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Jl. Ahmad Yani, K.M. 33,5 - Kampus STMIK Banjarbaru
Loktabat – Banjarbaru (Tlp. 0511 4782881), e-mail: puslit.stmikbjb@gmail.com
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Data Warehouse for Study Program Accreditation Data Management at Private University X

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Tifani Anasya Putri[1], Jap Tji Beng[2*], Dedi Trisnawarman[3], Sri Tiatri[4], Fouad Nagm[5], Michael S. Naidas[6], Tasya Mulia Salsabila[7], Rahmiyana Nurkholiza[8]

[1,8]Information Systems Undergraduate Program, Universitas Tarumanagara, Jakarta, Indonesia
[2,3] Faculty of Information Technology, Universitas Tarumanagara, Jakarta, Indonesia
[4] Faculty of Psychology, Universitas Tarumanagara, Jakarta, Indonesia
[5] BT Financial Group, Sydney, Australia
[6] Department of Psychology, Adventist University of the Philippines
[7] Faculty of Computer Science, Universitas Indonesia, Indonesia
[2,4,5,7,8] Science, Technology and Society Research Centre, Universitas Tarumanagara, Jakarta, Indonesia
[*]Corresponding author's e-mail: t.jap@untar.ac.id

Abstract

Technological advancements in the Fourth Industrial Revolution have transformed higher education, yet accreditation processes often suffer from inefficient data management, causing delays, inconsistencies, and limited monitoring of performance indicators. This study designs a data warehouse integrated with a dashboard and Early Warning System (EWS) to improve accreditation data management at University X, West Jakarta. Using Kimball's Dimensional Model, data were structured into fact and dimension tables, with collection methods including interviews with the Head of the IT Department and document analysis of accreditation processes. Descriptive statistics were applied to identify trends and patterns. The dashboard enables real-time visualisation of key metrics, while the EWS issues alerts on missing or outdated data. Results show that the snowflake schema enhances data organisation and clarity, reducing manual processing and facilitating proactive monitoring. The system supports more efficient accreditation management and strengthens institutional readiness for assessment.
Keywords: *Nine-Step Kimball; Database design; Accreditation Process; Data warehouse.*

1. Introduction

The Fourth Industrial Revolution (Industry 4.0) has transformed industries and education through digitalization [1], artificial intelligence, connectivity, and system integration across various aspects of production and human life [2], technology has become an essential and inseparable element of human activity, both in industry and in personal life [3]. Technology not only enhances efficiency but also plays a crucial role in decision-making, innovation, and competition. Virtually every aspect of life, from education to industry, has undergone significant transformation in line with the advancements in technological innovation. In the field of education, particularly in the process of higher education accreditation, the impact of the Fourth Industrial Revolution is highly significant. The accreditation process, aimed at ensuring the quality of education, presents a major challenge [4] and plays a crucial role in providing information to prospective students and parents about the performance of higher education institutions [5]. However, many institutions face challenges in faculty engagement due to resistance to change and unclear responsibilities, making accreditation risk becoming a mere administrative task rather than a tool for continuous improvement [17]. Since the primary responsibility of universities is to produce graduates who are prepared for the future [6], strong accreditation can help prospective students select institutions capable of equipping them with relevant skills for the workforce. Therefore, the implementation of technology-based accreditation becomes a strategic step to optimize this process. Implementing technology-based accreditation optimizes this process by improving data collection efficiency and learning quality [7]. Moreover, it enhances institutional reputation, strengthens public trust, and potentially increases student enrollment.

