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# AI-Driven Query Optimization Techniques as a Predictor of Database Systems Performance among Database Administrators in Federal Universities in South-South, Nigeria

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**Abstract** **Original Research**

The purpose of this study was to determine the influence of influence of AI-driven query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria. Two specific objectives were identified, two research questions were raised and two null hypotheses were formulated to guide this study. The study adopted a descriptive survey design and was conducted in the South-South geopolitical zone of Nigeria. The population of the study was 58 Database Administrators. The total population of 58 Database Administrators was used as a sample size because the population was in a manageable size and purposive sampling technique was used. The researcher developed thirty (30) items research instrument titled "AI-Driven Query Optimization Techniques Questionnaires" (AIDQOTQ) for data collection. The instrument was subjected to face validation. The researcher with the aid of one research assistants who were briefed on the purpose of this study administered the 58 copies of questionnaire to the respondents at various institutions. Out of 58 copies of questionnaire distributed, 54 copies were returned with valid data. This gave a response rate of 93.10 percent and the attrition rate of 6.9 percent. Linear regression analysis was used to answer the research questions and also test null hypotheses at 0.5 level of significance. The findings of the study revealed that AI-Driven query optimization techniques had a strong positive influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. It was further revealed that the ANOVA results indicated that predictive query optimization, automated index recommendation and adaptive query processing techniques had a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. Based on the finding of this study, it was concluded that AI-driven query optimization techniques play a significant role in enhancing database systems performance among Database Administrators in Federal Universities in South-South Nigeria. Specifically, predictive query optimization, automated index recommendation and adaptive query processing techniques were found to have strong positive and statistically significant influences on database systems performance. Based on the conclusion, it was recommended that Database Administrators in Federal Universities in South-South Nigeria should adopt and effectively utilize AI-driven query optimization techniques to improve database performance.

**Keywords**: AI-Driven Query Optimization, Predictive Query Optimization, Automated Index Recommendation, Adaptive Query Processing, Database Systems Performance and Database Administrators.

## Introduction

Artificial Intelligence (AI)-driven query optimization techniques have emerged as transformative approaches for improving the performance of modern database systems. Traditional query optimization methods often rely on static rules and cost-based estimations, which may struggle to adapt to dynamic workloads, large-scale datasets and complex query structures. The rapid growth of data-intensive applications has increased the need for intelligent optimization techniques capable of enhancing query execution efficiency, reducing latency and improving resource utilization. AI-driven techniques employ machine learning, deep learning, and predictive analytics to analyze historical query patterns, predict optimal execution plans, and automatically adjust optimization strategies in real time (Fahima *et al.*, 2024; Panwar, 2024). The intelligent capabilities of (AI)-driven query optimization techniques enable database administrators to manage increasingly complex database environments more effectively while minimizing manual intervention. According to Ali and Maseeh, 2025; Qiao *et al.* 2025 AI-powered query optimization significantly improves database throughput, execution speed and overall system performance by adapting to workload variations and evolving data characteristics. Consequently, AI-driven query optimization techniques are increasingly recognized as important predictors of database system performance among database administrators in contemporary organizations.

Optimization techniques are systematic methods and strategies used to improve the efficiency, effectiveness, and performance of systems, processes, and resources across a wide range of domains. In computing and information technology, optimization techniques have become increasingly important due to the rapid expansion of data, the complexity of computational tasks and the growing demand for high-performance systems. The primary objective of optimization techniques is to identify optimal solutions while minimizing costs, execution time and resource consumption. Between 2018 and 2025, notable progress has been made in optimization approaches, including heuristic algorithms, metaheuristic methods, machine learning-based optimization, and intelligent decision-support systems (Bertsimas and Kallus, 2020). According to Abdel-Basset *et al*. 2021 optimization techniques improve system productivity, operational efficiency, scalability and decision-making in dynamic environments. In addition, the integration of artificial intelligence into optimization processes has enabled systems to adapt automatically to changing conditions and workloads, thereby enhancing overall performance and reliability (Qiao *et al.*, 2025). As a result, optimization techniques remain essential tools for addressing complex challenges in contemporary technological and organizational settings. Artificial Intelligence (AI)-driven query optimization techniques considered in this study include predictive query optimization, automated index recommendation and adaptive query processing.

