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Analyzing The Impact of Database Design on The Success of Regional Information Systems

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ABSTRAK

Desain basis data merupakan komponen fundamental dalam pengembangan Sistem Informasi Regional (Sistem Informasi Rujukan Daerah/KPU), karena menentukan kualitas data, integrasi antarlembaga, kinerja sistem, dan keberlanjutan pelayanan publik. Studi ini bertujuan untuk menganalisis dampak desain basis data terhadap keberhasilan implementasi KPU dengan meneliti aspek kualitas data, integrasi sistem, efisiensi operasional, keamanan informasi, dukungan pengambilan keputusan, dan skalabilitas sistem. Penelitian ini menggunakan tinjauan pustaka dan analisis konseptual berbagai model desain basis data dan implementasinya dalam lingkungan pemerintahan daerah. Hasil penelitian menunjukkan bahwa desain basis data yang efektif yang dicirikan oleh struktur data yang terstandarisasi, hubungan antar tabel yang jelas, validasi data yang kuat, dan mekanisme keamanan berlapis secara signifikan meningkatkan efektivitas dan akurasi manajemen data regional. Sebaliknya, desain basis data yang suboptimal menyebabkan duplikasi data, interoperabilitas yang rendah antar unit pemerintahan daerah, proses pelayanan publik yang lebih lambat, dan peningkatan risiko pelanggaran data. Oleh karena itu, keberhasilan Sistem Informasi Regional sangat dipengaruhi oleh kualitas desain basis data sebagai fondasi utama untuk pengolahan data dan penyediaan informasi di pemerintahan daerah.

Kata Kunci: desain basis data; sistem informasi regional; keamanan data; kinerja sistem; kepuasan pengguna

ABSTRACT

Database design is a fundamental component in the development of Regional Information Systems (RIS), as it determines data quality, inter-agency integration, system performance, and the sustainability of public services. This study aims to analyze the impact of database design on the success of RIS implementation by examining aspects of data quality, system integration, operational efficiency, information security, decision-making support, and system scalability. The research employs a literature review and conceptual analysis of various database design models and their implementation within local government environments. The results indicate that effective database design characterized by standardized data structures, clear inter-table relationships, strong data validation, and multi-layered security mechanisms significantly enhances the effectiveness and accuracy of regional data management. Conversely, suboptimal database design leads to data duplication, low interoperability among local government units, slower public service processes, and an increased risk of data breaches. Therefore, the success of Regional Information Systems is strongly influenced by the quality of database design as the primary foundation for data processing and information provision in local governments.

Keyword: database design; regional information systems; data security; system performance; user satisfaction

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1. INTRODUCTION

The rapid advancement of information technology has driven digital transformation in public governance in Indonesia. Local governments are required to deliver public services that are effective, transparent, and accountable through the utilization of Regional Information Systems (RIS). This development has not only changed the way people communicate and interact but has also transformed key sectors such as the economy, government (e-government), and education (Wardiana, 2002). Regional Information Systems function as tools for data management, inter-agency information integration, and data-driven decision-making support. The success of RIS implementation is strongly influenced by the quality of the data produced and the system's ability to provide timely, accurate, and reliable information.

One of the main factors determining the quality of RIS is database design. A database serves not only as a data repository but also as a structural framework that defines how data are organized, related, and accessed by various system modules. Proper database design enables system developers to create consistent and flexible data structures. With a normalized database, data modifications can be performed without causing inconsistencies, thereby ensuring the reliability of the information generated (Efendy, 2018). A well-designed database allows data to be stored consistently, avoids duplication, facilitates efficient processing, and supports inter-agency integration. Conversely, suboptimal database design may result in data redundancy, lack of synchronization among government agencies, degraded system performance, and increased data security risks.

Many problems encountered in regional information systems originate from poor database design, such as invalid population data, inconsistent reference codes across systems, public service applications that cannot exchange data, and inaccurate regional reports. These conditions reduce the reliability of information systems and hinder government administrative processes. Although many institutions and organizations have implemented e-government systems, significant challenges remain at the local government level. Similar obstacles and service delivery issues persist, indicating that public services provided by government officials are still far from being effective and efficient (Diani, 2024). Therefore, an in-depth analysis of the impact of database design on the success of Regional Information Systems is essential to improve the quality of public governance.

