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Article *in* Jurnal Teknik Informatika (Jutif) · December 2024

DOI: 10.52436/1.jutif.2024.5.6.1747

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Jurnal Teknik Informatika (JUTIF)
Vol. 5, No. 6, December 2024, pp. 1517-1527

DOI: https://doi.org/10.52436/1.jutif.2024.5.6.1747
p-ISSN: 2723-3863
e-ISSN: 2723-3871

ENHANCING COLLABORATION DATA MANAGEMENT THROUGH DATA WAREHOUSE DESIGN: MEETING BAN-PT ACCREDITATION AND KERMA REPORTING REQUIREMENTS IN HIGHER EDUCATION

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(Article received: January 18, 2024; Revision: March 06, 2024; published: December 29, 2024)

Abstract

In higher education institutions, effective management of collaboration data is crucial for academic reporting and strategic planning. This study addresses the challenges of managing diverse data types and the necessity for streamlined data management to meet BAN-PT accreditation and Kerma reporting requirements. It aims to design and implement a data warehouse utilizing the star schema for improved accessibility and decision-making. Highlighting the development process, special emphasis is placed on the Extract, Transform, Load (ETL) process with Pentaho to assure data integrity and quality. The methodology involves a systematic approach to constructing the data warehouse, aimed at resolving identified challenges through efficient data organization and quality management. Results demonstrate significant enhancements in data accessibility, reporting efficiency, and quality, leading to reduced administrative efforts and improved decision-making. The research also considers the wider implications of such data management systems in academic administration, suggesting the potential of data warehouses in higher education as benchmarks for similar institutional challenges. Future research directions are recommended for optimizing data warehouse designs and adapting to evolving academic standards, underlining the critical role of advanced data management in meeting stringent accreditation and reporting needs, thus providing a model for technology-driven solutions in educational data management.

Keywords: *Academic Data Analytics, BAN-PT Compliance, Collaboration Data Management, Data Warehouse Design, Higher Education Accreditation, Kerma Reporting.*

1. INTRODUCTION

Ensuring the integrity and effectiveness of educational programs is paramount, especially in the context of accreditation and reporting requirements. Engaging academics in quality assurance processes is essential to ensure the integrity of educational programs. Research has shown that stakeholder engagement, particularly that of academics, has become a norm in higher education governance, especially in quality assurance[1]. The integrity of quality assurance agencies is integral to quality higher education systems, and effective collaboration reinforces and safeguards academic integrity[2]. Assessing the quality of educational programs involves investigating different sets of standards related to the quality assurance of educational programs in various countries[3]. One of the standards in Indonesia is the BAN-PT accreditation standards and Kerma Report requirements. Universitas Amikom Purwokerto faces the challenge of managing detailed collaboration data required for these reports, including partner names, types of cooperation, scale, duration, and other critical details. This data is essential for maintaining accreditation status and reflecting the university's commitment to national and international collaborations.

The rapid evolution of technology and educational demands necessitates robust data management systems, particularly for handling the collaboration data required for BAN-PT accreditation and Kerma Reports. These systems must efficiently capture, store, and process detailed information about collaborations, ensuring data is accurate, complete, and readily accessible. The complexity of managing such diverse and complex data underscores the importance of a specialized data warehousing solution.

BAN-PT, the national accreditation body, and the annual Kerma Report by the Ministry of Education demand precise and comprehensive data on university collaborations. These stringent requirements make the efficient organization and retrieval of data crucial for timely and successful report submission. Traditional data management methods are needed to meet the evolving data management needs[4]. They often need to meet these needs, leading to inefficiencies and potential errors.

Data warehousing in higher education has significantly enhanced efficiency, productivity, and

information integration. For the Universitas Amikom Purwokerto, a tailored data warehousing solution, particularly one utilizing the star schema, can revolutionize how collaboration data is managed and used for accreditation and reporting purposes. With enhanced query processing and efficient data management capabilities, the star schema is particularly beneficial for handling the complex and detailed collaboration data required by BAN-PT and Kerma Reports.

In academia, the design of a data warehouse offers enormous advantages in efficiency, productivity, cost reduction, and information integration systems[5]. Recent studies have further illuminated the importance and application of data warehousing in various educational contexts. For example, [6] demonstrates the efficacy of the Kimball methodology in designing data warehouses for decision-making purposes, a principle that can be adapted for managing collaboration data in higher education. Similarly, the study [7] showcases the integration of advanced algorithms in data warehousing to enhance predictive analysis. The approach taken in [8] illustrates the application of data warehousing in managing complex information systems, a concept relevant to our design for managing collaboration data. A study at Universitas Muhammadiyah Surakarta introduces a Telegram bot-based system for the Muhammadiyah Student Association Orientation (MASTA IMM) registration, transitioning from manual to automated data management [9]. In [10] provides insights into the life cycle approach in data warehouse design, emphasizing the importance of a comprehensive strategy from inception to implementation. Collectively, these studies underscore the versatility and effectiveness of data warehousing in addressing diverse data management needs in the educational sector. Adding to this discourse, a recent study highlights the crucial role of data visualization techniques in analyzing and presenting academic data to facilitate strategic decision-making in Indonesian higher education institutions, offering a comprehensive process to display interactive data visualizations for insightful academic reporting [11]. Collectively, these studies underscore the versatility and effectiveness of data warehousing in addressing diverse data management needs in the educational sector.