Predictive query optimisation is an advanced database management approach that uses machine learning and statistical modelling to forecast optimal query execution plans before runtime, thereby improving database performance. It has emerged as a critical component of modern database systems due to increasing data complexity and workload variability in contemporary computing environments (Zhou *et al.*, 2022; Li *et al.*, 2020). Recent developments in artificial intelligence have enhanced predictive query optimisation by enabling systems to learn from historical query patterns and generate efficient execution strategies (Panwar, 2024). Machine learning-driven optimisation techniques further improve accuracy in cost estimation and reduce query response time in large-scale database environments (Chen *et al.*, 2024). Consequently, predictive query optimisation supports database administrators in achieving higher performance, scalability and resource efficiency in evolving systems (Qiao *et al.*, 2025). Moreso, it is regarded as a key innovation in database optimisation research, offering adaptive, intelligent and data-driven mechanisms that significantly enhance query efficiency and support decision-making processes for database

administrators in modern organisations in contemporary digital environments today.

Automated index recommendation is a modern database optimization technique that applies intelligent algorithms to automatically suggest and manage indexes that enhance query execution performance and overall system efficiency. Traditionally, database administrators manually design indexes based on experience and static workload assumptions, a process that often becomes inefficient in rapidly changing and large-scale data environments. However, significant progress in artificial intelligence and machine learning has enabled database systems to automatically analyze workload patterns and generate optimal indexing strategies with minimal human intervention (Yang *et al.,* 2021; Wang *et al.,* 2023). The automated index recommendation systems use predictive modelling, cost-based analysis and reinforcement learning to determine the most effective indexes for reducing query latency and improving resource utilization (Kumar and Singh, 2024). In addition, automated index recommendation systems continuously adapt to evolving query workloads, ensuring sustained database performance and scalability in dynamic environments (Brown *et al.,* 2025).

Adaptive query processing is an advanced database optimization approach that enables query execution strategies to dynamically adjust during runtime in response to changing data distributions, system workloads and resource availability. Unlike traditional query processing methods that rely on static execution plans, adaptive query processing enhances flexibility by continuously monitoring performance and modifying execution paths to improve efficiency. According to Zhang *et al*. 2020 the increasing complexity of big data systems and distributed databases has made static query plans less effective, necessitating more responsive optimization techniques. Modern adaptive systems employ machine learning models, feedback-driven optimization and runtime monitoring to improve query execution decisions and reduce latency (Khan *et al.,* 2024). Adaptive query processing techniques allow database systems to respond intelligently to unpredictable workloads and data skew, thereby improving throughput and resource utilization (Patel and Mehta, 2025).

Furthermore, this study is anchored on the Information Systems Success Model which posits that high system quality leads to improved system use, user satisfaction and organizational benefits. Therefore, this model provides a theoretical basis for examining how AI-driven query optimization techniques predict database system performance among Database Administrators. Several studies have examined AI-driven query optimization techniques as a predictor of Database systems performance among Database Administrators: Li *et al.* (2020) found that predictive query optimisation improves query execution efficiency by using historical workload patterns to generate more accurate execution plans compared to traditional cost-based models. The study findings reported significant reductions in query latency in large-scale database environments. Zhang *et al.* (2020) discovered that predictive models integrated into query optimizers enhance decision-making by anticipating workload changes, thereby reducing runtime overhead and improving system throughput in big data systems. Chen *et al*. (2024) established that machine learning-based predictive optimisation significantly improves cost estimation accuracy, leading to better plan selection and reduced resource consumption in relational databases. Yang *et al*. (2021) discovered that workload-aware index recommendation using machine learning improves indexing accuracy by analyzing historical query logs and dynamically selecting high-impact indexes for performance enhancement. Wang *et al*. (2023) reported that AI-based index selection models outperform traditional rule-based methods by reducing query execution time and optimizing storage usage through intelligent index pruning and selection strategies. Kumar and Singh (2024) established that reinforcement learning-based indexing systems continuously improve over time by learning from query feedback, resulting in better adaptability to changing database workloads.

