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Data mining as a tool for detecting anomalies and patterns in the internal audit processes of medium-sized Venezuelan enterprises

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Abstract

This study aims to analyze how data mining can be applied to detect anomalies and patterns within the internal audit processes of medium-sized Venezuelan enterprises. The research is descriptive in nature and follows a qualitative, phenomenological–interpretive approach. Data were collected through semi-structured interviews with experts in internal audit departments from selected Venezuelan entities, all of whom possessed specialized knowledge in data mining techniques. The results indicate that data mining optimizes internal audit processes by enabling the automation of operational tasks, reducing the time required to detect irregularities, and strengthening risk management. The study also found that implementing continuous auditing facilitates the early detection of deviations while significantly reducing the operational burden on auditors. Data mining's capacity to analyze large volumes of data and uncover hidden patterns aligns with established theoretical evidence. However, successful implementation in the Venezuelan context faces organizational challenges, including resistance to change, financial limitations, and a gap in specialized technical skills. The findings highlight the urgent need for organizations to invest in both technology and specialized training in advanced analytical tools—such as Power BI, SQL, and ACL—to ensure a more effective and modern internal audit framework.

Keywords: Anomalies and patterns, Data mining, Internal audit, Medium-sized enterprises, SDG 8, SDG 9.

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Institutional Review Board Statement: The authors declare that this research was conducted in accordance with international ethical standards for research involving human subjects. Given that the home institution does not currently have a formal Institutional Review Board (IRB), the researchers assumed full responsibility for ensuring ethical compliance. All participants were fully informed about the nature and purpose of the study, and voluntary informed consent was obtained prior to the interviews. Furthermore, the anonymity of the key informants (IC1 and IC2) and the confidentiality of the institutional data were strictly maintained throughout the entire research process.
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1. Introduction

Economic and commercial entities—large, medium, or small—share a fundamental objective: value creation. This occurs when people share a common vision, align their interests, and ensure that their actions are directed toward clearly defined goals. Regardless of size, profit-oriented organizations seek to maximize revenue and profitability by delivering products and services in competitive markets. In this context, the information society has increased the demand for faster, more effective, and more efficient methods to extract, transform, and distribute organizational data into actionable information across the value chain, thereby improving overall management performance [1].

Many functional areas in these organizations remain tied to traditional structures. These areas face significant challenges in meeting organizational objectives, and internal audit is no exception. The audit function plays a critical role in identifying anomalies and patterns in financial operations. As a core element of performance across industries, internal auditing provides an objective assessment of operations and outcomes, enabling corrective actions that strengthen governance, risk management, and control processes. Estupiñán Gaitán [2] describes internal auditing as an independent and objective activity focused on evaluation and advisory services, aimed at enhancing organizational value and improving operations. In turn, internal auditing helps the entity achieve its objectives by applying a systematic and disciplined approach to assess and enhance the effectiveness of risk management, control, and governance processes.

The practice of auditing has evolved in parallel with Information and Communication Technologies (ICTs). Within this context, data mining (DM)—utilizing statistical methods and machine learning—allows enterprises to analyze vast datasets and uncover patterns that would otherwise remain hidden. This digital transformation has forced a paradigm shift toward "Audit 4.0," moving from retrospective sampling toward proactive monitoring. While classical definitions describe DM as the extraction of non-obvious patterns, recent studies emphasize its role in real-time risk mitigation [3]. This allows auditors to shift from mere compliance to value-added analysis, identifying significant deviations that traditional methods overlook [4].

From this perspective, DM serves as a vital tool for the early detection of irregularities. As noted in Jiménez and Álvarez [5] DM permits the discovery of potentially useful information from large quantities of data. This capacity is reinforced by advances in database engines and information integration. By uncovering meaningful relationships, technological tools have transformed data analysis through innovative and specialized techniques [1] and are supported by mature methodologies in artificial intelligence and statistics [6]. As Gibert Oliveras, et al. [7] observe, DM has demonstrated the validity of algorithms through real-world applications.

Within internal auditing, DM aligns with Sustainable Development Goal 8 (SDG 8) by optimizing anomaly detection and enhancing corporate transparency. Its efficiency relieves auditors of repetitive tasks, allowing a focus on strategic analysis and the development of specialized human capital, essential for the growth of medium-sized Venezuelan enterprises. Simultaneously, integrating DM aligns with SDG 9 (Industry, Innovation, and Infrastructure), modernizing internal control systems and accelerating digital transformation in Venezuela.

This framework addresses the central research question: How can data mining be implemented in the internal audit functions of medium-sized Venezuelan enterprises to improve efficiency in detecting financial and operational irregularities? Consequently, this study aims to: i) describe the advantages of DM for internal audit; ii) identify applicable DM mechanisms for Venezuelan enterprises; and iii) determine implementation options for these departments.