It is crucial to understand the goal and analyze the requirements from the perspective of the identified goal to design and implement a data warehouse effectively for an organization [12]. Moreover, the literature consists of case studies of data warehouse design used to support various industries, including education, which emphasizes the importance of data warehouse design in academia [13].

The proposed data warehouse's architecture centers on managing and analyzing collaboration data with a star schema. This includes data from joint research projects, community service initiatives, academic collaborations, and other collaborative activities within and outside the institution. The design involves creating a central repository where all collaboration-related data is stored. This repository will integrate data from various sources, including the Public Relations and Cooperation Division, Student Affairs Division, Research and Community Service Institute, Faculty of Computer Science and Faculty of Business and Social Sciences, and Library Unit.

The star schema is a valuable tool in data modeling, particularly in data warehousing and online analytical processing (OLAP). It involves normalizing dimension tables to eliminate redundancy and improve data integrity [14]. A typical data warehouse based on a star schema organizes data in a fact table and dimension tables, contributing to efficient data organization and retrieval [15].

Managing data in higher education institutions presents several challenges that must be addressed to ensure effective and efficient operations. Knowledge management in universities has been shown to impact curriculum development, educator development, and collaboration [16]. Moreover, the challenges of managing big data, mainly related to storage, processing, and general management, have been recognized, underscoring the need for effective big data management strategies in higher education institutions[17].

The design will align with the standards set by BAN-PT accreditation and Kerma reporting requirements. This involves understanding the specific data points, metrics, and documentation these bodies require and ensuring the warehouse can store and process this information effectively. One of the critical features of the proposed design is the ability to generate customizable reports that cater to the needs of BAN-PT and Kerma. This flexibility ensures institutions can respond to changing requirements or provide additional details.

The star schema has been utilized in various domains within higher education institutions. For instance, a data warehouse in research and community service has been designed using the star schema to enhance the performance of research and community service activities [18]. This approach provides a structured framework for organizing and managing data related to these activities, facilitating efficient data retrieval and analysis.

By consolidating collaboration data into a single, structured repository, the proposed design will enhance the accessibility and quality of data. This will enable more accurate and efficient analysis and reporting, supporting better decision-making. The ability to generate customizable reports easily will streamline the process of compiling and submitting data for BAN-PT accreditation and Kerma reporting. This reduces the administrative burden on staff and ensures timely and accurate reporting.

The data warehouse will provide deep insights into the nature, scope, and outcomes of collaborative activities. This can help identify successful collaborations, understand the impact of various initiatives, and guide future collaboration strategies. The proposed design will support strategic planning by providing a comprehensive view of collaboration activities and their outcomes. Institutions can use the data to allocate resources more effectively, identify areas for growth, and enhance their reputation and competitiveness.

This study aims to design a data warehouse using the star schema to address the challenges of managing collaboration data for BAN-PT accreditation and Kerma Reporting specifically. By streamlining the management of this data, the proposed solution seeks to ensure compliance, improve data quality, and enhance the faculty's ability to meet reporting requirements effectively. This aligns with broader objectives of enhancing academic quality assurance and decision-making through improved data management strategies.

In conclusion, the proposed data warehouse design represents a comprehensive approach to managing collaboration data in higher education institutions. This design will significantly enhance the institution's collaboration and data management capabilities by addressing the specific needs of BAN-PT accreditation and Kerma reporting and providing a range of benefits.

2. METHOD

The study adopts a detailed, phased approach, leveraging established best practices in data warehousing to develop a sophisticated data warehouse. This warehouse is designed to efficiently manage collaboration data, ensuring compliance with accreditation standards and reporting requirements. This methodology is visually summarized in Figure 1, the Research Method Diagram, which encapsulates the comprehensive process from conceptualization to implementation, underlining the strategic planning and technical execution involved in aligning the data warehouse with institutional objectives.