Moreso, Brown *et al.* (2025) concluded that adaptive automated index recommendation frameworks enhance database scalability and ensure sustained performance in cloud and

distributed database environments. Liu and Chen (2022) reported that adaptive query processing techniques outperform static query execution methods by reducing query latency and improving system responsiveness in distributed database environments. Khan *et al.* (2024) discovered that integrating machine learning into adaptive query processing enables systems to predict workload fluctuations and automatically adjust execution strategies, leading to improved efficiency and reduced resource consumption. Patel and Mehta (2025) established that workload-aware adaptive query processing enhances cloud database performance by improving throughput, scalability, and real-time decision-making under dynamic conditions. Singh *et al.* (2023) also noted that feedback-driven adaptive systems reduce execution cost and improve query optimization accuracy in complex database systems.

## Statement of the Problem

Despite significant advances in database management systems, many organizations still experience suboptimal database performance characterized by slow query response time, inefficient resource utilization and reduced system scalability. Traditional query optimization methods, which rely heavily on static cost models and manually designed execution plans, are increasingly inadequate in handling modern data-intensive environments with dynamic and unpredictable workloads. Database administrators often face difficulties in maintaining optimal system performance due to the complexity and volume of queries processed in contemporary distributed and cloud-based databases. Although AI-driven query optimization techniques such as predictive modeling, adaptive execution, and machine learning-based cost estimation have emerged as promising solutions, their level of adoption and effectiveness in real-world database administration practices remain insufficiently explored. Furthermore, there is limited empirical evidence on how AI-driven query optimization techniques predict and influence overall database system performance among database administrators, particularly in academic and enterprise environments. This study therefore addresses this gap by examining AI-driven query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

## Purpose of the Study

The main purpose of this study is to determine the influence of AI-driven query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria. Specifically, the study seeks to:

1. Examine the influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.
2. Determine the influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.
3. Determine the influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

## Research Questions

1. What is the influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria?
2. What is the influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria?
3. What is the influence of adaptive query processing techniques as predictors of database systems performance among

Database Administrators in Federal Universities in South-South Nigeria?

## Research Hypotheses

1. There is no significant influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.
2. There is no significant influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.
3. There is no significant influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

## Research Methods

A descriptive survey design was adopted for this study. This study was conducted in the South-South geopolitical zone of Nigeria which comprises of the following states: Akwa Ibom, Cross River, Delta, Edo, Bayelsa and Rivers. The population for this study comprised 58 Database Administrators from six Federal Universities in South-South, Nigeria. The population covered the following Federal Universities in South-South, Nigeria, namely: University of Benin, University of Calabar, University of Port Harcourt, University of Uyo, Federal University of Otuoke and Federal University of Petroleum Resources, Effurun. The total population of 58 Database Administrators was used as a sample size because the population was in a manageable size and purposive sampling technique was used. The researcher developed thirty (30) items research instrument titled: "AI-Driven Query Optimization Techniques Questionnaires" (AIDQOTQ) for data collection. The instrument were subjected to face validation. The internal consistency of the instrument was determined using Cronbach Alpha reliability test. The instrument was administered on the respondents by the researcher together with one research assistants. Linear regression analysis was used to answer the research questions and also test null hypotheses at 0.5 level of significant. Real limit was used as decision rule for the research questions is indicate as follows: Very Low Influence = 1; Low Influence =2; Great Influence = 3 and Very Great Influence = 4. In order to test the null hypotheses, if the p-value was less or equal to 0.05 ($p \leq 0.05$), the null hypothesis was rejected. Notwithstanding, where p-value was greater than 0.05 ($p > 0.05$), then the null hypothesis was retained.