1.1. Data Mining in Internal Audit: An Innovative Paradigm

Traditionally focused on strengthening internal controls, internal auditing has been reshaped by emerging technologies. Han, et al. [8] define DM as the process of discovering valid and novel patterns in large datasets. This enables auditors to analyze massive volumes of information, facilitating the identification of fraudulent activities, such as payments to fictitious suppliers [9].

Anomaly detection remains a primary challenge in high-volume transactional environments. As noted by Ngai, et al. [10] modern organizational data requires advanced analytical techniques to uncover hidden associations. Recent research Zhang and Wang [11] demonstrates that unsupervised learning algorithms, such as clustering, are particularly effective for fraud detection in emerging markets, providing a robust framework for identifying risks that threaten financial integrity.

Beyond fraud detection, DM supports proactive risk identification by analyzing historical data to signal potential adverse events. In this regard, the application of anomaly detection techniques is fundamental, as it allows for the discovery of patterns in complex datasets that deviate from normal behavior, such as cybersecurity vulnerabilities or unusual financial fluctuations [12]. Furthermore, DM significantly improves audit efficiency by automating repetitive and routine tasks. This automation enables auditors to focus on high-value strategic analysis while optimizing resources by systematically flagging high-risk transactions that require deeper investigation [13].

However, the successful implementation of these tools in internal audit departments involves addressing critical structural challenges. According to Tan, et al. [14] the quality of the data and the specialized training of the audit staff are essential factors; without a solid data foundation and the technical expertise to interpret algorithmic outputs, the potential of DM remains limited. Finally, given that DM processes require access to the organization's most sensitive information, ensuring data confidentiality and robust security protocols is an indispensable requirement for maintaining institutional integrity [15].

1.2. Pattern and Anomaly Detection as a Tool to Ensure Transparency in Organizational Operations

Transparency has become a critical requirement in the modern business environment, driven by the need to mitigate corporate scandals and enhance social accountability. In this context, detecting patterns in business data serves as a fundamental tool for identifying non-transparent practices and strengthening trust among stakeholders. By analyzing significant deviations from expected behavioral patterns, organizations can reveal hidden risks and irregularities that would otherwise remain undetected [16]. Specifically, pattern detection enables entities to identify financial trends that signal potential accounting irregularities by comparing current datasets with historical benchmarks, thereby facilitating early intervention [17].

Furthermore, anomaly analysis is essential for uncovering unusual events, such as unauthorized system access or suspicious transactional flows, which are often indicative of deeper systemic issues [12]. However, implementing such advanced detection systems is not merely a procedural change; it requires a robust technological infrastructure and the application of sophisticated machine learning algorithms to process large-scale data efficiently [18].

The impact of these tools extends beyond simple oversight. For medium-sized enterprises, this digital transformation modernizes internal control systems, fostering an environment where ethical conduct is reinforced by technological precision [19]. Ultimately, a transparent framework supported by data-driven insights not only prevents financial losses and improves operational efficiency but also builds a resilient culture of collaboration and trust [20]. From a broader economic perspective, these techniques facilitate informed decision-making and comprehensive market analysis, positioning the organization for long-term sustainability [21].

1.3. Data Mining and Its Fundamental Role in Business Operations

For medium-sized enterprises, DM has emerged as an essential tool for process optimization and strategic decision-making. As a non-trivial process focused on extracting actionable knowledge, it allows these entities to identify valid and interpretable patterns within their operational data [7]. In this context, anomaly detection is crucial for preventing financial losses and strengthening institutional security. By utilizing specialized algorithms, enterprises can apply machine learning to flag atypical data that may indicate underlying risks, although the ability to distinguish true anomalies from false positives remains a critical technical challenge [16].

The scope of DM extends beyond financial oversight into operational resilience. For instance, by analyzing IoT sensor data, organizations can identify potential system failures and predict maintenance needs before they occur, thereby reducing downtime and operational costs [9]. Furthermore, these techniques are increasingly applied to analyze customer behavior and macroeconomic trends. This allows firms to anticipate the effects of economic policies and financial risks while identifying patterns that signal potential customer attrition [20].

However, implementing DM in developing economies, particularly in Latin American firms, presents unique hurdles. Current research indicates that resistance to organizational change and a lack of specialized technical training are primary barriers to adoption [21]. Beyond financial investment, the effective use of tools such as SQL, Power BI, and ACL requires a strategic alignment to ensure data quality. Consequently, internal audit serves as a vital pillar in this ecosystem, providing constructive advisory support to management [22]. Ultimately, maintaining strong internal controls is essential for managing these technological risks and protecting company assets, ensuring the long-term sustainability of the enterprise [23].