At Private University X in West Jakarta, accreditation data management remains a persistent issue, as information is still scattered across departments and processed manually through spreadsheets and document archives. This fragmentation causes delays in accreditation reporting, data inconsistency, and difficulties in tracking Key Performance Indicators (KPIs) set by the National Accreditation Board for Higher Education (BAN-PT). Similar issues were also identified by Acevedo-De-los-Ríos and Rondinel-Oviedo [4], who found that inefficient data management in accreditation systems significantly reduces institutional responsiveness and transparency. These measurable challenges illustrate the need for an integrated data solution that supports automated data collection and evaluation. As the complexity and volume of data required to be collected and analyzed in the accreditation process increase, traditional methods often fall short in addressing these challenges. Accreditation should not be treated merely as a procedural requirement but as a development tool to enhance institutional quality, improve teaching methods, and align learning outcomes with market needs [17]. However, advancements in digital technology now enable universities to optimize the accreditation process of academic programs through more efficient and accurate systems. Information technology has opened opportunities for higher education institutions to leverage various tools and systems for managing accreditation data. One innovative approach that can be adopted is the development of dashboard-based systems and an Early Warning System (EWS). Dashboards provide data visualizations that allow real-time monitoring and analysis of information, making it easier to identify trends and issues that may not be apparent in raw data [8]. Dashboards display data in a user-friendly visual interface, with all key information presented concisely on a single screen. This enables users to quickly and comprehensively view and analyze data, simplifying decision-making processes. Meanwhile, EWS offers early warnings [9] of potential issues that need to be addressed before they affect the accreditation process. This allows corrective actions to be taken promptly, ensuring the quality of the institution and supporting the success of the accreditation process.

In visualizing data, relevant and accurate data is essential to support analysis and decision-making processes. The data required for the accreditation process encompasses various aspects [10], [11]. Students are evaluated based on their numbers, distribution, and academic success. Research evaluates contributions to the advancement of knowledge, while community service assesses the social impact of the institution. The outcomes and achievements of the "tridharma" (three pillars of higher education) reflect results in education, research, and community service as a form of accountability for universities in implementing these pillars. However, only quantitative data can be displayed on the dashboard. Since not all data required for accreditation is quantitative, the design of the data warehouse for the dashboard in this article focuses only on data that can be numerically measured and provides a clear depiction of program performance. To support automated data management, it is crucial to ensure that all data is stored in a well-structured database to facilitate data collection and processing. Furthermore, the integration between the dashboard and the data warehouse is vital to optimize data management and reduce reliance on manual methods. The database design process is critical in data processing as it ensures an efficient and consistent data structure across the organization, facilitates data sharing between applications, reduces redundancy, and enables easy system scalability. A well-designed database ensures centralized data management, including effective security, integrity, and access control [12]. Moreover, in modern organizations dealing with rapidly increasing data volumes, data warehouse design plays a crucial role in supporting effective decision-making by leveraging stored information [13].

To address these challenges, this study proposes the design of a data warehouse integrated with a dashboard and an Early Warning System (EWS) to improve accreditation data management. The Kimball methodology was selected because it allows for incremental data integration through data marts, making it suitable for institutions with diverse and dynamic data needs. A dashboard provides real-time visual analytics for accreditation indicators, while the EWS automatically alerts stakeholders to missing or outdated information. This approach is rationalized by findings from Jwo, Lin, and Lee [8], who demonstrated that interactive dashboards enhance decision-making efficiency by providing visual insights in real time, and Meckawy et al. [9], who showed that EWS frameworks effectively detect potential risks before they escalate. Therefore, integrating these two systems provides a logical and evidence-based solution for proactive accreditation management. In database design, utilizing design methodologies can streamline the process and provide a systematic approach to ensure that each phase is executed sequentially and structured. One such methodology is the Kimball approach, which focuses on developing a data warehouse using dimensional modeling techniques [14].

The objective of this study is to design and validate a data warehouse system for managing accreditation data that is accurate, integrated, and easy to monitor through dashboards. The benefits include improving the efficiency of accreditation data processing, supporting evidence-based decision-making, and enhancing institutional readiness for external evaluations. In a broader sense, the system contributes to strengthening university governance, transparency, and accountability in ensuring educational quality. This method emphasizes building the data warehouse incrementally through data marts, ensuring flexibility and scalability [14].

2. Literature Review

The Fourth Industrial Revolution has triggered significant technological transformations in education, with Industry 4.0 emphasising digitisation, connectivity, and system integration [2]. These advancements have also influenced the accreditation process in higher education, where efficient data management is crucial for institutional quality assurance [4], [5]. However, accreditation procedures are often hindered by fragmented data sources, inconsistent records, and reliance on manual reporting, which reduce efficiency and reliability [17].

