ITERA Astronomical Observatory Information System

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Abstract

In the current information age, data is a valuable asset for companies [1]. Technological advances encourage the digitization of information in almost all fields of science, including astronomy. Technological developments make it easy to access open data in the public domain. The availability of open data will encourage the acceleration of research. ITERA Astronomical Observatory is an observatory located in Lampung. This observatory is claimed to be the largest in Southeast Asia [3]. To face the challenges in the digitization of information, ITERA Astronomical Observatory plans to build an information system specifically for storing and handling astronomical data.

Keywords: Information System, Astronomical Data, ITERA Astronomical Observatory.

1. Introduction

In the current information age, data is a valuable asset for companies [1]. Data represents an event in the business world and tangible objects such as places, objects, and people [2]. Processing a set of data will produce information that is more useful for the recipient. There are two activities in data processing, namely data storage and data handling [2]. The data storage process includes: collecting, searching, and maintaining data. Meanwhile, the data handling process includes checking, comparing, selecting, summarizing, and using data. Advances in technology and the development of the internet today encourage digitizing information in almost all disciplines, including astronomy. Technological developments make it easy to access open data in the public domain. The availability of open data will help researchers and practitioners to utilize the data further. The challenge of digitizing information makes companies/organizations have to adapt.

In addition to being faced with the challenges of digitizing information, companies/organizations that do not yet have an information system have problems with their data. The manual data storage process can cause issues with data quality, such as duplicate data, lost data, or corrupted data. The absence of a single source of truth has resulted in multiple data where there are many versions of one data. The manual recording process also results in lost data during archiving or problems with damaged data due to human error or natural disasters.

ITERA Astronomical Observatory is an observatory located on the Sumatera Institute of Technology campus, Lampung Province. This observatory is claimed to be the largest in Southeast Asia [3]. In the ITERA Astronomical Observatory case study, astronomical data is still stored manually and does not yet have an information system that can perform centralized data storage and processing. To face the challenges of digitizing information and maintaining the quality of astronomical data at the ITERA Astronomical Observatory, ITERA Astronomical Observatory plans to build an information system that explicitly processes data at ITERA Astronomical Observatory.

ITERA Astronomical Observatory Information System is an information system that becomes a centralized database that functions to store and handle astronomical data used for research by the academic community of the Sumatra Institute of Technology. The ITERA Astronomical Observatory Information System (OAIL) provides various data...
types such as stars, solar system objects, astrophotography, the latest moon images, the latest solar images, weather data, and image data captured by the observatory sky camera.

The difference between the ITERA Astronomical Observatory Information System and the information system in the literature review is that the ITERA Astronomical Observatory Information System performs storing and handling astronomical data. Database design for astronomical data, astronomical data processing, keeping the quality of data astronomical, and ease of data access are the focus of this research.

2. Research Methodology

2.1. Literature review

The literature review in this study aims to form a theoretical framework, a conceptual framework, and the stages of research adopted in this research. Some of the studies discussed include astronomical data, astronomical data processing, information systems, and previous analysis.

a) Astronomical Data

Data represents an event in the business world and real objects such as places, objects, and people [2]. According to the classification carried out [2], classification of data based on type, nature, and source. In the classification of data by type, there are measurement data that shows the value of a data and arithmetic data that shows the value of a certain amount of data. Then on the classification based on its nature, quantitative data is related to the summation of data, and qualitative data is related to data quality. The classification data, based on data sources, there are 2 data. First is internal data, which is original data, and second is external data resulting from observations of others.

Astronomical data generally includes 1D, 2D spectrum data, spectral data, time-series data, photometric data, image data, etc. [4]. Astronomical data in this study were source from observations of celestial objects/objects conducted at the ITERA Astronomical Observatory. Several astronomical data objects obtained from the ITERA Astronomical Observatory are in the FITS format. The FITS format meets the needs of the standard format of astronomical data. The FITS format already has embedded human-readable metadata, has some software package capable of reading it; published specifications; and a well-defined set of models, metadata, and keywords [5].

b) Astronomical Data Processing

In [2], there are two activities in data processing, namely data storage and data handling. The data storage process includes: collecting, searching, and maintaining data. Meanwhile, the data handling process includes checking, comparing, selecting, summarizing, and using data.

In this research, astronomical data, which is the object of research in developing information systems, will apply data processing processes, including data storage and data handling processes. The ITERA Astronomical Observatory Information System implements several processes include: collecting (adding data), searching (based on parameters), maintenance (data management), checking (data validation), selection (data filtering), summarizing (archiving), and data usage (displaying data).

c) Information Systems

The information system is a system that supports the goals of the organization through operational activities, managerial activities, and strategic activities and provides output in the form of reports [6]. The information system developed in this research will focus on
managing specific data types, maintaining data quality, and making it easier for users to access data.

d) Previous Research

Four similar studies were analyzed using 3c+2s (compare, contrast, criticize, summarize, and synthesize). First, the research focuses on developing an academic and administrative information system at the Korean Language Ambassador Training and Training Institute. This information system aims to assist the sending of Indonesian workers to South Korea [7]. System development using the extreme programming method with four stages of development planning, design, coding, and testing [7]. The second research focuses on developing a Hotel Administration Information System [8]. This study applies the six steps of the extreme programming cycle [8]. There are several iterations in the system development cycle required in this research. The number of iterations of the system development cycle corresponds to the number of tasks in the user story [8]. The third research focuses on developing a Telecommunication Equipment Sales Information System. There are three iterations of the system development cycle in this research. The system development cycle approach uses extreme programming techniques with four steps (exploration, planning, system development iteration, and production). The fourth research focuses on the development of a Food Product License Information System. The development process goes through five stages of system development (exploration, planning, system development iteration, and production). The four previous studies have similarities in the system development techniques used with an agile model system development method using extreme programming.