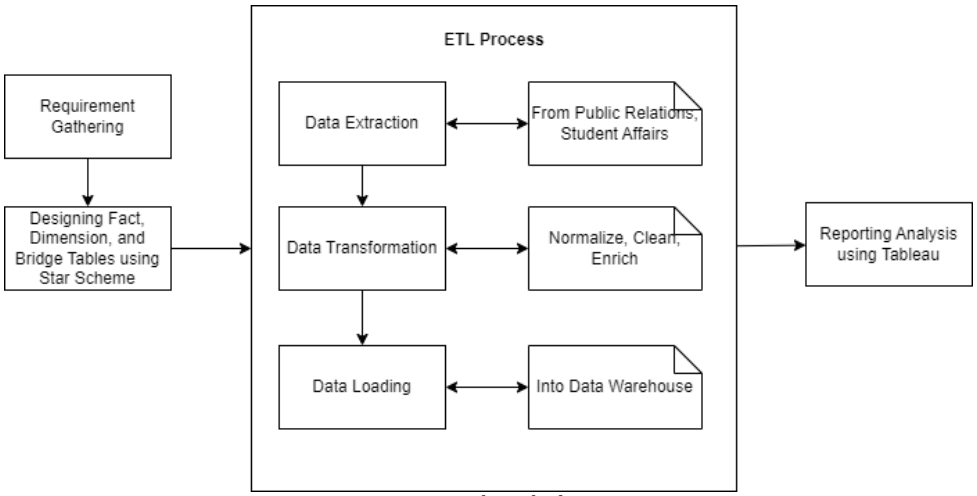

Figure 1. Research Method Diagram

2.1. Requirement Gathering

The study commenced with an extensive requirement-gathering phase, employing interviews, surveys, and focus groups involving faculty, administrative staff, and IT personnel. This process was designed to fully understand stakeholders' needs concerning collaboration activities, accreditation, and reporting. Questions and discussions were tailored to identify specific data elements and reporting functionalities required to effectively support BAN-PT accreditation and Kerma reporting guidelines.

2.2. Data Warehouse Design

The design phase involved detailed planning of the data warehouse architecture, focusing on the creation of fact, dimension, and bridge tables. Each table was designed to align with research goals and fulfill BAN-PT and Kerma requirements. The adoption of the star schema was driven by its efficiency in organizing data for analysis and reporting, facilitating complex queries with better performance and simplicity.

2.3. Extraction Process

Data was sourced from various departments, including Public Relations, Student Affairs, and Research and Community Service, selected based on their relevance to the research objectives. The extraction process involved converting Excel datasets into SQL-compatible formats using Pentaho, which was chosen for its robust data integration capabilities.

2.4. Transformation

Within Pentaho, data underwent normalization, cleaning, and enrichment to address inconsistencies and missing values, ensuring high-quality, reliable data ready for analysis.

2.5. Loading into the Warehouse

The transformed data was loaded into the warehouse, with Pentaho facilitating the efficient transfer. Post-loading, extensive data integrity and completeness checks were conducted to ensure the reliability of the warehouse.

2.6. Implementation of Data Warehouse

The implementation phase saw the data warehouse construction on a MySQL platform optimized for performance and integrity. Pentaho Data Integration (PDI) tools were configured for seamless ETL operations. At the same time, Knowage was deployed for its advanced analytics capabilities, enabling the creation of customized reports and dashboards for BAN-PT and Kerma compliance.

2.7. Reporting and Analysis

Utilizing Tableau, the project developed interactive reports and dashboards, focusing on delivering insights essential for accreditation and reporting. This stage gave stakeholders crucial data-driven insights, enhancing decision-making and strategic planning.

Through this multi-faceted and meticulously designed approach, the data warehouse transcends a mere data repository, transforming it into a valuable tool for monitoring collaboration data and fulfilling crucial accreditation and reporting requirements.

3. RESULT

3.1. Requirement Gathering

The initial phase of the data warehouse design prioritized a comprehensive requirement-gathering process to build a robust and functional system tailored to the institution's collaborative activities, accreditation, and reporting needs. This phase was crucial in understanding the diverse and complex data demands across various domains.

Stakeholders representing faculty, administrative staff, and IT personnel were actively engaged. Each stakeholder group played a unique role within the institution, offering valuable and varied perspectives on data usage. Faculty members shared insights into academic and research collaboration requirements, while administrative staff provided views on operational and reporting needs. IT personnel contributed technical expertise on data integration and system capabilities. A comprehensive list of data requirements was collated through interviews, surveys, and focus group discussions, ensuring all user needs were captured and understood.

Understanding the nature and scope of collaboration activities within the institution was a significant area of focus. This involved identifying the types of collaborations (e.g., research collaborations, community engagements, industry linkages), the participants involved (e.g., faculty, students, external partners), and the desired outcomes or deliverables. The data needed to track and manage these activities effectively could be determined by comprehending these elements.

Meticulous analysis of accreditation standards and criteria ensured understanding of the data elements required for compliance with BAN-PT. Documentation from BAN-PT, previous accreditation reports, and guidelines were reviewed to identify specific indicators, metrics, and evidence needed for the accreditation process. Consultations with accreditation experts and personnel with prior involvement in the process further ensured a thorough understanding of the requirements.

Similarly, for Kerma's reporting, reporting guidelines and standards were reviewed to identify necessary data for various reports. This involved understanding the frequency of reports, specific data points required, and the required format for data presentation. Consultations with staff responsible for Kerma reporting provided additional insights into challenges faced in the current reporting process and the potential improvements a data warehouse could offer.

These discussions and analyses identified specific data points needed for collaboration activities, accreditation, and Kerma reporting. These included details on collaborative projects, funding received, participants involved, outcomes achieved, and various metrics required for accreditation and reporting. The sources of these data points were also determined, whether they were already captured in existing systems or if new data collection processes needed to be implemented.

This meticulous approach to data warehouse requirement gathering ensures the construction of a system that empowers collaboration, facilitates accreditation compliance, and streamlines Kerma reporting within the institution, ultimately fulfilling its specific needs and objectives.