Several researchers have also explored the application of data warehouse models to improve higher education evaluation and accreditation management. For instance, Acevedo-De-los-Ríos and Rondinel-Oviedo [4] conducted a study on the impact and relevance of accreditation processes in higher education institutions, emphasizing the need for structured and centralized data systems to ensure quality assurance. Their model proposed integrating institutional performance indicators into a digital data repository that enables automated tracking and reporting. The study utilized a multi-layered data warehouse framework that consolidated academic, administrative, and research data, reducing redundancy and improving transparency in the accreditation process. This research demonstrated that the implementation of a well-structured data warehouse model enhances the effectiveness of quality assessment and supports decision-making in university management. Similarly, Fernandes and Singh [5] reviewed the challenges and best practices of accreditation and ranking systems in higher education, highlighting the inefficiency of manual data collection and fragmented databases. They proposed a conceptual data warehouse model designed to standardize accreditation data management across multiple departments. Their model employed dimensional tables and data marts to handle large-scale educational data, allowing performance indicators to be dynamically updated and visualized through an integrated dashboard. The study concluded that this architecture significantly improves the consistency, accessibility, and reliability of accreditation data, facilitating more objective institutional evaluations. In Indonesia, accreditation guidelines published by BAN-PT [10], [11] have formalised the assessment framework, although their implementation often requires a high administrative burden.

Technological approaches have been applied to support decision-making and data management in education. Decision support systems using fuzzy methods have proven effective in optimising resource-based choices, such as in agriculture [1]. Similarly, dashboards have been designed for real-time monitoring and decision-making in smart manufacturing, enabling users to quickly identify trends [8]. Additionally, Early Warning Systems (EWS) have proven effective in detecting potential risks in other fields, such as infectious disease outbreaks [9]. These findings support the integration of dashboards and EWS into accreditation systems, ensuring proactive responses to emerging issues.In terms of database design, the adoption of dimensional models has become established. Kimball's methodology advocates a bottom-up approach using fact tables and dimensions to improve data retrieval and reporting efficiency [14]. A comparative study between Kimball and Inmon models also confirms that Kimball's model is more flexible and suitable for phased implementation in dynamic environments [18]. Additionally, object-oriented database design has been explored for effective data classification [13], while Huawei's ICT framework highlights the importance of database principles in managing large-scale institutional data [12].

While previous studies have examined accreditation frameworks [4], [5], the use of technology-based dashboards [8], and Early Warning Systems (EWS) in various domains [9], there remains a clear research gap in integrating these components into a comprehensive model specifically designed for higher education accreditation. This study distinguishes itself by developing a unified data warehouse architecture that combines Kimball’s dimensional modeling with a snowflake schema, enabling the systematic consolidation of accreditation data across multiple academic dimensions. By incorporating both a Dashboard for real-time visualization and an EWS for proactive risk detection, the proposed framework transcends existing fragmented solutions and introduces a dynamic, data-driven approach to accreditation management. Consequently, this research establishes a new benchmark for institutional data governance by bridging the gap between theoretical accreditation standards and their practical technological implementation, ensuring scalability, transparency, and continuous quality improvemen.

3. Methods

Various methods are employed to support the design of databases for dashboards and Early Warning Systems (EWS) in managing accreditation data for academic programs. These methods include the Kimball approach, data collection through interviews and literature reviews, and descriptive statistical data analysis techniques. The combination of these methods ensures a systematic database design based on valid data and effective analysis. This study adopts the Kimball approach due to its bottom-up design, which builds data marts per business process and integrates them through a data bus. Unlike Inmon’s top-down method, which structures a centralized atomic data warehouse, Kimball’s approach offers flexibility and faster implementation. Its dimensional modeling structure simplifies data retrieval and enhances user accessibility, making it well-suited for monitoring accreditation metrics efficiently [18].