In addition to affecting data quality, effective database design also has a direct impact on operational efficiency. Optimal table structures, appropriate indexing strategies, clear data relationships, and the enforcement of database constraints can significantly improve system performance and accelerate public services such as licensing, taxation, population administration, and regional financial management. However, to ensure long-term system sustainability, database design must also address scalability and security concerns. Local government information systems continue to evolve in terms of user volume, data size, and integration requirements with national systems such as SIAK, SIPD, and OSS. Therefore, flexible and secure database design is essential to enable continuous system adaptation.

Commonly identified design issues include inadequate normalization, which leads to severe data redundancy and update anomalies, as well as improper indexing that forces systems to perform full-table scans even for simple queries, resulting in exponential performance degradation as data volumes increase. Quality aspects of database schemas in population data management include consistency, completeness, redundancy minimization, referential integrity, and ease of maintenance. Schema consistency ensures that each entity and attribute is defined uniformly, thereby minimizing data interpretation errors (Fikri, 2016). Violations of referential integrity—where relationships between tables are not properly enforced—lead to orphan records and inconsistencies across related tables. This phenomenon creates a condition in which the data generated by RIS become unreliable, ultimately undermining system credibility in the eyes of users and decision-makers. If data are the fuel, then the database is the engine; poor design means the engine operates inefficiently and frequently breaks down.

The urgency of this research is particularly high given the substantial national budget allocated to information and communication technology (ICT) and e-government initiatives. E-government implementation in Indonesia involves multiple key actors, including the government as a policymaker and service provider, civil servants as operational implementers, and the public as users of digital public services. The government plays a central role in establishing regulations, providing technological infrastructure, and ensuring the sustainability of e-government programs (Nugroho, 2020). If database design is proven to be a key determinant of system success, the findings of this study will offer a clear roadmap for local governments and system developers. This research provides concrete and measurable best practices—such as recommended minimum levels of normalization and effective indexing strategies—that can be used by local government ICT teams to conduct quality assurance (QA) on Regional Information Systems they procure or develop. Ultimately, these findings can serve as technical benchmarks in information system procurement processes, ensuring that local governments acquire systems with strong technical foundations rather than merely attractive user interfaces.

2. LITERATURE REVIEW

Database design constitutes the primary technical foundation of any information system. In the context of local government, the quality of database design directly affects data availability, processing speed, information integrity, interoperability among government units, and ultimately the success of regional information systems (such as SIPD, e-government platforms, and public service applications). Well-designed and properly managed databases enhance data access speed, reduce redundancy, and maintain information consistency and integrity.

By applying sound database design principles—such as normalization, the definition of primary and foreign keys, and proper management of inter-table relationships—information systems can minimize data errors and processing anomalies (Sari, 2025). This literature review examines studies related to database design, data quality, system performance, information system success models, and prior research that links these aspects within the context of government and public sector organizations.

Several foundational concepts and aspects in database research are outlined as follows.

A. Concepts and Principles of Database Design

1) Data Models and Conceptual Modeling

Entity–Relationship (ER) modeling, introduced by Peter Chen, along with other conceptual models, represents the initial stage in defining the logical structure of data. Sound conceptual design facilitates the translation of functional requirements into stable and well-structured data architectures.

2) Logical and Physical Design

Logical design, which includes relational schemas and normalization, aims to reduce redundancy and data anomalies, while physical design—such as indexing, clustering, and partitioning—determines system performance and scalability. Achieving a balance between normalization for data integrity and denormalization for performance optimization is a recurring topic in database literature.

3) Integrity Principles and Constraints

Integrity rules such as primary keys, foreign keys, and database constraints ensure data consistency. Without proper integrity enforcement, systems become vulnerable to corrupted data, ultimately reducing user trust.

B. Data Quality and Data Governance

1) Data Quality Dimensions

Key dimensions of data quality include completeness, accuracy, consistency, timeliness, and trustworthiness. Database design influences each of these dimensions; for example, poor schema design may lead to inconsistencies across related tables.

2) Data Governance

Policies related to data ownership, metadata management, and master data management serve as essential complements to technical database design. The literature emphasizes that database design should be developed in parallel with data governance policies to ensure sustainable and reliable data management.

C. System Performance and Architecture

1) Indexing, Query Optimization, and Storage Architecture

Indexing strategies, query optimization techniques, and storage architecture significantly affect system response time, which is a critical factor for online public services that are highly sensitive to latency.

2) Scalability and Availability

Database designs that incorporate replication, partitioning, and clustering support high availability for large-scale usage and help maintain service continuity during peak workloads.