Table 1. Requirements from BAN-PT and Kerma Reporting

Category	Table	Attributes
BAN-PT Accreditation Requirement	LKPT 1.c - University Collaboration Data	Partner Institution, Category of Trdiharma Level - Local, National, International, Form of Activity, Benefit. Proof of Collaboration
Kerma Reporting Requirement	Partner	Partner Classification, Institution Name, Address, Country, Telephone, Website
Kerma Reporting Requirement	Collaboration	Status, Start Date, End Date, Document, Type of Collaboration Document, Document Number, Title of Collaboration, Description, InstitutionName1, Address1, Signatory1, Position1, Contact1, InstitutionName2, Address2, Signatory2,

	Position2, Contact2, Form of Activity

The data requirement gathering phase was pivotal in laying the foundation for a data warehouse tailored to the institution's needs. This meticulous process, involving engaging various stakeholders and analyzing their input, culminated in identifying specific data requirements and their alignment with crucial objectives.

A precise mapping between data attributes and the specific requirements of BAN-PT accreditation and Kerma reporting was established. This served as a roadmap, guiding the design of each table in the data warehouse to ensure it captured the necessary data points and fulfilled both accreditation and reporting obligations.

By the end of this phase, a crystal-clear understanding of the data warehouse's requirements emerged. This comprehensive knowledge laid a solid foundation for the subsequent design and implementation phases, guaranteeing that the final system would effectively meet the institution's needs for managing collaboration data, meeting accreditation standards, and fulfilling reporting requirements.

Engaging with various stakeholders and analyzing their input led to identifying specific data requirements. This involved meticulously delineating the data attributes necessary for each table within the proposed data warehouse model. The objective was twofold: capturing essential data elements and ensuring alignment with the requirements of BAN-PT accreditation and Kerma reporting.

By employing this rigorous approach, the data requirement gathering phase transformed stakeholder insights into a structured data warehouse model, primed to effectively manage collaboration data, navigate accreditation challenges, and streamline Kerma reporting within the institution.

3.2. Data Warehouse Design

The data warehouse design for managing collaboration data in higher education institutions is meticulously structured to ensure comprehensive data capture and analysis tailored to meet BAN-PT accreditation and Kerma reporting requirements. The schema includes a well-defined set of fact and dimension tables to handle complex many-to-many relationships.

At the core of the warehouse is the `Fact_Collaboration` table, which records every instance of collaboration, provides a unique identifier for each activity, and links to various dimensions like partners, documents, activities, and benefits through foreign keys. This table is the central point for querying and analyzing detailed collaboration data, offering insights into the status, duration, and nature.

The dimension tables, including `Dim_Partner,` `Dim_Activity,` `Dim_Document,` `Dim_Date,` and `Dim_Benefit`, provide rich contextual details. For instance, the `Dim_Partner` table stores critical information about each partner institution, including classification, contact details, and location, facilitating a deeper understanding of the collaborative network. `Dim_Activity` categorizes the types of collaborative activities and their scope, while `Dim_Document` maintains records of collaboration documents, crucial for verification and reporting purposes. The `Dim_Date` table allows for time-based analysis of collaborations, and `Dim_Benefit` details the outcomes and proofs of collaborative efforts.