4.3 Data Collection Methods

This study employs two primary data collection methods, namely interviews and document collection, to ensure that the data obtained is complete and comprehensive. Interviews were chosen to gain in-depth insights, with the primary respondent being the Head of the IT Department at a leading private university, referred to as University X, in Jakarta. On the other hand, document collection was conducted to verify the information gathered from the interviews and provide additional context, ensuring that the collected data is clearer, more comprehensive, and of high quality.

The data collection process implemented in this study is illustrated in **Figure 1**, depicting the stages from method selection, respondent identification, to data analysis. First, an evaluation was conducted to determine whether the interview method was appropriate for achieving the research objectives. Subsequently, interview questions were carefully designed to ensure that the data obtained would be relevant and in-depth. The interviews were then conducted, followed by transcription to prepare the data for analysis

The analysis stage was carried out using descriptive statistics to identify patterns and trends in the collected data [17]. If the analysis results indicate valid patterns, the process proceeds to data interpretation to determine the key attributes that should be included in the database design. However, if the analysis is insufficient or yields inconsistent results, additional data collection is conducted to complete the information.

In defining Key Performance Indicators (KPIs) for accreditation, relevant metrics were selected based on accreditation requirements outlined by the university and regulatory bodies. These KPIs were refined through discussions with stakeholders, including accreditation officers and IT staff, ensuring alignment with institutional needs and compliance standards. The selection process involved reviewing accreditation guidelines, historical accreditation reports, and identifying data points frequently monitored during evaluations.

Once the data is deemed sufficient and demonstrates consistent patterns, the results are interpreted to design a database capable of meeting the needs of the accreditation system. This approach ensures that the collected data not only supports system design but also guarantees that the database design can accommodate all necessary data before the system development process begins.

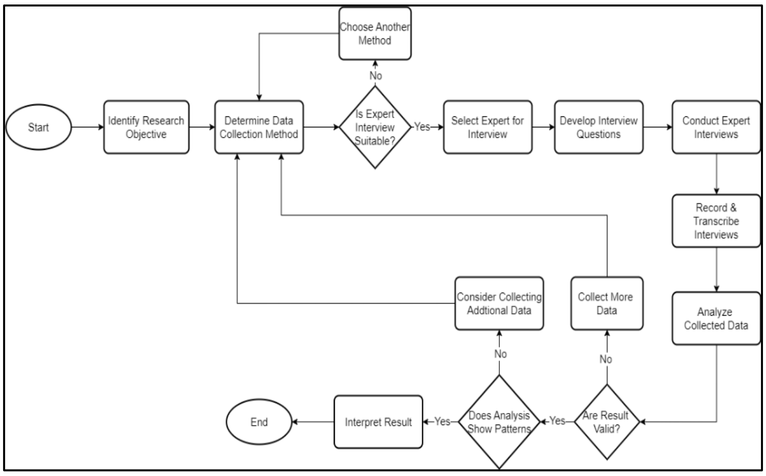

Figure 1. Data Collection Steps (Source: Personal Documentation)

4.4 Nine-Step Kimball Methodology

This study employs the Kimball approach in designing the data warehouse, focusing on dimensional modeling [14] to create a system that is easily accessible and understandable for end-users. This approach is implemented incrementally through the creation of data marts, facilitating efficient data collection and analysis. Data is organized into facts and dimensions to simplify queries and analysis while supporting the integration of data from various sources to ensure consistency and accuracy of information.

A snowflake schema was chosen over a simpler star schema due to the complexity and granularity of accreditation data, which includes hierarchical relationships across multiple dimensions, such as faculty, study programs, courses, and assessment criteria. The snowflake scheme enhances data normalization, reducing redundancy and improving consistency, which is critical for ensuring data integrity in accreditation monitoring. Additionally, this structure supports more flexible queries and optimizes storage efficiency, particularly when dealing with multidimensional accreditation evaluations [1].