1.4. The Importance of Internal Auditing for Medium-Sized Enterprises

Internal audit serves as a fundamental instrument for strengthening the operational framework of medium-sized enterprises. According to Monasterio and Martínez [21] its primary objective is to provide constructive advisory support to management, thereby enhancing oversight and economic performance. By implementing systematic internal audit processes, mid-sized companies can identify procedural weaknesses, mitigate the risk of fraud, and optimize resource allocation. A key advantage of this function is the reinforcement of internal control systems. As emphasized by Auditool [22] robust internal controls are essential for managing operational risks and safeguarding organizational assets. For

enterprises operating with limited resources, maintaining solid internal controls often represents the decisive factor for long-term sustainability.

Beyond risk mitigation, internal auditing drives the continuous improvement of business processes. By evaluating the efficiency of various operations, internal audits identify specific opportunities to reduce costs and enhance productivity. It is important to note that modern internal auditing is not limited to detecting non-compliance; it also serves as a catalyst for organizational excellence. Another critical dimension is the capacity of internal audits to build stakeholder confidence. By demonstrating that the entity possesses effective evaluation mechanisms, it fosters trust among investors, customers, and employees—an asset that is indispensable for growth in competitive markets.

From a strategic perspective, internal auditing constitutes a vital tool for the resilience of medium-sized enterprises. By integrating internal controls, process optimization, and risk mitigation, these audits contribute significantly to the overall success of the organization. Furthermore, the findings generated by an audit provide a factual basis for management to implement strategies that enhance financial oversight. Ultimately, these measures ensure that the enterprise remains agile and transparent, laying the groundwork for a more efficient industrial sector in the Venezuelan context.

2. Method

This study employs a descriptive-analytical approach [24] to examine the implementation of data mining (DM) within the internal audit functions of Venezuelan medium-sized enterprises. The research is framed under a qualitative, phenomenological-interpretive paradigm, emphasizing the collection and systematic analysis of expert perspectives to develop a comprehensive understanding of the phenomenon. The design is field-based and non-experimental, as the research objectives are addressed through information obtained directly from primary sources in their natural business environment, analyzed as they occur without deliberate manipulation.

The categorization process was utilized to organize the collected information systematically, presenting it in a conceptual form that is clear and intelligible to others. The first step involved reviewing the collected information to fully understand its significance. This initial analysis provided a broad overview and ensured alignment with the categorization process. Subsequent reviews were conducted to capture details that had been overlooked or insufficiently assessed. Finally, the most significant expressions were highlighted, and interpretive models were developed, from which categories and their respective attributes emerged (see Table 1).

Table 1.
Categorization process.

Research objectives	Group level	A Priori Categories
Describe the advantages of data mining in internal auditing.	Data mining	A1. Process optimization in auditing. A2. Improved detection of irregularities and risks
Identify the data mining mechanisms that can be applied within the internal audit of medium-sized enterprises in Venezuela.	Data mining mechanisms in internal auditing.	B1. Optimizing internal auditing through data mining. B2. Challenges and requirements for implementing data mining in internal auditing.
Determine the implementation options for data mining in the internal audit of Venezuelan medium-sized enterprises.	Implementation of data mining	C1. Resources required for implementing data mining. C2. Importance of applying data mining.

Following the principles of holistic research [25] the unit of analysis is defined as data mining, while the unit of observation consists of the internal audit departments of selected medium-sized enterprises. To define the scope of these organizations, the study adheres to the legal framework established in the Venezuelan "Ley para la Promoción y Desarrollo de la Pequeña y Mediana Industria" [26], which provides the parameters for categorizing enterprises based on their workforce and production capacity. Furthermore, the analysis considers the financial reporting standards for such entities as outlined in the "NIIF para las PYMES" [27].

Regarding data collection, structured (formal) interviews were utilized as the primary technique. This method, characterized by its depth, allows for a broad inquiry into the various factors contributing to the optimization of operational and financial processes. The instrument used was a pre-designed interview guide, which was applied to two key informants with extensive professional experience: the Manager of the Quality Management Audit Unit at Mercantil Banco Universal C.A. (IC1) and the Manager of the Internal Audit Department at Alimentos Polar, C.A. (IC2). The categorization process was then applied to condense the collected information into a conceptual form, ensuring the findings were systematic and intelligible, following established qualitative ethnographic methods [28].

3. Results

3.1. Advantages of Data Mining in Internal Auditing

Interviews with IC1 and IC2 confirmed that DM offers transformative benefits for fraud and anomaly detection. Their insights provided practical experiences, reflections, and evaluations relevant to the research.

3.2. Process Optimization in Auditing

Through the priori category A1, information was gathered from each informant's experience regarding their knowledge of data mining and how these tools could contribute to optimizing processes within internal audit departments. The responses reflected each expert's individual understanding and interpretation of the subject matter (see Table 2).

