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Web-Based Alumni Information System for Career Tracking and Alumni Networking Using Graph Network Algorithm at Politeknik Negeri Fakfak

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Abstract

The web-based Alumni Information System is a digital solution designed to facilitate alumni career transitions and foster interpersonal relationships. This system is developed using the Object-Oriented Programming (OOP) method, which makes the code structure more modular, organized, and easy to use in long-term development. The main features of this system are alumni registration, filling and updating alumni work history, searching for alumni based on certain criteria, and a communication forum. Each component of the system can be tested independently and is highly integrated with OOP. The system performance is guaranteed to be stable and functions according to user needs. This system not only helps institutions manage their undergraduate careers; but also fosters professional collaboration among alumni. This system is expected to be effective in creating an active and contributing alumni community.

1. Introduction

Alumni play an important role as valuable assets for universities in their efforts to enhance their reputation, obtain accreditation, and develop professional networks. The use of alumni data is not merely to meet administrative needs, but also serves as the basis for conducting tracer studies, evaluating curricula, promoting institutions, and developing collaborative communities among graduates. In various educational institutions, including the State Polytechnic of Fakfak, the process of monitoring alumni career development still relies on conventional methods such as manual questionnaire completion or data recording through spreadsheets separate from the main information system. This situation results in limited access to real-time data, irregularities in information management, and an inability to visualize relationships among alumni in both professional and academic fields.

The rapidly evolving digital era demands innovation in the development of a dynamic, responsive, and integrated web-based alumni information system. One of the main needs today is the presentation of alumni relational data in the form of interactive network visuals, professional network recommendations, and mapping of alumni distribution based on institution, geography, and employment sector. The implementation of the Graph Network algorithm is the right solution to represent the relationships between alumni entities through node (point) and edge (connecting line) structures.

Recent global studies have confirmed the effectiveness of Graph Network and Graph Neural Network (GNN) algorithms in unraveling the complexity of relationships in network data. Research (Zhou et al., 2020) in "Graph Neural Networks: A Review of Methods and Applications" reveals the ability of GNNs to solve various problems such as node classification, relationship prediction, and community identification in various fields including recommendation systems, bioinformatics, and social network analysis.
Alumni network structures are ideal objects for graph-based modeling. (Collins et al., 2021) in their publication "A Graph-Based Alumni Network Analysis" successfully applied this approach to identify key alumni through centrality analysis and community segmentation within the alumni network. In Indonesia, the adoption of graph technology in alumni information systems remains limited. Most existing platforms only offer basic static data collection functions without network analysis capabilities. For example, the work on "Analysis and Design of Web-Based Alumni Information Systems" at IAIN Jambi is still limited to conventional CRUD operations without network-based analytical components. Responding to this challenge, this study aims to create a web-based alumni information system enriched with Graph Network algorithms. This system is designed not only to display alumni profiles and career histories but also to comprehensively visualize and analyze patterns of relationships among alumni. Some of the key features developed include:

a. visualisasi_graph.php → to display the alumni network graph.
b. cari_koneksi.php → a feature to search for alumni based on field, campus, location, etc.
c. saran_koneksi.php → uses graph algorithms (e.g., shortest path, mutual connection, or centrality) to suggest connections.

2. RESEARCH METHODOLOGY

The research methodology used in this study is the Research and Development (R&D) methodology, which aims to create a web-based alumni information system with career tracking and professional relationship mapping capabilities through the application of the Graph Network algorithm (Pawana et al., 2024). The selection of the R&D approach is based on the nature of the research, which is not limited to theoretical analysis but also includes the development of a real product and its validation through a comprehensive series of methodological stages.