D. Information System Success: Theory and Measurement

1) The DeLone and McLean IS Success Model

This model evaluates information system success based on system quality, information quality, service quality, system use, user satisfaction, and net benefits. It is widely adopted in information systems research.

2) Public Sector Contextual Factors

In local government environments, indicators such as transparency, accountability, public service efficiency, and policy support are commonly used to assess system success.

E. The Relationship Between Database Design, Data Quality, and System Success

- Numerous empirical studies conducted in both private and public organizations demonstrate a positive relationship between database design quality and information quality, as well as between information quality and user satisfaction or service effectiveness.
- Research on e-government highlights that technical issues—such as inconsistent database schemas across organizational units—are major causes of cross-sector service integration failures and barriers to shared data utilization.

F. Practical Implications of the Literature

1) For Local Government Policymakers:

Investment in database design, including proper documentation and data governance, is not merely a technical concern but a critical factor in enhancing public services and transparency.

2) For IT Teams:

Emphasis should be placed on modular database design, comprehensive metadata documentation, and robust physical strategies—such as indexing and replication—to ensure system resilience and data reliability.

3) For Researchers:

There is a need for empirical studies that quantitatively measure database design variables and examine their mediating effects through data quality and system performance.

3. RESEARCH METHOD

This study adopts a quantitative approach because it aims to examine the causal relationship between database design and the success of regional information systems through numerical measurement and statistical analysis. This approach was selected to obtain objective, measurable, and generalizable empirical evidence. In addition, the study is complemented by brief interviews discussed in the discussion section to explore the technical context of database design implementation in local government institutions. Therefore, this research can be classified as quantitative research with supporting qualitative data (explanatory). Explanatory research is intended to test the influence among variables through the development of a structural model.

The research design employs a survey method, in which data are collected through questionnaires distributed to respondents involved in managing Regional Information Systems. The survey covers aspects such as database design quality, system accessibility and usability, data accuracy and security, integration between system modules, information processing speed, as well as user satisfaction and performance effectiveness in supporting decision-making within Regional Government Agencies (OPD). The findings of this study are expected to contribute academically to the development of public administration knowledge and to serve as a reference for local governments in formulating policies to improve the performance of government officials at the sub-district level (Siregar, 2011).

A. Types and Sources of Data

1) Types of Data

The types of data used in this study include:

- Primary data, obtained directly from research respondents, namely users of the Regional Information System.
- Secondary data, consisting of supporting information obtained from documents, reports, and relevant literature.

2) Data Sources

a) Primary Data Sources

Primary data were collected from:

- Civil servants (ASN) who use the Regional Information System,
- System operators,
- Database and information system administrators.

b) Secondary Data Sources

Secondary data were obtained from:

- Policy documents related to Regional Information System management,
- Performance reports of Local Government Organizations (OPD),
- System manuals and database documentation,
- Scientific journals, books, and relevant prior research (Kuantitatif, 2016).

B. Data Collection Techniques

1) Questionnaire

Primary data collection was conducted using a closed-ended questionnaire with a five-point Likert scale (1–5), distributed to Regional Information System users (Hair, 2010).

The Database Design variable (X) was measured using the following indicators:

- Table structure and relationships,
- Data normalization,
- Data integrity and consistency,
- Database security,
- Ease of database maintenance.

The Regional Information System Success variable (Y) was measured using the following indicators:

- Information quality,
- System quality,
- User satisfaction,
- System usage intensity,
- Impact on organizational performance.

2) Limited Interviews
Structured interviews were conducted with:

- Database administrators,
- Regional Information System managers, to obtain in-depth insights into database design implementation and the technical challenges encountered.

3) Documentation
Documentation techniques were used to collect data in the form of:

- Database structures,
- Entity Relationship Diagrams (ERD),
- System usage reports,
- Archives and other supporting documents.

C. Data Analysis Techniques

1) Instrument Testing
Prior to the main analysis, the research instruments were tested through:

- Validity testing, to assess the accuracy of questionnaire items,
- Reliability testing, to measure instrument consistency.

All tests were conducted using SPSS software.

2) Descriptive Analysis
Descriptive analysis was employed to describe:

- Respondent characteristics,
- Respondents' perceptions of database design,
- The level of success of the Regional Information System.

3) Inferential Analysis
Inferential analysis was conducted to test the research hypotheses, including:

a) Simple linear regression analysis, to examine the effect of database design on the success of the Regional Information System.
b) t-test (partial test), to assess the significance of the effect of database design on RIS success.
c) Coefficient of determination (R^2), to determine the extent to which database design explains the success of the Regional Information System (Ghozali, 2018).