Table 2.
Process Optimization in Auditing.

IC	Expert's Perspective	Researchers' Observations
IC1	"Data mining improves audit efficiency by automating routine tasks and freeing auditors to focus on higher-value work. The use of continuous auditing enables ongoing monitoring of core transactional operations, allowing for early detection of deviations and generating real-time alerts. One of the key benefits is cost reduction: by identifying deviations early, organizations can take corrective action to reduce expenses before issues escalate into major problems."	An essential aspect of data mining is the need to define clear objectives before initiating the process. Clearly established goals guide the analysis and make it more effective. Yet the success of data mining also relies on the quality of the available data, the capability of analytical tools to detect patterns and anomalies within large data volumes, and the use of an appropriate methodology that ensures a comprehensive review.
IC2	"The most important thing when applying data mining is to have a clear objective, since that goal drives the entire process. It's essential to define exactly what you want to find within the data. Data mining enables the analysis of large data sets, helping identify patterns and anomalies more efficiently. Using an appropriate methodology for data processing ensures a more comprehensive analysis and leads to more precise, reliable conclusions."	

Data mining has emerged as a critical tool for enhancing internal audit workflows, enabling organizations to modernize their operations and address the growing complexity of financial activities. Both experts emphasized that DM has modernized operations by reducing time spent on repetitive tasks through platforms such as Power BI, SQL, and Python. This shift allows auditors to focus on strategic analysis. In large organizations, Continuous Auditing Solutions (SACs) provide real-time monitoring, strengthening the ability to respond immediately to deviations.

In large organizations, continuous auditing solutions (SACs) have been implemented to provide real-time monitoring of high-risk transactions. Both experts noted that these systems have strengthened the audit function's ability to respond immediately to anomalies. Furthermore, integrating audit teams with professionals skilled in mathematics, data science, and software development has been identified as a key enabler for effectively extracting, analyzing, and visualizing large datasets. Notably, this combination of capabilities—process automation and early anomaly detection—helps mitigate the financial impact of errors and fraud while driving organizational efficiency and competitiveness. The interviewees unanimously highlighted measurable cost savings as a tangible benefit that justifies continued investment in data-mining frameworks.

3.3. Enhancing the Detection of Irregularities and Risks

Under the a priori category A2, insights were collected from each key informant regarding how data mining can enhance the detection of audit irregularities and help mitigate risks identified through data analysis. The responses revealed each expert's distinct understanding and interpretation of the topic (see Table 3).

Table 3.
Enhancing the Detection of Irregularities and Risks.

IC	Expert's Perspective	Researchers' Observations
IC1	"Data mining has become a transformative force in auditing—not because business processes have grown simpler, but because traditional audit frameworks increasingly struggle to address today's complex and evolving risk environment. The key advantage of data mining lies in its ability to enhance audit efficiency: by automating routine tasks, it frees auditors to focus on higher-risk areas. This tool enables proactive detection, helping to identify unusual patterns or irregular processes early on—facilitating the recognition of potentially fraudulent activities. Furthermore, through continuous transaction monitoring, deviations from established parameters can be detected and timely alerts generated, thereby improving organizations' ability to manage risk more effectively"	Experts note that data mining enhances auditing by automating routine tasks and enabling auditors to focus on high-risk areas. It also allows for the proactive identification of atypical patterns and potential fraud—directly improving organizations' ability to detect and mitigate risks more efficiently. This is achieved through the early detection of irregularities, which shortens audit timelines and facilitates the analysis of large datasets.
IC2	"From my perspective, data mining is an extremely valuable tool for the internal audit department, as it facilitates the identification of patterns and anomalies within business processes. This is critical because it allows the detection of irregularities that might be difficult to identify manually. In addition, data mining improves the accuracy of audits and reduces the risk of human error. With more precise data and deeper analysis, audits become more transparent and reliable, enabling better-informed and timelier decision-making. Ultimately, it helps optimize review times and enhance efficiency across the entire internal audit process."	

One of the key benefits of data mining is its ability to detect atypical patterns and emerging risks. Both interviewees emphasized that this capability has greatly improved the precision and timeliness of internal audits—particularly by enabling the early identification of transactional deviations, which allows errors to be corrected before they lead to significant consequences. Technology also strengthens risk management by generating real-time anomaly alerts, a feature experts agree is critical to fraud prevention. Although not every irregularity indicates fraud, data mining helps reveal patterns that may suggest fraudulent activity.

Furthermore, both interviewees shared concrete examples of how this technology helped identify irregularities. They consistently emphasized that data mining contributes to standardized, cleaner datasets, reducing errors caused by incomplete or inconsistent records. Both experts highlighted this as a key advantage, noting that it also minimizes dependence on the IT department for data retrieval, shortening response times and enabling more effective audits. The interviewees agreed that this autonomy is essential for the efficient execution of audit processes.