1. Compatibility with System Characteristics
   a. It is necessary to create an integrated solution that combines basic data management functions with relational network analysis
   b. Facilitates the development of cutting-edge features such as dynamic graph visualization and professional networking recommendations
2. Scientific Convergence
   a. Integrates the disciplines of software engineering and graph-based artificial intelligence
   b. Provides a breakthrough in overcoming the weaknesses of traditional systems in visualizing alumni relationships
3. Institutional Relevance
   a. Meeting the demands of the Fakfak State Polytechnic for a digitalized platform for alumni management
   b. Developing a system that is responsive to the latest technological advances
4. Research will be conducted through:

a. Identifying system requirements
b. Designing the system and algorithms
c. Building a prototype
d. Functional testing
e. Final refinement

The R&D method is considered the most ideal because it not only produces functional products that meet practical needs, but also provides added value through its ability to analyze alumni networks visually and computationally. This approach effectively connects the academic realm with real-world applications in higher education.

2.1SYSTEM DEVELOPMENT MODEL

This study applies a sequential Waterfall development model to build an alumni information system. The Waterfall model has proven to be reliable and effective, making it the primary choice for software development (Watung & Sinsuw, 2014) This model consists of five main stages that are carried out sequentially: (1) requirements analysis, (2) system design, (3) coding, (4) testing, and (5) final evaluation. Reasons for Using the Waterfall Model:

1. System Specification Maturity
    a. System requirements have been comprehensively defined
    b. Enables the formulation of detailed technical specifications before development begins
2. Methodological Advantages
    a. Each phase is completed thoroughly before moving on to the next stage
    b. Facilitates tracking relationships between system components
    c. Ideal for projects with stable and well-defined requirements
3. Academic and Practical Value
    a. Supports the creation of systematic documentation
    b. Reduces the risk of major changes during the development process
    c. Enables comprehensive assessment at each stage

The selection of the Waterfall model is based on its structured and predictive nature, which aligns with the characteristics of this alumni information system development project. This approach ensures that all aspects of the system have undergone careful design and verification processes before being implemented in the form of a program.

2.2NEEDS ANALYSIS

The needs analysis in this study aims to thoroughly understand the functions, features, and characteristics of the web-based alumni information system to be developed. From observations at the Fakfak State Polytechnic, it was found that alumni data management is currently still done manually, stored in several spreadsheet files, and not centralized in a single digital platform. Additionally, the process of tracking alumni careers has not been systematic, only occasionally conducted through online forms without a monitoring dashboard or regularly updated reports. The institution also lacks tools to map relationships among alumni, whether based on workplace, field of expertise, or further education history. This information is crucial for strengthening collaboration among alumni, facilitating mentoring processes, and assisting the institution in connecting alumni with industry partners.

To determine the appropriate system requirements, three data collection methods were employed: interviews with alumni managers and student affairs departments, observation of previous tracer study documents, and literature review and benchmarking of alumni systems from various other universities. From the analysis, several system requirements were identified:

1. Functional Requirements
    a. Login and Verification: Admin and alumni roles.

b. Alumni Data Input and Changes: Name, student ID number, study program, occupation, and location.
c. Data Validation by Admin: Approve, correct, or delete data.
d. Alumni Career Visualization: Work history in table or graph form.
e. Alumni Network Visualization: Interactive graphs based on relationships between institutions or study programs.
f. Alumni Connection Recommendations: Suggestions based on similarities and shortest paths.
g. Alumni Search: Based on name, institution, location, or graduation year.
h. Alumni Statistics: Graphs showing the number of alumni per study program, sector, and region.
i. Job Posting Management: Input and access job posting information.
j. Notifications: Information related to new connections and job postings.

2. Non-Functional Requirements
a. Web-Based and Responsive: Accessible from all types of devices.
b. Real-Time Database: Uses Firebase for real-time data synchronization.
c. Interactive Visualization: Uses a graphics library (Cytoscape.js).
e. Security: Login and access system, data is encrypted.
f. Efficient: Fast loading time, uses local cache.
g. Easy to Maintain: Modular structure and well-documented.
h. Portable: Can be moved to various servers.

