Yogyakarta. The data is provided by the Office of Dinas Komunikasi dan Informatika (Kominfo) Daerah Istimewa Yogyakarta.

2.2. Methods of study
The studies use survey, observation, and analysis methods with details as follows:

- Preliminary studies. This stage is intended to conduct a preliminary study with the goal of finding gap information needs between users and existing application systems and determining alternative relevant solutions.
- Data collection. Data collection is done through literature review and field survey to obtain supporting data for the needs of database integration of applications that will use the database.
- Needs analysis. At this stage, an analysis is done to find the technical and non-technical requirements for the system. The analysis is done by examining the needs of all applications, looking for patterns of data requirements, making the design normal, not duplicate and meet the needs.
- Design Databases. In this stage consists of two parts, the first database design is realized by building the database with the use case tools, class diagrams, and build the relation. The second part to make the system design logically using diagram-shaped tools consisting of use case diagrams, class diagrams, activity diagrams, and sequence diagrams. In this stage also compiled design display, input, output, and integrated database that allows for use by many GIS applications on mobile devices.
- Build prototypes. The prototypes are used to test the performance of the database. At this stage, the system design is implemented into an integrated application package. The developed application package consists of 2 (two) versions, which is the version of the manager (web-based) and the user version (based on Android mobile).
- Testing. Testing is done to find possible errors in the system. Testing on the reliability of database design is done in 3 ways [13], namely component testing, connectivity testing and system testing. While the prototype testing is performed using an emulator device that allows displaying the results of each module developed in the coding stage. If the testing time found an error then immediately fixed so that in the end obtained the system by the design that has been set [14].
- Implementation. At this stage, the developed application system is implemented in a real Android mobile device. At this stage also tested the compatibility of the application system against several mobile devices and different browsers, so that in the end will be obtained system application as expected.
- Documentation and reporting of research results.

3. Results and Discussion
The main result of this study is the design of an integrated database which can be seen in the relational diagram as shown in Figure 1. In Figure 1, there are 13 tables in the database, consisting of “Provinsi”, “Kabupaten”, “Kecamatan”, “kode_pos”, level, user, object, Log_edit, temp_login, sub_category and details_objects.

[12]
Figure 1. Database design with its clarity.

The design of this database has represented all the objects in this study, whether tourist attractions, schools, cultures, hotels, and inns, government offices with each distinguished by the object code. The object type can be expanded by adding new code. The key to integrity is in the provincial code (if the data increases in addition to the Daerah Istimewa Yogyakarta), as well as other area codes.

The class diagram shows the class relationship formed from the database along with its actions, as shown in Figure 2. The class diagram is a logical representation of the database design. In the class, the diagram has classified the classes to be formed along with methods to be done by the class. Each class has its task, whether it be an interface class, a connecting class or a master class [4].
As a test of database design, the application prototypes were built as support in this research. The system is built with two different systems, the first web-based system used by the admin, the operator and the manager and the second Android-based mobile application used by the user. This system has several actors namely admin, manager, operator, and user. Each actor has different access rights. Admin has access rights to manage level data, user data, change the password, change email and view and print activity log data. Managers have access rights to manage provincial, district, sub-district, postal code, category, sub-categories, change passwords and change emails. The operator has access rights to manage object data, image data, change password and change email. Operators in this system are divided into operators per district. Users have access rights to view and search for information about the intended object. After admin enters the level and user data, then this system can be used. Managers enter data of provinces, districts, sub-districts, zip codes, categories, and subcategories. After that, the operator entered the data object and image. The data will be stored in the integrated database. This Android-based app is built based on a dynamic client-server where data is extracted from an external database MySQL. So if there is a change of data in the database, then the data on Android applications will also change. The application results are described in Figure 3 to 11.

The login page is the page used by the user, i.e., Admin, Manager or Operator to enter the system. Users must enter the username and password correctly to enter the system. The display of the login page is shown in Figure 3.