3.4. Identifying Data Mining Methodologies Applicable to Internal Audit in Venezuelan Medium-Sized Enterprises

To identify data-mining methodologies applicable to internal audit in medium-sized Venezuelan enterprises, this study developed general insights from the categorization process within the "Data Mining Mechanisms in Internal Audit framework," aligned with the study's second specific objective. These findings correspond to categories B1 and B2 (see Table 1).

3.5. Optimization of Internal Audit Processes Through Data Mining

For optimizing internal audit processes through data mining, it was essential to consider the perspectives of key informants (IC1 and IC2). As experts from different companies, these informants possess firsthand knowledge of the types of information and data that can be extracted elements that are critical for detecting anomalies (see Table 4).

Table 4.
Optimization of Internal Audit Processes Through Data Mining.

IC	Expert's Perspective	Researchers' Observations
IC1	"Data mining is key to optimizing internal audit processes, as it enables the analysis of a large percentage of transactions and detects irregularities more accurately than traditional methods. It facilitates continuous monitoring, enhances report generation, and reduces manual workload—allowing the audit function to focus on strategic decision-making. The greatest challenge lies in training teams to correctly interpret results and fully leverage these tools."	Experts emphasize that data mining is a key tool for optimizing internal audit processes in medium-sized enterprises, enabling the detection of anomalies and the reduction of risks. However, its adoption faces barriers such as limited technical knowledge and resistance to change. Although accessible tools are available, training remains essential to fully harness their potential.
IC2	"Data mining can be challenging for organizations, yet it is highly rewarding because it helps place the company in context—promoting healthy organizational practices, data transparency, and the accuracy of reported information. Ultimately, it ensures that information is transparent, clear, and timely."	

Data mining has revolutionized internal audit by enabling teams to efficiently analyze vast datasets. Unlike traditional manual transaction reviews—which examined limited samples at significant speed—data mining now allows 100% of data analysis, dramatically increasing the likelihood of identifying anomalous patterns, irregularities, and potential risks. The interviewees consistently noted that tools such as Excel, Power BI, and ACL enhance the systematic analysis of large datasets, enabling the identification of anomalies that would otherwise go undetected through manual review. These platforms automate data filtering, cross-referencing, and real-time anomaly detection, thereby expediting audit workflows and enabling audit teams to concentrate on high-risk areas.

Moreover, data mining is not only useful for detecting irregularities but also for identifying trends and patterns in financial and operational data. By analyzing these patterns, internal audit teams can gain deeper insights into the business and make more informed decisions. In doing so, they can identify process improvement opportunities, assess the effectiveness of internal controls, and anticipate potential issues. To successfully implement data mining in internal audits, it is essential that teams receive proper training in the use of relevant tools and systems, as well as in interpreting analytical results. Equally important is ensuring that audit teams clearly understand the objectives of data analysis and how to apply data mining techniques within their day-to-day audit processes.

3.6. Challenges and Requirements for Implementing Data Mining in Internal Audit

Based on the information obtained from interviews with key informants, the a priori category (B) was developed, which made it possible to identify the challenges and requirements for implementing data mining in internal audit departments (see Table 5).

Table 5.
Challenges and Requirements for Implementing Data Mining in Internal Audit.

IC	Expert's Perspective	Researchers' Observations
IC1	"From a financial standpoint, each organization manages its own budget. However, I believe that the primary requirement for these organizations is technology, specifically, having robust, up-to-date equipment. It is critically important to recognize that when working with Big Data, such infrastructure is essential, along with high-speed and reliable internet connectivity."	Implementing data mining in internal audits presents challenges related to staff training, change management, and integration with existing systems. While the tools are available, their effectiveness depends on adequate training and the ability to adapt traditional audit processes to a more technology-driven approach.
IC2	"The team also requires stronger training to use these tools effectively. Additional investment in IT infrastructure and systems that ensure data security and confidentiality is necessary, since these remain ongoing challenges when relying on free or external tools. The team needs to develop skills in managing specific systems and tools such as Power BI and ACL. Furthermore, it is essential to understand the goals of data analysis and how to interpret results accurately. The main challenge is the team's limited technical expertise in using these tools to generate meaningful insights. Another significant challenge is resistance to change and persistent misconceptions about adopting advanced technologies. It's also essential to ensure data confidentiality when using external or free platforms."	

Insights from the interviews show that both experts agree: implementing data mining in internal audit brings several critical challenges. One of the main hurdles involves technology and the team's technical capabilities — both essential for effectively using data mining tools to extract valuable insights. Through large-scale data analysis, organizations can identify unusual patterns or anomalies that may signal potential issues. Another key challenge lies in developing the skills needed to interpret results accurately. Effective data mining requires technical proficiency and analytical judgment to translate findings into meaningful conclusions and avoid misinterpretation.