2.3SYSTEM DESIGN

At this stage, the author collects various information and data that will be used as the basis for designing a web-based alumni information system. The goal is to meet the institution's needs in storing alumni data, tracking their career development, and mapping relationships between alumni visually and analytically using a graph network algorithm approach. After being collected, the information is then categorized and reorganized into a more efficient system structure so that it can run according to the needs of users in the environment of the Fakfak State Polytechnic.

1. Analysis
The analysis phase began with determining the scope of the system, namely an alumni information system that is not only used to store data but can also display the relationships between alumni based on several factors such as workplace, field, and location. To obtain information, interviews were conducted with alumni administrators, observations were made of the manual tracer study process, and alumni systems from other universities were read and compared.
headings should be left justified, bold, with the first letter capitalized and numbered consecutively, starting with the Introduction. Based on the results obtained, the system was designed with several key features, such as role-based login (admin and alumni), filling in alumni data, career history visualization, searching for alumni, managing job vacancies, and displaying the network between alumni. This system is expected to display alumni data directly and provide a network visualization that can be customized according to user preferences. The user interface is designed to be simple, clear, and interactive to facilitate users in accessing and exploring the network data.
2. Design
The design phase aims to translate the results of the analysis into a technical system design. This system uses a web-based client-server architecture, where React JS is used as the front end, Firebase Realtime Database as the data storage, and Python as the graph processing engine. In the graph, nodes represent alumni, while edges indicate relationships based on specific attributes. A Use Case Diagram showing the interaction between admins and alumni with system features.
a. An Activity Diagram to illustrate the data entry flow, validation, and graph visualization.

b. Firebase database structure supporting the creation of graph nodes and edges.
c. UI/UX design for the alumni dashboard, input forms, and interactive graph visualization display.
d. Flexible data structure to support the "alumni connection recommendation" feature based on shortest path or centrality calculated by the Python graph module.

3. Programming

This phase is the stage where the system design is converted into actual program code. The frontend is created using React JS to enable dynamic displays that can adapt to various devices. The backend uses Firebase to manage user logins and store alumni data. Additionally, graph algorithms are run using Python and the NetworkX library to calculate centrality, detect communities, and find the shortest paths between alumni. Graph data is converted into JSON format and sent to the frontend for display using Cytoscape.js. All components are designed separately (modular) to facilitate future development and maintenance.

4. Testing

System testing is conducted to ensure that all functions work as expected and are free from logical errors. Testing was conducted in the following forms:

a. Black Box Testing to verify all features (login, data input, graph visualization, connection suggestions),
b. White Box Testing on the Python module that calculates graphs to ensure calculation accuracy,
c. User Acceptance Test (UAT) by campus administrators and alumni to assess the usability and convenience of the interface. Test results show that the system is capable of reducing data duplication, quickly presenting alumni connections, and providing accurate connection suggestions.

5. Maintenance

Once the system is up and running, regular maintenance is performed to keep it functioning properly. This maintenance includes fixing errors, updating features, and adjusting the graph algorithm if there are changes in the alumni data structure. Since alumni data continues to grow each year, the database structure and graph module are designed to be scalable and flexible to accommodate increases in the number of nodes and connections. Maintenance is also performed to ensure the system remains aligned with technological advancements and future user needs.

3. RESULT AND DISCUSION

To facilitate understanding of the alumni information system to be developed, a design process was carried out. In designing the system, consideration was given to the need to combine alumni data and process it into visual graphics.

a. System Design (Use Case Diagram)

A use case is a visual representation that illustrates the interaction between users (usually humans) and a system. This diagram shows the various functions (use cases) that users can perform, as well as the relationships between users and the system (Fa'ainzani & Abidin, 2023). The diagram explains how actors, namely administrators and alumni, interact with the system in several processes such as logging in, entering data, validating data, viewing alumni statistics, and exploring the alumni network with a graphical display.

Sub-section headings should also be in the same style as the headings, numbered 1.1, 1.2, etc, and left justified, with second and subsequent lines indented.