2.2. Theoretical framework

Based on the literature study and the team’s condition, the system development method with an agile model using extreme programming techniques was chosen. Development using extreme programming techniques allows developers to build applications quickly, be flexible to changes, and be suitable for team conditions that are not yet clear in defining the system. The extreme programming method has several iterations of development that allow clients to try prototypes of the application, thereby minimizing the risk of developing system features errors. [11] The flow of this research, starting from identifying the problem, then conducts a literature study regarding selecting the right system development technique according to the conditions of the case study. After choosing a system development method, then carry out the information system development process.

2.3. System Development Life Cycle

The system development cycle in this research uses an agile model approach using extreme programming techniques. The development phase goes through the exploration, planning, iteration, production, maintenance, and death phases of system development. Figure 1 is a system development cycle using an agile approach with extreme programming techniques.
a. Exploration phase

In the exploration phase, it produces system development documents in the form of user stories. Break down user stories into small tasks, where each task created has attributes of name, type (analysis, design, coding, testing), description, dependencies, priority, difficulty level, and work time. In this phase, the research uses focus group discussions to collect information. In the exploration stage, it produces system development documents in the form of user stories.

b. Planning phase

In the planning phase, the development process is carried out by selecting tasks in the next iteration. Task selection considers priority, dependencies, estimated difficulty level, and estimated duration of work. For stories that are not selected will be worked on in the next iteration. This process occurs at the beginning of the iteration and repeats until all tasks are completed.

c. Iterations phase

There are four development processes, including analysis, design, coding, testing in the iterations phase. Process analysis explores the current task to ensure that it can be worked on in the development process. After that, then do the mockup design, and discuss it with the team. Next is the process of coding. The coding process is done by creating features of the program. After this process ends, the program test for unit tests using a white box testing approach where the amount of code coverage for each file is calculated, and if the code coverage is below 70%, then the test is considered failed. [12]

d. Production (production phase)

At the production stage, the team will get system updates. If the features released are according to the team's wishes, then continue to the next iteration, but if not, return to the system development iteration phase with application improvement stories.

e. Maintenance (maintenance phase)

After going through the feature testing stage by the client, the system is released to production and can be seen by end-users. The iteration process continues until the system successfully releases all features to the end-user. This stage marks the end of the system development process.

3. Results and Discussion

The result of this research is the development of the ITERA Astronomical Observatory information system.

Figure 3. Home page (without authentication)

The picture above is the result of the implementation of the ITERA Astronomical Observatory Information System development. Figure 3 shows when the user first visits
the website page, and Figure 4 is the first display when the user authenticates into the system.

Figure 4. Stars page

Figure 4 shows star data; we can use a filter and search function on data as a user. In addition, as a user, we can download star data.

Figure 6. All-sky camera page

The picture above is a sky-camera page that shows the last image that was input into the system, and this process enters the sky-camera data manually into the system. ITERA Astronomical Observatory Information System has four user roles.

Table 1. User role and user access

| Role          | Access Control List                                                                 |
|---------------|-------------------------------------------------------------------------------------|
| Admin         | search, filter, insert, view, add, delete, download, and edit star data search, filter, insert, view, add, delete, download, and edit solar system object data search, filter, insert, view, add, delete, download, and edit astrographic data search, filter, insert, view, add, delete, download, and edit the latest month data search, filter, insert, view, add, delete, download, and edit the latest sun data search, filter, insert, view, add, delete, download, and edit weather data search, filter, insert, view, add, delete, download, and edit all-sky camera data |
| Contributor   | search, filter, insert, view, add, download, and edit star data search, filter, insert, view, add, download, and edit solar system object data search, filter, insert, view, add, download, and edit astrographic data search, filter, insert, view, add, download, and edit the latest month data search, filter, insert, view, add, download, and edit the latest sun data search, filter, insert, view, add, download, and edit weather data search, filter, insert, view, add, download, and edit all-sky camera data |
ITERA Astronomical Observatory Information System was built using the python programming language with the pyramid framework for the server-side and using reactjs language for the client side. Several features have been successfully implemented in the ITERA Astronomical Observatory Information System, including:

**Table 2. Features**

| Features          | Description                                           | Role  |
|-------------------|-------------------------------------------------------|-------|
| Multiple uploads  | Upload astronomical data                              | Admin and Contributor |
| Filter            | Filtering astronomical data                           | All roles |
| Search            | Searching astronomical data                           | All roles |
| Authentication    | login using OAuth 2 (ITERA email)                     | All roles |
| Manage data       | Manage astronomical data by user role                 | All roles |
| Manage user       | Manage user data, and only admin can use active users  | Admin |
| Log Activity      | display a table of user activity in accessing each feature | Admin |

4. Conclusion

Based on the ITERA Astronomical Observatory Information System research, it can conclude that there are five user roles needed in the system to support data processing management, include admin, contributors, staff, students, and lecturers. In the ITERA Astronomical Observatory Information System, there are 7 features the system attached in table 2, including upload, search, filter, login, manage data, manage users, and log activity. ITERA Astronomical Observatory Information System will provide various data types such as stars, solar system objects, astrophotography, the latest moon images, the latest solar images, weather data, and image data captured from the observatory sky camera. The data will be used for research purposes by the academic community of the Sumatra Institute of Technology.

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