D. Research Hypotheses

The hypotheses tested in this study are as follows:

- H_1: Database design has a positive and significant effect on the success of the Regional Information System.
- H_0: Database design has no significant effect on the success of the Regional Information System.

E. Presentation and Reporting of Research Results

The research results are presented in the form of:

- Tables,
- Figures,
- Systematic narrative interpretations,

and are reported in accordance with academic writing standards to support the study's conclusions and recommendations (Khosla, 2021).

4. RESULTS AND DISCUSSION

Database design is widely recognized as a fundamental element in information system architecture. Consequently, every technical aspect—such as normalization, table structures, relationships, indexing, metadata, referential integrity, and storage strategies—plays a significant role in shaping information quality and overall system performance. Importance–Performance Analysis (IPA) is one of the commonly used approaches for evaluating information system quality by comparing the level of importance and performance of various service attributes. In the context of Academic Information Systems, evaluated attributes typically include ease of use, access speed, information accuracy, system reliability, and the quality of supporting services (Emanuel & Setiawan, 2020).

The relationships among variables indicate that database design is not merely an isolated technical factor, but rather functions as an enabler, driver, and quality assurance mechanism that influences key aspects

of regional information systems. Layered effects can be observed, whereby effective database design leads to stronger data quality; improved data quality subsequently enhances the quality of information received by users and the system's ability to generate accurate, timely, and consistent reports. Ultimately, these processes contribute to overall system success, as reflected in user satisfaction, work efficiency, transparency, and improved decision-making within local government environments.

A. The Importance of Proper Database Structure

Effective database design begins with conceptual modeling that aligns with business process requirements. In the context of regional information systems, these business processes include budgeting, planning, regional asset management, population administration, regional finance, licensing, education, and healthcare services. Integrated regional systems require databases capable of handling complex, cross-sectoral data structures.

When database structures are designed in accordance with normalization principles and accurate mappings among entities, attributes, and relationships, systems become easier to develop, maintain, and enhance. Conversely, weak database design results in numerous anomalies, such as data redundancy, information duplication, and inadequate integrity controls, which ultimately disrupt information flows and reduce the accuracy of regional government performance reports. Through systematic data management mechanisms—such as the use of primary keys, inter-table relationships, and integrity constraints—databases can minimize redundancy and data errors. This is essential to ensure that information presented to management is reliable and can be used as a basis for organizational planning and control (Syahputri & Nasution, 2023).

B. Normalization as a Mechanism for Maintaining Integrity

Normalization ensures that data are grouped logically, non-duplicative, and free from update anomalies. In the context of local government, proper normalization can prevent data inconsistencies across different Regional Government Agencies (OPD). This is particularly important because each OPD typically operates distinct systems while remaining interconnected at the data level.

Without normalization, financial, asset, or planning reports may present different figures even though they originate from the same data source. Such inconsistencies undermine the quality of public services, decision-making processes, and government accountability. The implementation of electronic-based government systems (SPBE), the integration of regional information systems, and the utilization of digital data can accelerate public service delivery and enhance the quality of decision-making when supported by proper database normalization (Zein, 2024).

C. Index Utilization and Query Optimization

Indexes function to accelerate data access and reduce system load. Regional information systems that handle thousands or even millions of transactions daily depend heavily on well-designed indexing strategies. Poorly designed indexes can slow application response times, leading to processing failures, user dissatisfaction, and declining trust in the system.

Query optimization is also a critical factor. Inefficient queries can overload servers, particularly when generating large-scale reports periodically. The performance of financial and budgetary reports may decline significantly if queries are not optimized, even when database structures are well designed. Asset management information systems, therefore, not only facilitate record-keeping but also support transparent financial reporting, error minimization, and managerial decision-making (Siswati, 2015).

D. Metadata and Schema Documentation

Metadata provide comprehensive descriptions of stored data, including table definitions, column attributes, data types, relationships, and integrity rules. Complete metadata documentation ensures that systems can be maintained and developed by different teams over time. In local government environments, where IT staff turnover tends to be relatively high, thorough metadata documentation is critically important. Without clear documentation, system maintenance and enhancement efforts risk introducing schema errors or data inconsistencies with potentially severe operational consequences (Ashari).