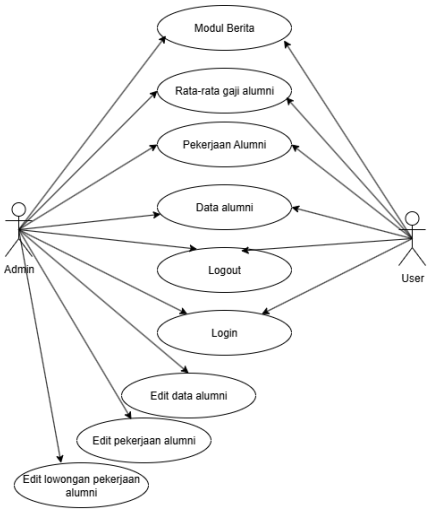

Figure 1 Use Case

b. Activity Diagram

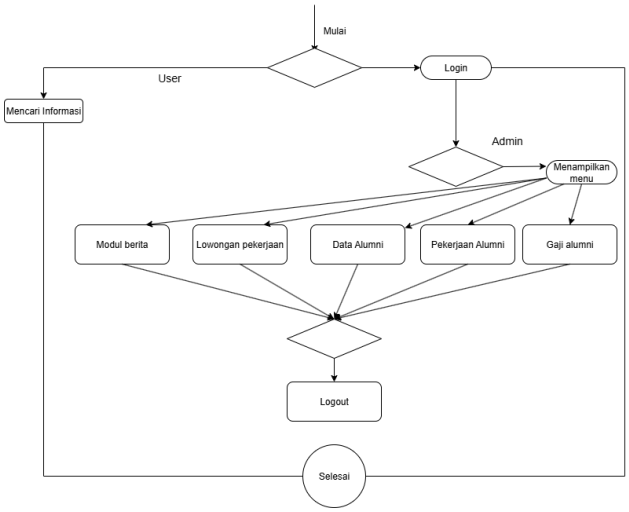

Figure 2 Activity Diagram

An activity diagram is a visual representation that illustrates the flow of business processes or work steps that occur within a system (Widjaja & Hadiwidjaja, 2023). The process begins with information retrieval and login, after which the system displays the main menu. From this menu, users can select various features such as viewing news modules, job vacancies, alumni data, alumni employment information, and alumni salary data. Once the activity is complete, users can log out, and the process concludes. This diagram helps visualize the sequence of user interactions with the system in a logical and systematic manner.

c. User Interface Design

The following is the interface display of the alumni information system that was developed:

1. Dashboard

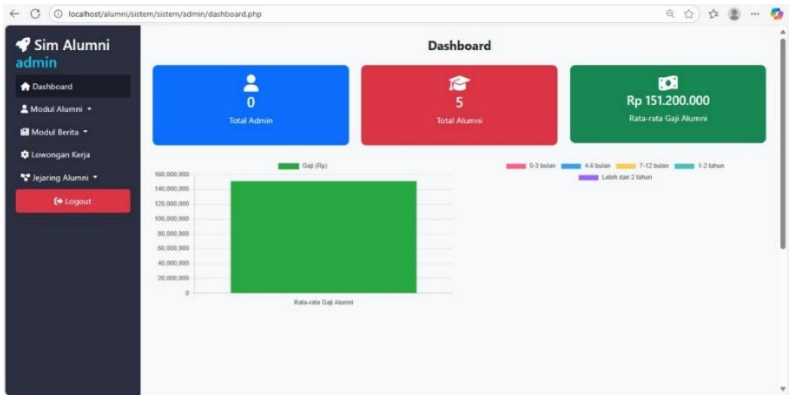

Figure 3 dashboard display

This is the Admin Dashboard, which displays important data summaries such as the number of administrators, the number of alumni, and the average alumni salary in the form of colored information cards. Below that is a bar chart that visually displays the average alumni salary. On the left side is a sidebar that provides menus for accessing the alumni module, news, job vacancies, and alumni networking features. This display is designed so that administrators can monitor and manage alumni data quickly and efficiently.