When discussing the requirements for implementing data-mining tools in internal audit, the interviewees highlighted the importance of training the teams responsible for using these solutions. Training should focus on mastering key software such as Power BI and ACL, as well as developing the analytical skills needed to interpret results and understand the business situations being analyzed. The successful adoption of data mining in internal audits depends on several factors: targeted training, clearly defined objectives, strong technical expertise, and continued investment in technology.

3.7. Exploring Data-Mining Implementation in the Internal Audit Functions of Mid-Sized Venezuelan Enterprises

3.7.1. Resources Required for Implementing Data Mining

The resources required to implement data-mining solutions largely depend on the specific objectives defined for their adoption. This perspective is reflected in the interviewees' responses, which informed the development of the priori category C1 (see Table 6).

Table 6.
Resources Required for Implementing Data Mining.

IC	Expert's Perspective	Researchers' Observations
IC1	"To implement data mining in internal audit departments, adequate human, technological, and financial resources are required. In terms of human resources, a team that combines developers, mathematicians, and auditors is needed, as it is essential for auditors to have the necessary knowledge to interpret the data, while developers and mathematicians handle the technical aspects. The team should be scaled according to the complexity of the organization—if the company has greater operational complexity, a more robust team will be required. On the technological side, it is critical to have cutting-edge hardware and a high-performance internet connection, as data mining involves working with Big Data environments and cloud-based storage solutions. Finally, from a financial standpoint, the organization's budget should prioritize investment in technology infrastructure to ensure the necessary processing speed, data capacity, and connectivity for effective data mining operations."	Both interviewees agreed that implementing data mining within audit functions requires a multidisciplinary team comprising developers, data scientists, and auditors. They emphasized that continuous training is essential—particularly for auditors, who must be able to interpret and apply data-mining results effectively. The interviewees also underscored the need for robust hardware and reliable connectivity to support Big Data workloads. From a financial perspective, both concurred that investment in technology is critical; however, the second interviewee stressed the importance of developing internal capabilities through ongoing training. Finally, they highlighted the need for a cultural shift within organizations—especially in more traditional teams—to facilitate smoother adoption of new technologies.
IC2	"Staff must be trained in specialized software and data-interpretation techniques to fully leverage analytical tools. From a technical standpoint, high-performance systems are essential to process large data volumes efficiently, and team members must be able to filter and analyze information accurately. From a cost perspective, investing in training—whether through external experts or internal development programs—is critical to ensure the team has the necessary skills and can adapt smoothly to new technologies. With the right balance of people, technology, and funding, data-mining initiatives can be implemented effectively and with minimal disruption."	

When analyzing the experts' perspectives, several areas of alignment emerge, along with insights that further clarify the resources required to implement data mining within the internal audit functions of mid-size enterprises. From a human resources standpoint, a multidisciplinary team (developers, data scientists, and auditors) is essential. While IC1 stresses the need for robust equipment and cloud connectivity for Big Data, IC2 emphasizes a cultural shift and building internal capabilities through continuous learning. Both underscore the importance of identifying talent within existing teams and ensuring auditors can interpret results objectively and without bias.

From a technological-resources perspective, both experts underscore the importance of having adequate infrastructure to handle large data volumes. IC1 highlights the need for robust equipment and reliable connectivity, giving reliance on Big Data and continuous cloud access. IC2 adds that systems must have sufficient capacity to process information efficiently and be equipped with the appropriate analytical tools. Both emphasize the importance of software proficiency to manage data-mining operations and generate accurate, reliable evidence. From a financial-resources standpoint, both experts agree that the largest investment should be directed toward technology. IC1 notes that priority spending should focus on high-performance equipment and connectivity, while IC2 stresses that funding for expert training is equally essential. Both state that organizations must allocate resources for ongoing internal training—through continuous workshops or self-learning initiatives—to help staff adapt effectively to new tools and methodologies

While both interviewees share common ground on several key points, their views diverge in notable ways. IC1 stresses that the team's structure should reflect the organization's level of complexity, suggesting that enterprises with broader operations require larger, more specialized teams. In contrast, IC2 places more emphasis on promoting a cultural shift within the organization. He notes that data mining is now a core component of modern audit work and that younger professionals generally adapt more quickly to new technologies. IC2 also highlights the importance of building internal capabilities through continuous learning and self-development, noting that many large organizations may already have staff with the necessary technical expertise. This reflects a more flexible approach to resource allocation compared to IC1, who prioritizes investment in advanced technology and strong connectivity.