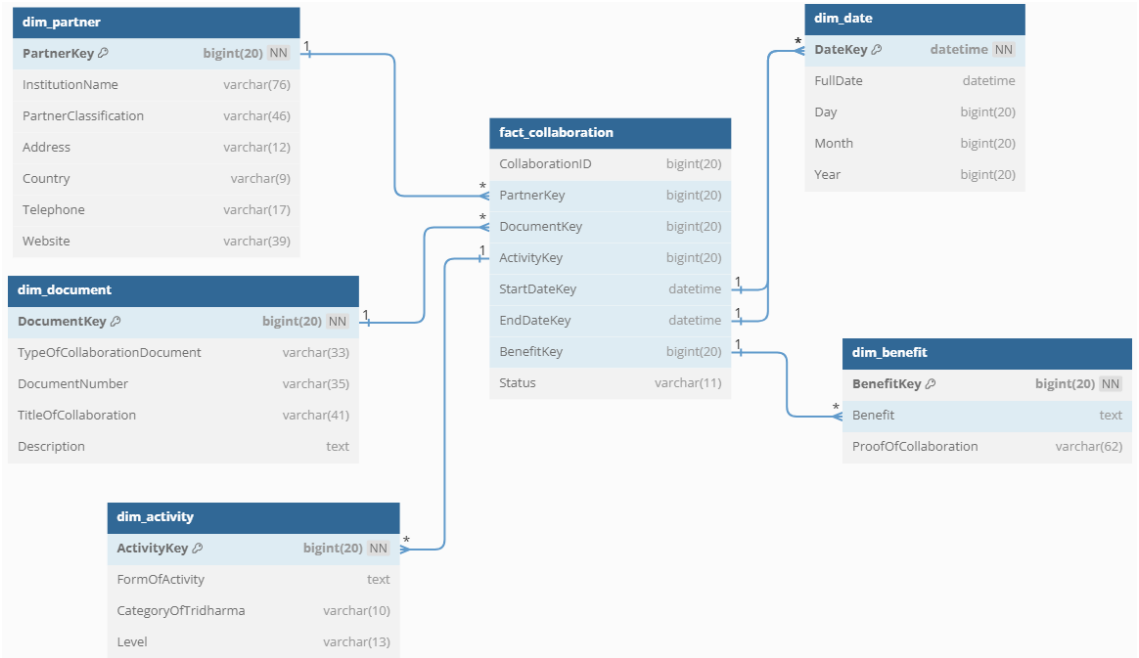

Figure 2. Star Scheme of Collaboration Data Warehouse

Figure 2 presents a Star schema to meet the specific data requirements for BAN-PT accreditation and Kerma reporting. This comprehensive schema is structured to capture and analyze various aspects of collaboration activities within the institution. At its core, the 'Fact_Collaboration' table records each unique instance of collaboration, offering a central point for querying and analyzing collaboration data. This fact table is intricately linked to a series of dimension tables: 'Dim_Partner' details each partner institution, 'Dim_Activity' categorizes types of collaborative activities, 'Dim_Document' maintains records of relevant documents, 'Dim_Date' provides a time-based context, and 'Dim_Benefit' outlines the benefits and outcomes of collaborations. This schema reflects a deliberate and strategic approach to data management, aiming to enhance the institution's ability to manage, analyze, and report collaboration activities, thereby meeting the stringent standards of BAN-PT accreditation and Kerma reporting.

3.3. Extraction Process

Pentaho is selected for its powerful data integration capabilities, user-friendly interface, and ability to handle large volumes of complex data. Its flexible connection to various data sources makes it ideal for our needs.

Data has been gathered from several critical units within the institution, each contributing essential information such as a) Public Relations and Cooperation Division, b) Student Affairs Division, c) Research and Community Service Institute, d) Faculty of Computer Science and Faculty of Business and Social Sciences; and e) Library Unit.

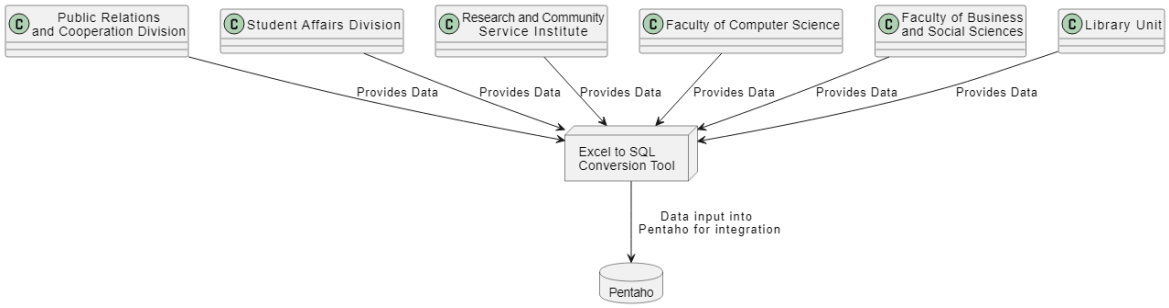

Figure 3. Flowchart of Extraction Process

Staff from each unit have provided the relevant data in Excel format. Before inputting it into Pentaho, the data must be converted into an SQL-compatible format. This conversion has been done using scripts or tools designed to convert Excel data into SQL statements, ensuring data could be efficiently loaded into Pentaho for transformation. Figure 3 presents a detailed flowchart of the data extraction process, illustrating the step-by-step workflow from data acquisition to its integration into Pentaho.

3.4. Transformation

Pentaho has been used to clean, standardize, and reformat the Excel-derived data to fit the warehouse schema. This includes correcting inconsistencies, handling missing values, and standardizing formats. Data may be enriched to provide additional context or detail by combining data from multiple sources, calculating new metrics, or aggregating data to a higher level for analysis. Any issues encountered during the extraction or transformation stages will be logged and addressed. Strategies may include returning to the source units for clarification, employing additional validation rules, or manually reviewing suspect data.

Figure 4 provides a visual representation of the data processing steps carried out in Pentaho, as described above.

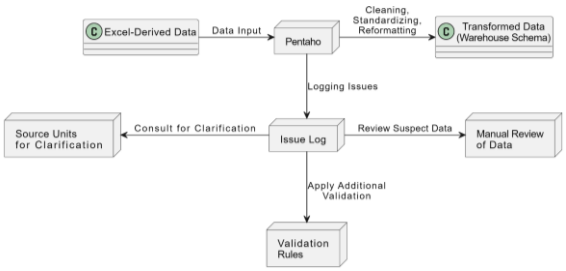

Figure 4. Flowchart of Transformation Process

3.5. Loading into the Warehouse

A one-time load for data from 2018-2023 has been conducted using Pentaho. To accurately and efficiently transfer all relevant historical data into the warehouse, Pentaho was configured specifically for this operation. Various checks have been performed following the load to ensure the data's completeness and accuracy. This may involve comparing record counts to expected totals, checking key metrics against known records, or performing spot checks on specific data points to ensure the integrity of the loaded data.