2. Alumni Data

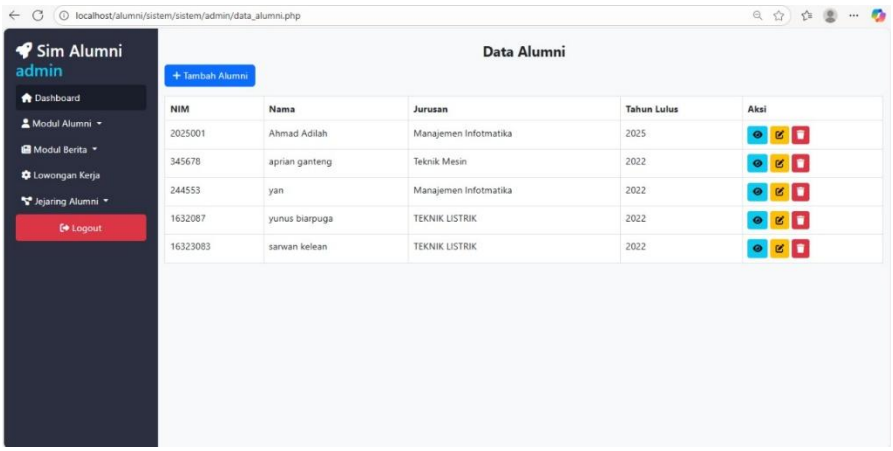

Figure 4 Alumni data

This screen is the Alumni Data page used by administrators to view, add, edit, and delete alumni data. The data is displayed in a table consisting of columns for Student ID, Name, Department, Year of Graduation, and Action. The action buttons, colored blue (view details), yellow (edit), and red (delete), make it easy for administrators to manage each alumni data entry directly and quickly.

3. Visualization of Alumni Network

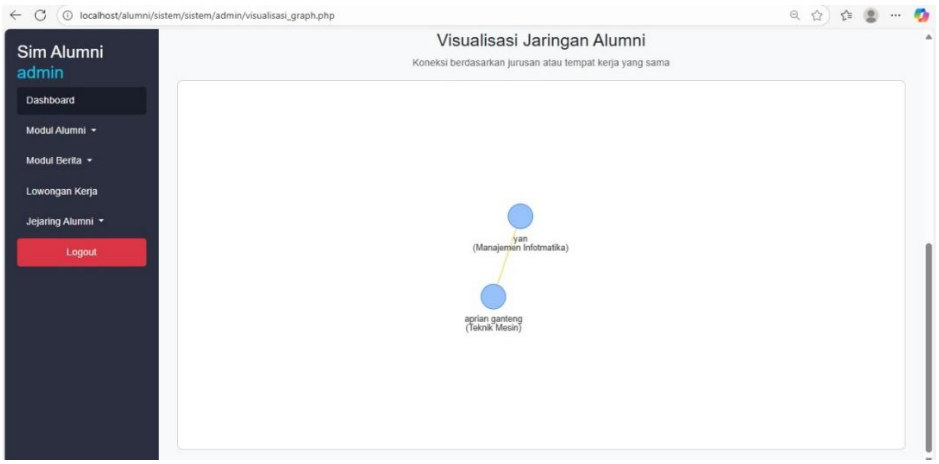

Figure 5 Visyalisasi alumni

This display shows the Alumni Network Visualization feature, which is the result of applying the Graph Network algorithm in the alumni information system. Each circle (node) represents an individual alumnus, while the lines connecting them (edges) indicate connections based on shared majors or workplaces. In this example, the alumnus named "yan" from the Computer Science department is connected to "aprian ganteng" from the Mechanical Engineering department, indicating a specific relationship, such as working at the same place.