3.8. Importance of Applying Data Mining

The adoption of data mining within internal audit functions compels organizations to make strategic decisions, balancing factors such as technology investment, process efficiency, and overall impact on profitability. To explore this dynamic, we developed a priori category C2, derived directly from insights shared by key interviewees. (see Table 7).

Table 7.
Importance of Applying Data Mining.

IC	Expert's Perspective	Researchers' Observations
IC1	"Data mining is essential because it enables a more precise analysis of large volumes of information. It helps identify patterns and anomalies that would go unnoticed through manual reviews. By applying data-mining techniques, organizations can process vast datasets that would otherwise be impossible to analyze, allowing for more effective detection of irregularities in financial behavior. It plays a critical role in auditing, as it provides a faster and more comprehensive analysis, helping to uncover potential fraud or inconsistencies that might not be detected through traditional methods. Although challenges exist—such as limited technical expertise or resistance to change—the benefits of data mining are substantial in terms of both efficiency and accuracy."	While both experts recognize the core advantages of data mining—improved efficiency, cost savings, and stronger compliance—their approaches differ. The first expert focuses on regulatory and technological dimensions, whereas the second highlights team development and the broader organizational and social impact of these improvements. Still, both agree that successful data-mining implementation in audit requires a multidisciplinary team.
IC2	"Data mining offers tangible advantages for audit functions—reducing costs, streamlining processes, and automating routine activities to support more informed decision-making. It can also detect early instances of non-compliance with regulations, allowing enterprises to mitigate risks and avoid potential penalties. For mid-sized enterprises, data mining enhances competitiveness, strengthens customer and market insights, and supports more effective strategic decisions. To fully realize these benefits, organizations need a multidisciplinary team capable of accurately interpreting analytical results, along with the appropriate infrastructure to manage large data volumes efficiently."	

Both experts agree on DM's role in cost reduction by identifying uncollected revenue or improper expenses. IC1 emphasizes process automation and the ability to detect deviations or fraud—factors that directly impact cost savings—while IC2 highlights how data mining improves efficiency by identifying uncollected revenue or improper expenses, which also lead to significant savings. Another key area of agreement is their shared perspective on preventive auditing: both experts believe that data mining enables continuous audit processes, allowing potential issues to be detected before they develop into serious problems. Proactive, preventive auditing enhances transparency and ensures regulatory compliance, protecting corporate reputation.

Both experts also emphasize the importance of multidisciplinary teams to conduct audit processes that leverage data-mining tools. IC1 highlights the need to integrate diverse professional profiles—such as accountants, developers, and data scientists—to ensure a comprehensive approach. IC2, meanwhile, stresses the creation of monitoring mechanisms and data analysis frameworks that enable more precise and complete results. The experts agree that data mining plays a crucial role in ensuring regulatory compliance and protecting corporate reputation. By implementing systems that allow effective data monitoring and auditing, organizations can reduce the risk of regulatory penalties and strengthen trust among clients, suppliers, and other stakeholders.

In contrast, the key difference lies in the technology and resources required to implement data mining. IC1 underscores the need for modern infrastructure and strong connectivity to handle large-scale data environments, enabling more efficient collection and analysis. IC2, on the other hand, focuses on developing internal capabilities through staff training and identifying talent within existing teams. Despite these differences, both experts agree that effective data-mining implementation in audit depends on multidisciplinary teams.

4. Discussion of Results

Data mining has become a strategic tool for internal audit, giving mid-sized enterprises the ability to analyze large volumes of data and efficiently detect anomalies. In this study, the findings from expert interviews confirm the theoretical framework, which holds that data mining enhances audit processes by automating repetitive tasks, improving the detection of irregularities, and strengthening risk management [8, 10].

One of the main findings from the interviews is that traditional internal audit faces challenges in detecting fraud due to the large volumes of data involved. The experts explained that data mining enhances audit performance by supporting large-scale, real-time analysis—consistent with Fayyad, et al. [9] who argue that data mining helps uncover hidden patterns in complex datasets.

It was also noted that implementing continuous auditing through data mining facilitates the early identification of deviations in financial and operational transactions. This finding aligns with Sharda, et al. [13] who argue that data-mining-based audit systems can generate automatic alerts for irregularities, enabling faster and more effective responses. In this regard, the experts emphasized that process automation reduces auditors' operational workload, allowing them to focus on strategic information analysis rather than manual data review.

The interviews highlighted a clear need for specialized data-mining training within internal audit teams. As the literature indicates, the effectiveness of these techniques depends heavily on data quality and auditors' technical expertise [15]. Respondents agreed that organizations must invest in both talent development and advanced analytical tools—such as Power BI, SQL, and ACL—echoing [17] who argues that combining technology with skilled professionals is essential for accurately identifying anomalies.