By leveraging Pentaho as the ETL tool and meticulously converting Excel data into a format compatible with SQL operations, we've laid the groundwork for a comprehensive and reliable data warehouse. This robust resource will effectively manage collaboration data, empowering analysis and

insightful decision-making. The unwavering focus on data quality, transformation, and loading processes ensures data integrity of the highest caliber, serving as a solid foundation for building successful initiatives. This approach will significantly enhance the institution's ability to manage and report on collaboration activities, meeting the stringent requirements of BAN-PT accreditation and Kerma reporting. Figure 5 illustrates the one-time data loading process from 2018-2023 into the data warehouse using Pentaho, as outlined above.

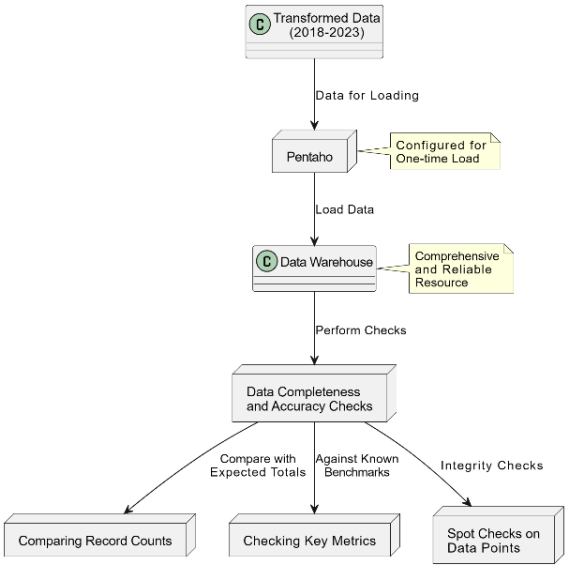

Figure 5. Flowchart of Loading Process

Figure 6 shows the ETL process carried out in Pentaho software for dimension tables.

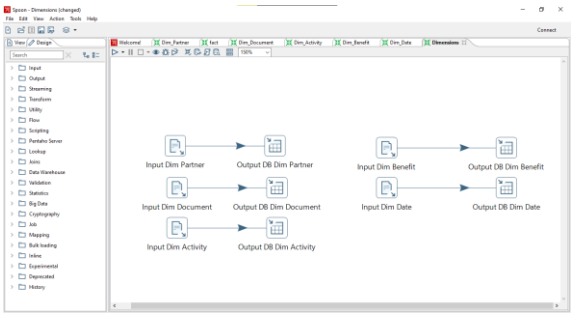

Figure 6. ETL Process for Dimension Tables

Figure 7 shows the ETL process carried out in Pentaho software for the fact table.

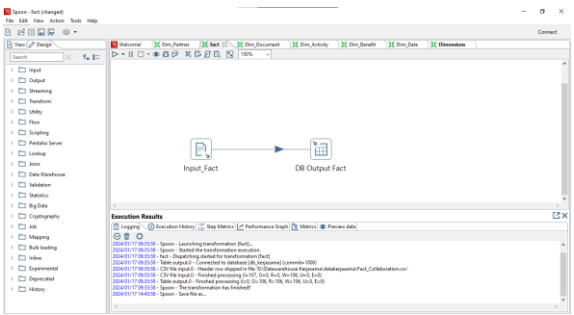

Figure 7. ETL Process for Fact Tables

3.6. Implementation of Data Warehouse

The implementation phase is crucial as it transforms the proposed design into a functional data warehouse system ready to manage collaboration data and meet reporting requirements. This section describes the software used in the implementation.

MySQL is chosen as the database management system for its robustness, scalability, and widespread support. Its compatibility with various applications and tools makes it an ideal choice for our data warehouse. The MySQL database is structured according to the warehouse schema, with tables created for each fact and dimension outlined in the proposed method. Indexes, constraints, and relationships are defined to ensure data integrity and optimize query performance.

Pentaho Data Integration (PDI) is used for the ETL process. It's responsible for extracting data from the converted SQL format, transforming it according to the warehouse schema, and loading it into the MySQL database. Pentaho is configured to work seamlessly with MySQL, utilizing JDBC connections to interact with the database and execute the necessary data operations.

Tableau is chosen as the reporting tool for its advanced analytics capabilities and its ability to create dynamic, interactive reports and dashboards. Its integration with MySQL allows direct access to the warehouse data for reporting purposes.

Reports and dashboards are designed within Tableau to meet the specific needs of BAN-PT accreditation and Kerma reporting. These reports are accessible to authorized users, providing insights and analysis derived from the warehouse data.

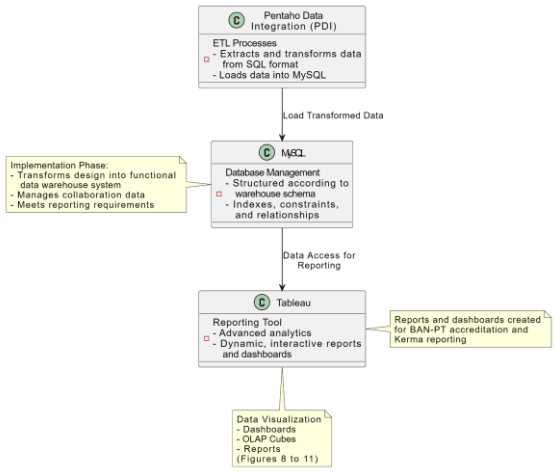

Figure 8. Flowchart of Data Warehouse Implementation with Pentaho, MySQL, and Tableau

Figure 8 offers a comprehensive visual overview of the implementation phase, effectively capturing the interplay between MySQL, Pentaho Data Integration (PDI), and Tableau in the development of the functional data warehouse system.