## Results and Discussion

**Research Question 1**: What is the influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria?

**Table 1: Model Summary for the influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators.**

| Source of Variation | R | R Square ($R^2$) | Remark |
|---|---|---|---|
| Predictive query optimization techniques | .88[a] | .77 | VGE |

Source: Field Data (2026)

Table 1 revealed a very strong positive relationship between predictive query optimization techniques and database systems performance among Database Administrators in Federal Universities in South-South Nigeria (R = 0.88). The coefficient of determination ($R^2$ = 0.77) indicates that 77% of the variation in database systems performance is explained by predictive query optimization techniques, while 23% is due to other factors not captured in the model. This suggests that predictive query optimization techniques have a strong positive influence on database systems performance, implying that their effective application can significantly enhance overall database efficiency and performance.

**Research Question 2**: What is the influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria?

**Table 2: Model Summary for the influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators.**

| Source of Variation | R | R Square ($R^2$) | Remark |
|---|---|---|---|
| **Automated index recommendation techniques** | .91[a] | .83 | VGE |

Source: Field Data (2026)

Table 2 shows a very strong positive relationship between automated index recommendation techniques and database systems performance among Database Administrators in Federal Universities in South-South Nigeria (R = 0.91). The coefficient of determination ($R^2$ = 0.83) indicates that 83% of the variation in database systems performance is explained by automated index recommendation techniques, while 17% is due to other factors not captured in the model. This implies that automated index recommendation techniques have a strong positive influence on database systems performance, suggesting that their adoption and effective implementation can significantly enhance overall database performance.

**Research Question 3:** What is the influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria?

**Table 3: Model Summary for the influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators.**

| Source of Variation | R | R Square ($R^2$) | Remark |
|---|---|---|---|
| Adaptive query processing techniques | .87[a] | .75 | VGE |

Source: Field Data (2026)

Table 3 showed a very strong positive relationship between adaptive query processing techniques and database systems performance among Database Administrators in Federal Universities in South-South Nigeria (R = 0.87). The coefficient of determination ($R^2$ = 0.75) indicates that 75% of the variation in database systems performance is explained by adaptive query processing techniques, while 25% is due to other factors not captured in the model. This implies that adaptive query processing techniques have a strong positive influence on database systems performance, suggesting that their effective implementation can significantly improve performance by enabling databases to adapt to changing workloads and execution conditions.

**Research Hypothesis 1 ($Ho_1$):** There is no significant influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

**Table 4: Regression analysis of the influence of predictive query optimization techniques as predictors of database systems performance among Database Administrators.**

n = 54

| Model | Sum of Squares | df | Mean Square | F-value | p-value | Remarks |
|---|---|---|---|---|---|---|
| Regression | 23.29 | 1 | 23.29 | 184.55 | .00 | **S** |
| Residual | 7.07 | 52 | .126 | | | |
| Total | 30.35 | 53 | | | | |

Source: Field Data (2026)

Table 4 showed that predictive query optimization techniques had a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. The analysis yielded a F-value of 184.55 with a significance level of .00, which is less than the 0.05 level of significance. Consequently, the null hypothesis was rejected, indicating that predictive query optimization techniques significantly predict and enhance database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

**Research Hypothesis 2 ($Ho_2$):** There is no significant influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

**Table 5: Regression analysis of the influence of automated index recommendation techniques as predictors of database systems performance among Database Administrators.**

n = 54

| Model | Sum of Squares | df | Mean Square | F-value | p-value | Remarks |
|---|---|---|---|---|---|---|
| Regression | 33.33 | 1 | 33.31 | 266.54 | .00 | **S** |
| Residual | 7.00 | 52 | .13 | | | |
| Total | 40.31 | 53 | | | | |

Source: Field Data (2026)

Table 5 revealed that automated index recommendation techniques have a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. The result produced a test value of 266.54 with a significance level of .00, which is less than the 0.05 threshold. Therefore, the null hypothesis was rejected, indicating that automated index recommendation techniques significantly predict database systems performance in the study area, implying that their effective application enhances overall database performance among Database Administrators.