Figure 2. Simplified class diagram.
The main page view of the admin is the view after the admin successfully login. There are five menus in this view, i.e., user menu, level, activity log, change password and change email. The main admin page view is shown in Figure 4. The event log page is the page that displays the activity log when the operator performs the edit activity on an existing object. The activity log page is shown in Figure 5.
The provincial governance page is used to manage provincial data. Managers can view, add and edit provincial data. The provincial list of page views is shown in Figure 6. The Objects management page is used to manage object data. The operator can view a list of objects, input data of object, view detail of objects and edit data of an object as shown in Figure 7. The prototype application for the user is a mobile-based app. The app's homepage for users is a caller for other mobile apps. Currently has been developed four applications namely Jogja Budaya, Jogja Wisata and Jogja Transportasi as shown in figure 8.

The main page of the application of Jogja Budaya has six main menus namely cultural heritage building menu, cultural heritage objects, cultural heritage strata, cultural heritage area, cultural preservation site and search menu. The search menu is used to search for the object the user wants as shown in Figure 9.
The Heritage List View displays a list of cultural presences with list view based on the subcategory of cultural preservation selected by the user. The data displayed is the object images, object name, object address and object distance from the user location to the location of the destination object. There is a button maps view at the bottom right of this page which is used to display a list of cultural presences through maps as shown in Figure 10. The list of cultural presence is displayed in the form of maps view according to the subcategories selected by the user. The data displayed when the object markers are selected the object name and sub-category name of the object as shown in Figure 11.

**Figure 9.** App jogja budaya menu.

**Figure 10.** Heritage list view.
Testing includes component testing, integration testing, and system testing [15]. Component testing is a test of system components. In this study, the interface component was tested as subject of the component testing. Component testing for the component interface is a test performed to determine the functionality of the interface that has been made whether it works as expected or not. Testing interface is done in the menu and button on the application. From the results of component interface testing, it can be concluded that all the menu components and buttons that exist in the application have led to the right page or form. The testing has been running as expected, for example, menu, added data has led to the form added data, edit data link has led to the data edit form, and the delete data button has succeeded to delete the data. Integration testing is a test group of components that are integrated to form sub-system or system. In this study, after each component was tested on component testing, tested the integration of the components. Integration testing related to the communication between applications with databases in the form of testing application functions associated with the database such as add, edit, delete and search. System testing is a test of the integration of sub-systems, namely connectivity between sub-systems. In this research, system testing is done to validate data before entering into the database. Each interface already has validation so that the data entered into the table in the database is valid data. The results of each test are shown in Table 1 below:
From the results of Table 1, it can be concluded that integration testing and system testing has been running well with a fairly short time. The result was excellent refer to Mittal et al. [15] have done. The length of time depends on the internet access and test equipment used. In this test used Oppo F1s mobile device and Acer Travelmate 9700 laptop. The final product proved to be a very satisfactory platform for online smart city data management.

4. Conclusions

From the design, development, and testing of the database using prototype application, it can be concluded that the integrated database can be utilized both on the admin and the user in an integral and comprehensive platform. This system can help admin, manager, and operator in managing the application easily and efficiently. This Android-based app is built based on a dynamic client-server where data is extracted from an external database MySQL. So if there is a change of data in the database, then the data on Android applications will also change. This Android app assists users in searching Yogyakarta related tourism information, especially in culture, government, hotels, and transportation.

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| Atribut Test                        | Table  | Result (s) | Type       | Atribut test                      | Result (s) |
|------------------------------------|--------|------------|------------|-----------------------------------|------------|
| Read,add,edit, seek                | Level  | (✓) 0.25   | Login      | Username and password unmatch     | Alert : 0.1|
| Read,add,edit, seek                | User   | (✓) 0.25   | User status inactive               | Alert : 0.1|
| Read,add,edit, seek                | Provinsi| (✓) 0.25  | User active in same IP address    | Alert : 0.1|
| Read,add,edit, seek                | Kabupaten| (✓) 0.3   | User and password match           | Direct to  |
| Read,write,edit, seek, delete      | Gambar | (✓) 0.35   | Data       | Add data fail                     | Alert 0.1  |
| Read,add,edit, seek                | Kategori| (✓) 0.2   | Add data success                    | Alert 0.1  |
| Read,add,edit, seek                | Obyek  | (✓) 0.2    | Edit data fail                      | Alert 0.1  |
| Add, delete                        | Temp_login| (✓) 0.1  | Edit data success                    | Alert 0.1  |
| Read,add,edit, seek                | Log_edit| (✓) 0.15  | Delete data success                   | alert 0.1  |
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