3.7. Reporting and Analysis

Following comprehensive data transformation through the ETL pipeline and subsequent storage within the data warehouse, the focus shifted towards unlocking its potential for impactful insights. Tableau software served as the primary tool in this endeavor. A direct connection was established between Tableau and the "db_kerjasama" database housed within MySQL or phpMyAdmin, bridging the gap between data storage and visual communication. This facilitated the creation of diverse and informative visualizations, empowering exploration, analysis, and, ultimately, data-driven decision-making.

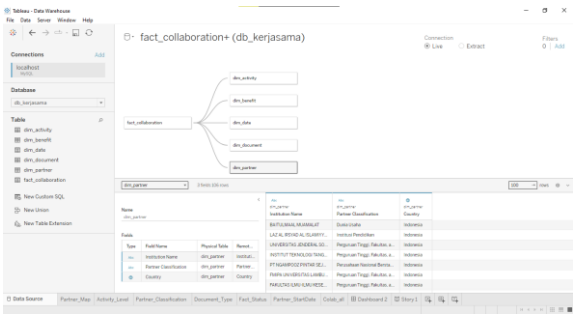

Figure 9. MySQL and Tableau Connection

Figure 9 provides a detailed graphical representation of the established connection between the 'db_kerjasama' database in MySQL or phpMyAdmin and Tableau, as described above.

Tableau enabled the construction of dynamic and interactive dashboards, synthesizing critical insights from multiple data sources. These dashboards provided a comprehensive overview of collaboration activities, including metrics related to project participation, funding received, and outcomes achieved. Additionally, accreditation compliance indicators and Kerma reporting parameters were visualized, offering a consolidated view of institutional performance in these crucial areas.

Multidimensional OLAP cubes were generated from the data warehouse, facilitating rapid exploration and analysis from various perspectives. Users could leverage these cubes to drill down into specific areas of interest, uncover hidden patterns and trends, and gain a deeper understanding of collaboration dynamics within the institution. This multidimensional approach empowered informed decision-making and strategic planning, ensuring alignment with accreditation requirements and reporting obligations.

Tableau's versatility extended to creating tailored reports for specific audiences and purposes. Reports on accreditation compliance presented required metrics and evidence in a structured format, readily digestible by evaluation committees. Similarly, Kerma reporting templates were generated, fulfilling all stipulated reporting requirements. This customization ensured effective communication and transparency related to collaboration activities within the institution and external stakeholders.

Figures 10 to 13 provide illustrative examples of these visualizations, showcasing the transformative power of Tableau in harnessing data from the "db_kerjasama" database. These visualizations, from interactive dashboards to detailed reports, demonstrate the software's ability to bridge the gap between raw data and actionable insights, ultimately empowering data-driven decision-making that benefits collaboration initiatives, accreditation compliance, and Kerma reporting within the institution.

Tableau software facilitated data visualization in diverse formats after processing through the ETL pipeline and storing the results in the data warehouse. Dashboards, OLAP cubes, and reports were all generated using the transformed data.

Figure 10. Dashboard of Partner Geolocation

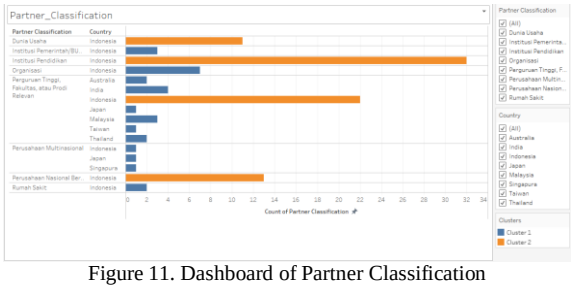

Figure 11. Dashboard of Partner Classification

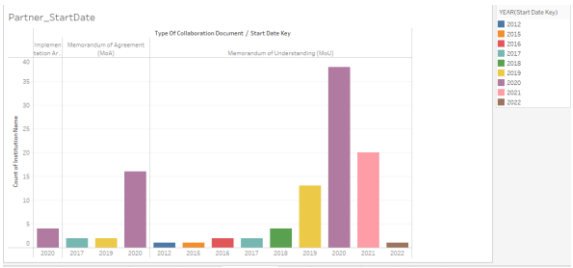

Figure 12. Dashboard of Collaboration Start Date

Figure 13. Dashboard of Overall Collaboration

The diverse outputs presented above offer valuable tools for executives to assess collaboration within the institution. By delving into the dashboards, OLAP cubes, and reports, they can gain insights into vital metrics like project progress, partner engagement, and knowledge sharing. This wealth of information empowers them to identify areas of success and potential roadblocks, ultimately fostering a more collaborative and productive research environment.