However, the results also revealed several key challenges to implementing data mining in internal audit, including resistance to change within audit teams and the budget constraints typical of mid-sized enterprises. This finding is consistent with Banerjee, et al. [12] who note that adopting new audit technologies requires a cultural shift within organizations. In this regard, the key informants emphasized that senior management must take a proactive role in integrating data mining and ensure that adequate resources are allocated for its effective implementation.

5. Conclusions

The findings of this study demonstrate that data mining plays a critical role in optimizing internal audit functions within mid-sized enterprises. Analysis of both the theoretical framework and expert interviews confirms that the integration of data mining not only improves the identification of fraud and irregularities but also enhances internal control systems, strengthens financial transparency, and facilitates decision-making grounded in accurate and timely data.

One of the study's key findings is that data mining enables enterprises to process large volumes of information efficiently, significantly reducing the time auditors spend on repetitive manual tasks. This automation not only streamlines internal resources but also reduces the risk of human error, resulting in more accurate and reliable financial reporting.

The study also demonstrated that integrating data mining into audit methodologies facilitates the establishment of continuous auditing systems, through which organizations can monitor financial and operational data in real time rather than relying exclusively on periodic evaluations. This proactive methodology promotes early identification of anomalies and atypical behavior, thereby preventing potential fraud or financial errors from going undetected for extended periods.

However, the study also identified several challenges and limitations that must be addressed to ensure the effective implementation of data mining in internal auditing. One of the key issues is the need for specialized training for auditors, as the use of advanced data-analytics tools requires technical proficiency in software such as Power BI, SQL, Python, and ACL. The lack of technical training can impede the effective adoption of these tools within enterprises, underscoring the importance of investing in continuous professional-development programs for audit staff.

Another challenge identified is the resistance to change among traditional auditors, who may perceive data mining as a threat to their established working methods. To overcome this barrier, it is essential for organizations to foster a culture of technological adoption, emphasizing the benefits of data mining in terms of efficiency, cost reduction, and improved audit quality. Additionally, it was found that many mid-sized Venezuelan enterprises face technological infrastructure limitations, which can hinder the implementation of advanced data-mining systems. The lack of high-capacity equipment, inadequate internet connections, and budget constraints pose significant challenges. Therefore, it is crucial for companies to assess their current technological capacity and develop strategic investment plans that enable the progressive and sustainable adoption of these tools.

In terms of organizational impact, it can be concluded that data mining not only improves internal audit processes but also enhances transparency and trust in companies' financial management. The ability to detect fraud and risk at an early stage strengthens corporate credibility among investors, clients, and regulators, which can translate into greater growth opportunities and market stability.

In conclusion, data mining represents a transformative tool for enhancing internal audit processes in mid-sized Venezuelan enterprises. Although its implementation entails certain challenges, it offers considerable improvements in efficiency, accuracy, and risk mitigation. To maximize its benefits, enterprises should prioritize auditor training, upgrade technological infrastructure, and promote a data-driven culture that supports informed decision-making.

6. Recommendations

This study recommends that mid-sized enterprises take a gradual approach to implementing data-mining tools in their internal audit functions. Initial efforts may focus on accessible analytical applications such as Power BI, Orange, or SQL, prior to investing in more advanced technologies. Successful adoption depends on auditors who are proficient in digital tools and analytical methods, supported by continuous training programs that build skills in statistics, programming, and data analysis.

Enterprises should also establish clear policies and procedures for data collection, storage, and analysis to ensure the security, confidentiality, and integrity of the information used in audit processes. In addition, companies are encouraged to move toward continuous-audit models, where data mining is used to detect anomalies in real time. This approach allows organizations to respond more quickly to potential fraud or irregularities and supports more effective decision-making. While this research focused on mid-sized Venezuelan enterprises, future studies could examine the role of data mining in fraud detection within specific industries, such as financial services or manufacturing. Comparative analyses across sectors could help identify which industries are more vulnerable to fraud and determine which data-mining techniques are most effective in each case.

This study has demonstrated the impact of data mining on internal auditing within Venezuelan mid-sized enterprises. However, this field still offers multiple opportunities for further research to expand knowledge and improve the practical application of these tools in the business environment. One of the main limitations encountered was the difficulty of accessing reliable financial and operational data, as many companies regard this information as confidential and restrict its availability for external analysis. It was also observed that internal audit departments are scarce among mid-sized enterprises, which made it challenging to identify professionals in these areas willing to share their expertise.

Many Venezuelan mid-sized enterprises still lack the technological infrastructure needed to implement advanced data-mining solutions, which limits immediate adoption. Training in data-mining and analytics tools remains limited within internal audit functions, and the lack of professionals skilled in statistics, programming, and data management continues to

be a major constraint. From a financial perspective, the upfront investment in software, technology infrastructure, and training also poses a challenge, often limiting enterprises' ability to fully integrate data mining into their audit processes.

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