To validate the proposed design, stakeholder feedback sessions were conducted, involving IT staff and accreditation officers to assess the usability and relevance of the dashboard and EWS. The validation process ensured that the system met accreditation requirements, provided clear and actionable insights, and facilitated proactive monitoring. Feedback was incorporated into the final iteration of the design to enhance its effectiveness in accreditation management.

4. Results and Discussion

This section presents the results of the data warehouse design using the Kimball approach, based on data from interviews and document collection. The design focuses on quantitative data to support accreditation reporting and integrates four main business processes: academic, alumni, students, and staff. By applying all nine steps of the Kimball approach, the system ensures structured and efficient data management.

1) Choose the Process

The process chosen in this study is the management of accreditation data for academic programs at a private university X. The focus is on the collection and monitoring of key data related to accreditation. This step is crucial as it defines the scope of the database and the Key Performance Indicators (KPIs) that will be tracked.

2) Choose the grain

At this stage, the entities that will be presented in the fact table in the four business processes are determined. The following is the master data that will be used to design the data warehouse, according to each business process:

a) Academic Business Process
   Lecturers: Data on lecturers who teach at Private College X, including information such as courses taught, qualifications, and workload.
b) Students Business Process

Students: Student data who are students at Private College X. This data will be divided into several categories, namely:
New students: Students registered in the current academic year.
Active students: Students who are currently studying.

c) Alumni Business Process
Alumni: Data on students who have graduated, including information related to employment fields and career tracking.

d) Staff Business Process
Staff: Data on non-lecturer employees working at Private College X.

3) Identify and Conform to The Dimension
At this stage, dimension tables are identified to be further linked to the fact table. The following are the dimension tables in the designed data warehouse.

a) Academic Business Process
Course dimension, consisting of id_course, kd_jur, kode_mk, kd_lecturer, sks.
Department dimension, consisting of id_jur, kode_jurusan, nama_jur.
Lecturer dimension, consisting of kd_lecturer, kode_dosen, nama, sts_lecturer, pendidikan, kdunitkerja.
Date dimension, consisting of id_date, tahun, and semester.

b) Students Business Process
Department dimension, consisting of id_jur, kode_jurusan, nama_jur.
Student dimension, consisting of kd_mhs, nim, nama, status, id_jur
Date dimension, consisting of date_ id_date, tahun, and semester.

c) Alumni Business Process
Department dimension, consisting of id_jur, kode_jurusan, nama_jur.
Alumni dimension, consisting of kd_mhs_alm, id_jur, nim_mhs, nama, lama_tunggu, kesesuain_bid_kerja, jangkauan_tmpat_kerja, ipk
Date dimension, consisting of date_ id_date, tahun, and semester.

d) Staff Business Process
Department dimension, consisting of id_jur, kode_jurusan, nama_jur.
Staff dimension, consisting of kd_staff, kode_staff, nama, sts_staff, pendidikan, id_jur.
Date dimension, consisting of date_ id_date, tahun, and semester.

4) Choose the Facts
At the Choose the Facts stage, the facts that will be measured or analyzed in each business process that has been identified are determined.

a) Academic Business Process, has the Fact_akademik fact table
b) Student Business Process, has the Fact_mahasiswa fact table
c) Alumni Business Process, has the Fact_alumni fact table
d) Staff Business Process, has the Fact_staff fact table

5) Store Pre-calculation in the Fact Table
This stage is the stage to consider the calculation of an attribute before it is loaded into the data warehouse.

a) Academic Business Process, has calculation, total_sks, pendidikan_mag, pendidikan_dok, sts_tetap, sts_tidak
b) Student Business Process, has calculation, number of students based on active or new status
c) Alumni Business Process, has calculation, jml_lama_tunggu _6, jml_lama_tunggu _618, jml_lama_tunggu_18, bidang_lokal, bidang_nasional, bidang_mul, sesuai_tempat, tdksesuai_tempat.
d) Staff Business Process, has calculation, pendidikan_sar, pendidikan_dip, pendidikan_mag, pendidikan_dok.

6) Round Out the Dimension Tables
At this stage, a description is created that contains information about the dimension table in the data warehouse. This is done to make it easier for users to understand the data warehouse.