4. DISCUSSION

Throughout this research, delving into the complexities of higher education data management required a meticulous approach, particularly in the development and execution of the Extract, Transform, Load (ETL) process. The challenge of ensuring data integrity and accuracy was met with an innovative implementation of the star schema in the data warehouse design, which was pivotal in facilitating efficient data analysis and robust reporting capabilities. This schema not only streamlined the handling of large datasets from disparate sources but also significantly improved query performance. Reflecting on the technical aspects, the application of Pentaho for the ETL process highlighted the critical role of sophisticated data integration tools in managing and transforming educational data into actionable insights. This technical journey underscored the indispensable value of advanced data management systems in enhancing academic administration and decision-making processes.

Compared to existing research on higher education data management, this study particularly highlights the sophisticated application of the star schema and the Pentaho-based ETL process. While numerous studies outline the strategic significance of data warehousing, the detailed exploration of ETL intricacies and the star schema application seen here offers a unique perspective. The study stands out by thoroughly examining data integration challenges and solutions, emphasizing enhanced data accessibility and quality alongside the development of custom reports and dashboards tailored for academic accreditation and reporting needs.

This study enriches the academic discourse on higher education data management by offering a nuanced exploration of data warehouse design and ETL process optimization. By meticulously detailing the implementation of the star schema and leveraging Pentaho for ETL operations, it presents a sophisticated model that addresses the specific needs of accreditation and reporting and sets a new benchmark for data management practices. The research demonstrates significant advancements over existing models by enhancing data quality, accessibility, and reporting capabilities, thereby contributing valuable insights and methodologies to the field.

The results of this study demonstrate a comprehensive and meticulously designed data warehouse using the star schema to manage collaboration data for BAN-PT accreditation and Kerma reporting in higher education institutions. The design, which focuses on organizing collaboration data into a single structured repository, significantly enhances the accessibility and quality of data. This approach meets the stringent requirements of BAN-PT accreditation and Kerma reporting and supports strategic planning and decision-making within the institution.

The data warehouse's key features include customizable reports and dashboards, which streamline compiling and submitting data for accreditation and reporting. This reduces the administrative burden and ensures timely and accurate reporting. Furthermore, the warehouse provides deep insights into the nature, scope, and outcomes of collaborative activities, identifying successful collaborations and guiding future strategies.

One of the primary challenges in this project was managing the complexity and diversity of collaboration data. This was addressed through the careful design of the data warehouse, ensuring comprehensive data capture and analysis. The ETL process, using Pentaho, played a crucial role in ensuring data integrity and quality. The successful data warehouse implementation highlights the importance of a meticulous and multi-stage approach in data management projects.

The study's findings have significant implications for higher education institutions. By consolidating collaboration data, the data warehouse enhances the institution's ability to comply with accreditation standards and reporting requirements efficiently. This aligns with broader objectives of enhancing academic quality assurance and decision-making through improved data management strategies.

The study opens avenues for further research in optimizing data warehouse design in higher education. Future studies could explore the integration of advanced data analytics and machine learning to provide even deeper insights into collaboration patterns and outcomes. Additionally, the scalability and adaptability of the data warehouse design to accommodate evolving accreditation standards and reporting requirements could be another area of exploration.

In conclusion, the data warehouse designed in this study represents a significant advancement in managing collaboration data in higher education. Its success in meeting BAN-PT accreditation and Kerma reporting requirements and its impact on strategic planning and decision-making underscores the importance of effective data management in the academic sector. This study sets a precedent for other institutions facing similar challenges and highlights

the potential benefits of adopting a structured and strategic approach to data management.

Integrating advanced data analytics and machine learning into data warehouse designs represents a promising avenue for future research within higher education. This approach has the potential to significantly refine how institutions manage, analyze, and interpret collaboration data, leading to more nuanced understanding and strategic decision-making. Future studies could explore the application of predictive analytics to forecast academic trends or how machine learning algorithms could automate the identification of patterns in collaboration data, thereby enhancing the efficacy of educational programs and research initiatives.

5. CONCLUSION

As detailed in this study, developing and implementing a data warehouse for managing collaboration data in higher education institutions marks a pivotal advancement in meeting the stringent requirements of BAN-PT accreditation and Kerma reporting. Adopting the star schema design within the data warehouse has been critical in organizing and streamlining complex collaboration data. This approach not only enhances data quality and accessibility but also significantly eases the process of compiling and submitting essential reports. Integrating customizable reports and dashboards reduces administrative burdens, thereby improving operational efficiency. The challenges encountered, especially in managing diverse data types, were adeptly addressed through a meticulous design and implementation process, underscoring the importance of a strategic approach in data management.

This study extends its implications far beyond meeting specific reporting requirements. It sets a precedent for using technology to enhance academic administration and quality assurance. The successful implementation of this data warehouse exemplifies how effective data management can facilitate data-driven decision-making and strategic planning in educational settings. This study further opens avenues for incorporating advanced data analytics and machine learning to enhance data management systems in higher education. The adaptability and scalability of these systems to evolving academic standards and reporting frameworks remain critical areas for future exploration. This study highlights the transformative impact of sophisticated data management solutions in the educational sector, offering a model for other institutions grappling with similar challenges.

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