4. Find Alumni Connections

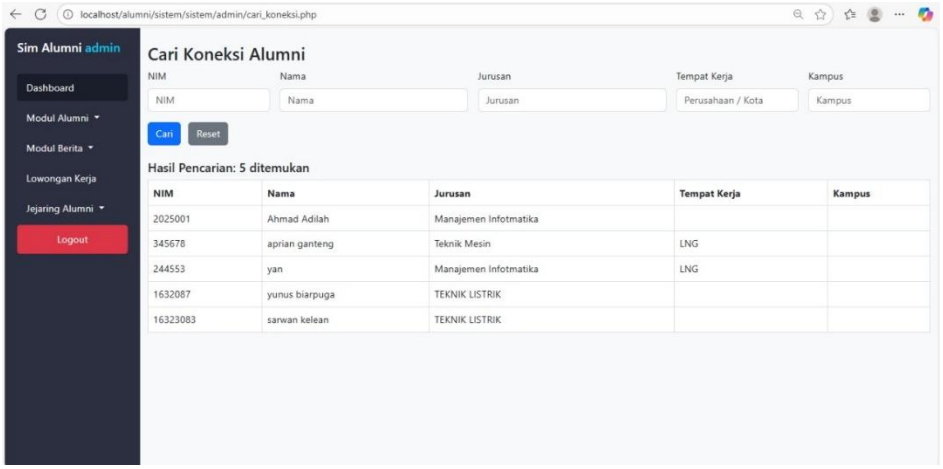

Figure 6 Find Alumni Connections

This page is the Alumni Connection Search page, which allows administrators to search for alumni based on several parameters such as student ID number, name, major, place of work, and campus. After the criteria are entered and the "Search" button is clicked, the system will display a list of alumni that match the search. Search results are displayed in a table containing complete information such as student ID number, name, major, workplace, and campus. This feature simplifies the process of tracing alumni networks, particularly for career tracking, collaboration among alumni, or mapping connections based on workplace location or academic background.

5. Alumni Connection Suggestions

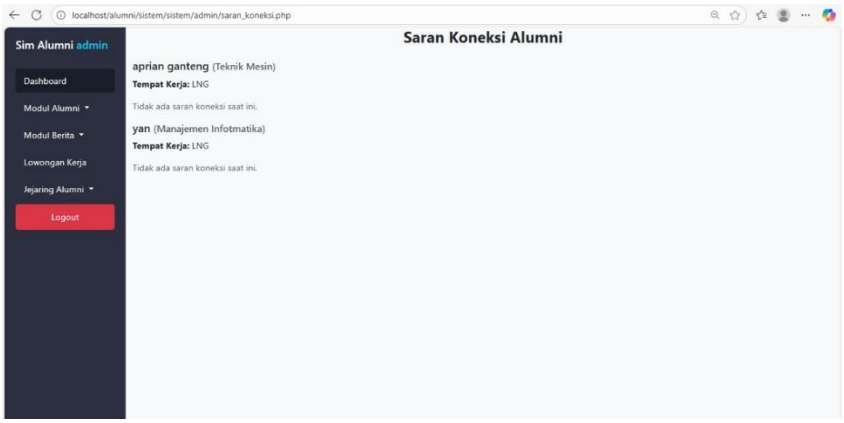

Figure 7 Alumni Connection

This page is the Alumni Connection Suggestions feature, which aims to provide connection recommendations between alumni based on similarities in majors, workplaces, or other attributes. In this example display, the alumni shown do not yet have connection suggestions because there may be no data matches when the system is run.

This feature supports the concept of an alumni network based on graph network algorithms, which can be further optimized to find the shortest path, mutual connections, or centrality among alumni.

4. Conclusion

The development of a web-based alumni information system with integrated Graph Network algorithms at the Fakfak State Polytechnic has successfully delivered a digital solution that supports more interactive and structured career tracking and alumni network mapping. Features such as alumni data management, connection search, network visualization, and connection suggestions based on attribute similarities have enabled administrators and users to gain a more comprehensive understanding of the relationships between alumni. The use of Graph Network not only enhances tracking functions but also opens opportunities for collaboration and strengthening relationships among alumni across departments and workplaces. As a result, this system serves as a crucial foundation for building a productive and sustainable alumni ecosystem for the institution.

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