7) Choose the Durations of the Database

After the fact tables and dimension tables are prepared, the next step is to define the duration for storing the accreditation data, which is set for a period of ten years. Although the university primarily needs to focus on data from the last seven years for effective analysis, the decision to store data for an additional three years was made to reduce the risk of insufficient historical data when needed.

8) Determine the Need to Track Slowly Changing Dimensions
Over time, dimensions may undergo gradual changes. Therefore, this stage aims to determine how to handle these changes. There are three main methods that can be used:
    a) Overwriting the changed attributes with new values
    b) Adding new records to the dimension to capture the changes
    c) Providing additional attributes to store new values without removing the previous ones

9) Decide the Physical Design
The final step is to determine the physical design of the data warehouse, which includes selecting the data storage technology, specifically SQL Server. This process also involves scheduling the ETL (Extract, Transform, Load) processes to ensure regular data updates, as well as optimizing indexes and partitions to achieve optimal system performance. The fact and dimension tables have been loaded into the data warehouse, which is managed using Microsoft SQL Server Management Studio 18.

4.1 Data Processing

The data processing in this study was carried out using the ETL (Extract, Transform, Load) method implemented with SQL and VB.NET to ensure efficient data handling and integration. First, data were extracted directly from multiple related tables within the existing database using SQL queries. Connection strings containing server, database, username, and password information were used to establish secure access. Only relevant attributes were selected to optimize processing performance, and the extracted results were temporarily stored in a DataSet for further manipulation. Extracted data were cleaned and transformed in VB.NET to match the required system format. The transformation process included data cleansing to remove null or inconsistent entries and table joining to integrate information from multiple sources into a unified dataset. The transformed data were then loaded into the system for visualization. Tabular data were dynamically rendered using ASP Repeater, while graphical representations were generated by passing processed variables from VB.NET to JavaScript for interactive chart visualization. This ETL-based process ensured structured data integration, reduced redundancy, and supported real-time analytics for accreditation data management

Figure 2. Database Connection (Source: Personal Documentation)

Compared to previous accreditation data management methods, which relied on fragmented data sources and manual entry, this data warehouse provides a centralized solution that ensures data consistency, minimizes redundancy, and improves accessibility, while the use of fact and dimension tables enhances query performance for more efficient report generation. However, its implementation at University X presents challenges, such as integrating data from multiple legacy systems, ensuring scalability as data volume grows, and facilitating user adoption through training, while maintaining accuracy, consistency, and security requires clear governance policies. Despite these challenges, the system significantly improves decision-making by reducing report generation time from weeks to hours, minimizing human errors, and decreasing administrative workload. With a structured design that supports future growth, the data warehouse enhances accreditation data management and institutional decision-making.

The designed data warehouse consists of fact and dimension tables grouped based on the four main business processes: academic, alumni, students, and staff. This design utilizes the snowflake schema, which illustrates the relationships between fact and dimension tables, with normalized dimensions. The schema for each business process is shown in **Figure 3.** (academic), **Figure 4.** (students), **Figure 5.** (alumni), and **Figure 6.** (staff). The implementation of fact and dimension tables is carried out using Microsoft SQL Server Management Studio 18, as shown in **Figure 7**. With this structure, data retrieval becomes more efficient and supports data analysis for each business process.

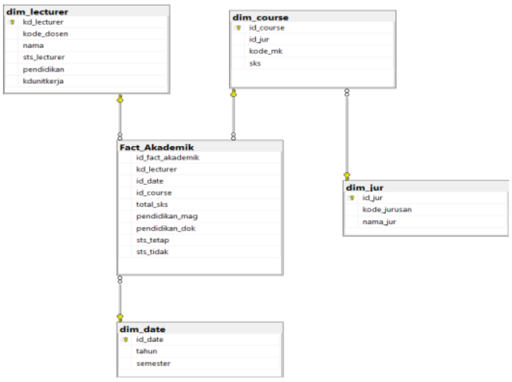

Figure 3. Academic (Source: Personal Documentation)