E. Data Quality Variables

1) Accuracy and Consistency as Direct Outcomes of Database Design

Data quality is a direct reflection of database design quality. When database structures and integrity mechanisms are properly maintained, the resulting data tend to be more accurate and consistent. This is especially crucial in the public sector, which demands high levels of accountability and precision in reporting budgets, assets, and population data. Inaccurate asset data, for example, may lead to incorrect valuations and potential financial losses, while inconsistent population data can disrupt administrative services, social assistance distribution, and development planning.

2) Data Completeness and Timeliness

Effective database design ensures that critical data fields are not left incomplete and that validation mechanisms support data completeness. Timeliness is also closely related to how databases manage updates

and synchronization across organizational units. In regional information systems, delayed updates can cause significant discrepancies between actual conditions and system records, thereby affecting the validity of performance reports, budget formulation, and public service delivery.

3) System Responsiveness

Optimal database design contributes significantly to system responsiveness. Users are generally more satisfied when systems operate quickly, stably, and without interruptions. Conversely, slow regional information systems can hinder administrative workflows, prolong service delivery times, and reduce employee productivity.

4) System Reliability and Availability

System reliability refers to a system's ability to function consistently according to established standards without disruption. Professionally designed databases are capable of handling heavy workloads while maintaining stable performance. System availability is equally critical, as many government services are time-sensitive. Planning applications, reporting systems, and financial platforms must remain accessible at all times, particularly during critical periods such as regional budget formulation (Elmasri, 2014).

F. Success of Regional Information Systems

1) User Satisfaction

User satisfaction is a key indicator of information system success. Users tend to be more satisfied when systems operate smoothly, data are accurate, and work processes become more efficient. In this regard, system success is strongly influenced by user experiences, which are directly shaped by database design quality.

2) Data-Driven Decision-Making

Well-structured and high-quality databases generate reliable information that supports data-driven decision-making. Local governments require accurate and up-to-date data to determine development priorities, adjust policies, and allocate budgets effectively.

3) Transparency and Accountability

Regional information systems function as instruments of public transparency. Databases that enforce data integrity are better able to provide accurate and accountable information, thereby supporting principles of openness and government accountability (Ghinaldi, 2025).

G. Mechanisms of Inter-Variable Influence

1) Influence of Database Design

Database design determines how data are stored, related, and maintained. Clear and validated structures produce accurate and consistent data.

2) Influence of Physical Database Architecture

Physical database architectures—such as indexing, partitioning, and replication—directly affect system performance and scalability.

3) Influence of Data Quality

High-quality data enhance system effectiveness by ensuring that the information produced meets user needs.

4) Influence of System Quality

Fast, stable, and reliable systems increase user satisfaction and encourage continuous system use, thereby reinforcing overall system success (Sari, 2025).

5. CONCLUSION

This study concludes that database structure design aligned with the operational needs of local governments is a key determinant of data quality. When databases are developed with appropriate standardization, data errors such as redundancy, inconsistency, and missing values can be significantly minimized. Conversely, poorly designed databases are difficult to maintain, prone to frequent errors, and hinder integration across regional applications. Effective database design has been empirically shown to enhance system quality, including processing speed, application stability, inter-organizational integration, and ease of maintenance.

Well-organized and clearly defined data structures enable users to perform information retrieval, data entry, and mandatory regional reporting more efficiently. The success of regional information systems is further strengthened through improvements in the reliability of the information produced. When databases are properly designed, systems are able to generate reports that are more credible, transparent, and aligned with the decision-making needs of OPD leadership and local governments. Financial reports, planning documents, population data, and public service information can be accessed more quickly and accurately, thereby reinforcing accountability and promoting good governance.

Based on the findings of this study regarding the impact of database design on the success of regional information systems, it is recommended that local governments and relevant agencies prioritize database design

quality as the primary foundation for information system development and management. A well-structured database design that aligns with organizational needs is expected to enhance data accuracy, consistency, and security, thereby enabling information systems to operate effectively and efficiently in supporting administrative processes and decision-making.

In addition, regular database evaluation and maintenance are essential to accommodate evolving information requirements and changes in regional policies. These efforts include updating data structures and strengthening information security mechanisms. Enhancing human resource competencies—particularly among system administrators and information system developers—should also be emphasized through continuous training programs to ensure databases are managed optimally and professionally. Furthermore, strong managerial support and the availability of adequate information technology infrastructure are expected to reinforce the comprehensive implementation of regional information systems. For future researchers, this study may be extended by incorporating additional variables such as data quality, user satisfaction, and organizational support, thereby providing a more comprehensive understanding of the factors influencing the success of regional information systems.

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