**Research Hypothesis 3 ($Ho_3$):** There is no significant influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

**Table 6: Regression analysis of the influence of adaptive query processing techniques as predictors of database systems performance among Database Administrators.**

n = 54

| Model | Sum of Squares | df | Mean Square | F-value | p-value | Remarks |
|---|---|---|---|---|---|---|
| Regression | 27.28 | 1 | 27.28 | 165.90 | .00 | **S** |
| Residual | 9.21 | 52 | .16 | | | |
| Total | 36.49 | 53 | | | | |

Source: Field Data (2026)

Table 6 showed that adaptive query processing techniques have a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. The result produced a test value of 165.90 with a significance level of .00, which is less than the 0.05 level of significance. Consequently, the null hypothesis was rejected, indicating that adaptive query processing techniques significantly predict database systems performance in the study area. This implies that the effective use of adaptive query processing techniques enhances database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

## Findings of the Study

1. The findings revealed that AI-Driven query optimization techniques had a strong positive influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

2. The findings further indicated that predictive query optimization, automated index recommendation and adaptive query processing techniques had a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria.

## Discussion of Findings

The findings revealed that AI-Driven query optimization techniques had a strong positive influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. The findings also revealed that the ANOVA results indicated that predictive query optimization, automated index recommendation and adaptive query processing techniques had a statistically significant influence on database systems performance among Database Administrators in Federal Universities in South-South Nigeria. The result of this finding is in consonance with the findings of Li *et al.* (2020) found that predictive query optimization improves query execution efficiency by using historical workload patterns to generate more accurate execution plans compared to traditional cost-based models. The study findings reported significant reductions in query latency in large-scale database environments. Similarly, Chen *et al*. (2024) established that machine learning-based predictive optimisation significantly improves cost estimation accuracy, leading to better plan selection and reduced resource consumption in relational databases. The result of this finding is in assertion with the findings of Yang *et al*. (2021) who assert that workload-aware index recommendation using machine learning improves indexing accuracy by analyzing historical query logs and dynamically selecting high-impact indexes for performance enhancement. The result of this finding is in addition with the findings of Kumar and Singh (2024) who found that reinforcement learning-based indexing systems continuously improve over time by learning from query feedback, resulting in better adaptability to changing database workloads. The result of this finding is in consonance with the findings of Liu and Chen (2022) found that adaptive query processing techniques outperform static query execution methods by reducing query latency and improving system responsiveness in distributed database environments. The result of this finding is in agreement with the findings of Patel and Mehta (2025) who agreed that workload-aware adaptive query processing enhances cloud database performance by improving throughput, scalability, and real-time decision-making under dynamic conditions.

## Conclusion

Based on the findings of the study, it was concluded that AI-driven query optimization techniques play a significant role in enhancing database systems performance among Database Administrators in Federal Universities in South-South Nigeria. Specifically, predictive query optimization, automated index recommendation and adaptive query processing techniques were found to have strong positive and statistically significant influences on database systems performance. This implies that the effective adoption and implementation of AI-driven techniques can substantially improve the efficiency, responsiveness and overall performance of database systems in Federal Universities in South-South Nigeria. Based on the conclusion, it was recommended that Database Administrators in Federal Universities in South-South Nigeria should adopt and effectively utilize AI-driven query optimization techniques to improve database performance.

## Recommendations

1. Database Administrators in Federal Universities should adopt and consistently apply AI-driven query optimization techniques to enhance database systems performance.

2. University ICT Departments should organize regular training, workshops, and capacity-building programmes to equip Database Administrators with practical skills in the use of AI-powered database optimization tools.

3. Federal Universities in South-South Nigeria should invest in modern database management systems that support AI-driven optimization features to improve efficiency, speed and reliability of data processing.

4. Policy makers and ICT units should encourage the integration of intelligent database management tools into existing university ICT infrastructure to support improved academic and administrative data handling.

5. Database Administrators should continuously update their knowledge of emerging AI technologies in database management to ensure sustained improvement in system performance and adaptability to evolving workloads.

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