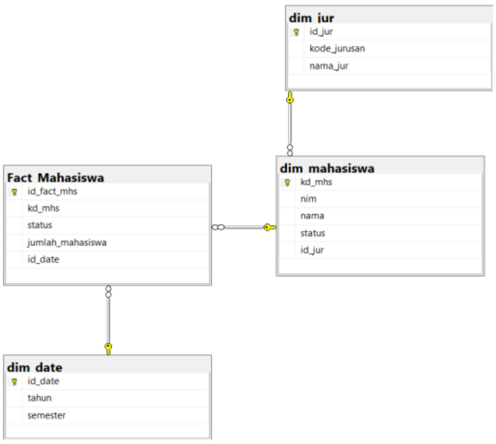

Figure 4. Students (Source: Personal Documentation)

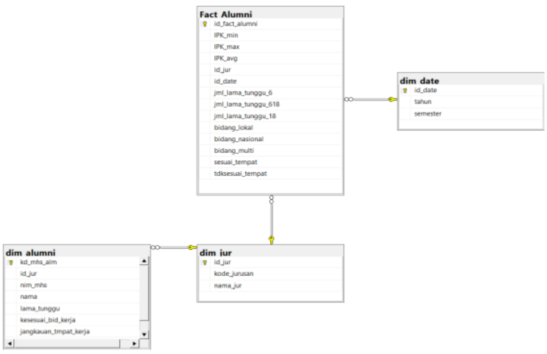

Figure 5. Alumni (Source: Personal Documentation)

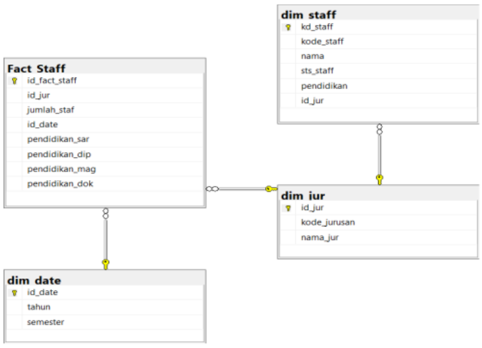

Figure 6. Staff (Source: Personal Documentation)

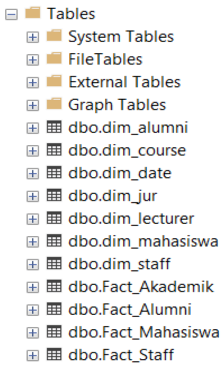

Figure 7. Fact and Dimension Tables in the Data Warehouse (Source: Personal Documentation)

4.2 System Testing

The system testing results of a dashboard application based on five main criteria: database integration, data validation, EWS notification delivery, data security, and error handling. Each test demonstrates that the system functions correctly, with all outcomes marked as “Sesuai” (appropriate), indicating that the dashboard successfully retrieves, processes, and visualizes data from the SQL Server database, securely transmits sensitive information, sends notifications as intended, and handles errors without system crashes. These results confirm that the proposed model effectively meets the objectives stated in the introduction, namely ensuring accurate data visualization, reliable system integration, secure data transmission, and stable performance, thus validating its capability to address the identified problems and achieve the intended goals.

Table 1. System Testing (Source: Personal Documentation)

No	Criteria of Testing	Description	Testing Steps	Expected Result	Final Result
1.	Database Integration	Tests whether the dashboard can correctly retrieve data from the SQL Server database.	1. Connect the application to the database 2. Execute queries to retrieve data. 3. Verify the data displayed on the dashboard.	Dashboard data matches the data stored in the database.	Pass
2.	Data Validation (Graphical)	Tests whether the graphs displayed on the dashboard accurately represent the underlying data.	1. Check raw data in the database. 2. Compare the raw data with the charts generated on the dashboard.	Charts display data accurately without errors.	Pass
3.	EWS Notification Delivery	Tests whether the EWS system sends email notifications correctly.	1. Simulate critical data conditions in the system. 2. Check server logs for email delivery. 3. Verify received email notifications.	Emails are sent according to predefined rules with correct information.	Pass
4.	Data Security	Tests whether data transmitted between the dashboard and the server is secure.	1. Ensure sensitive data is not transmitted in plain text. 2. Check server and browser logs to confirm no sensitive data is exposed.	Sensitive data is not exposed during transmission,	Pass

No	Criteria of Testing	Description	Testing Steps	Expected Result	Final Result
				even when using IP addresses.	
5.	Error Handling	Tests whether the system handles errors correctly without crashing.	1. Simulate incorrect data input. 2. Observe how the system handles the error.	The system displays clear error messages without crashing.	Pass

4.3 Discussion Pembahasan

This study addresses a critical issue in higher education accreditation. The functional features evaluated—integrated data warehouse architecture, dashboard-based visualization, and Early Warning System (EWS) demonstrate a strong potential to resolve these challenges. The centralized data warehouse designed using Kimball's dimensional modeling effectively consolidates accreditation-related quantitative data across academic, student, alumni, and staff domains, thereby reducing redundancy and ensuring data consistency. This finding reinforces prior studies emphasizing the importance of structured and centralized data systems for accreditation transparency and efficiency [4], [5], while confirming that dimensional modeling improves accessibility and analytical performance in complex institutional environments [14], [18].

Furthermore, dashboard functionality transforms static accreditation data into real-time visual analytics, enabling faster interpretation of Key Performance Indicators (KPIs) and supporting evidence-based decision-making. In line with previous research on interactive dashboards [8], the system allows stakeholders to identify trends and performance gaps more efficiently than traditional manual reporting methods. The inclusion of an Early Warning System extends these capabilities by introducing proactive monitoring through automated notifications for incomplete, outdated, or non-compliant data. Consistent with findings by Meckawy et al. [9], the EWS shifts accreditation management from a reactive, deadline-driven activity to a continuous quality assurance process, supporting early intervention and institutional preparedness.

Compared to prior research the proposed model demonstrates similar strengths in terms of integration accuracy, data visualization reliability, and system stability. Such as those by Fonggo et al. [1] and Akbar et al. [2], emphasized database-driven dashboard systems and interactive business intelligence visualizations. However, this study enhances those concepts by incorporating additional evaluation criteria, particularly data security and automated EWS notifications, ensuring a more comprehensive validation of dashboard functionality. hese results align with the conclusions drawn in Section V, which emphasize that the proposed data warehouse, dashboard, and EWS architecture not only improves operational efficiency but also strengthens institutional governance and long-term accreditation readiness. While the current implementation focuses on quantitative indicators, the findings provide a solid foundation for future system expansion, including the integration of qualitative accreditation evidence and interoperability with national accreditation databases, thereby supporting continuous institutional improvement.

5. Conclusion

This study designed and implemented a data warehouse integrated with a dashboard and Early Warning System (EWS) to enhance accreditation data management at Private University X. Using Kimball's Nine-Step Dimensional Modeling methodology, the research successfully structured accreditation-related data into fact and dimension tables across four major business processes—academic, student, alumni, and staff. Implementation of a snowflake schema improved data normalization, reduced redundancy, and enhanced query performance, ensuring greater data integrity and consistency. Integration with Microsoft SQL Server enabled centralized management, automated updates, and real-time data visualization through the dashboard, while the EWS provided timely alerts for incomplete or outdated information. The Kimball dimensional modeling approach has provided a flexible and scalable framework suitable for higher education accreditation systems. The snowflake schema was also effectively supported complex hierarchical relationships in accreditation data, improving analytical accuracy and system performance. The integration of the dashboard and EWS enhances monitoring efficiency and enables proactive decision-making in accreditation management.

Despite challenges in integrating legacy systems and ensuring user adoption, the proposed design establishes a sustainable foundation for long-term institutional data governance and accreditation readiness. In conclusion, the developed data warehouse model significantly strengthens accreditation management by transforming fragmented, manual processes into a structured, technology-driven framework that supports data-driven decision-making and continuous institutional improvement. Future work may include integrating qualitative data and expanding interoperability with national accreditation databases.

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