Leveraging Big Data in The Banking Sector: An Analysis of Challenges and Opportunities at the Central Bank of Aden

Shaima Abdulrahman Mohsen [1,*]
Dr. Nasr Mohammed Alsakkaf [2]
Prof. Mohammed Fadhl Abdullah [3]
Dr. Ali Saleh Belaeed [4]

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[1] Research Scholar Information Systems, University of Science & Technology, Aden, Yemen.
2 Faculty of Information Systems, University of Science & Technology, Aden, Yemen; Email: n.alsakkaf@ust.edu
3 Faculty of Information Technology, University of Science & Technology, Aden, Yemen; Email: m.albadwi@ust.edu
4 Faculty of Information Systems, University of Science & Technology, Aden, Yemen; Email: a.Baleed@ust.edu
* Corresponding author. E-mail: s.yahya@student.ust.edu

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Abstract:

Central banks in developing countries face numerous challenges, including counterfeiting and decision-making difficulties. These banks generate vast amounts of data daily, which may not be fully utilized. This study aims to explore the scope, nature, characteristics, sources, and application areas of Big Data in central bank of Aden, with a focus on why central bank should adopt it. The researchers used a descriptive methodology, conducting a comprehensive review of relevant studies, scientific theses, and research papers. The collected data were analyzed using SPSS software. A questionnaire, which was validated by experts and academic staff from the University of Science and Technology, was administered to the information technology management staff at the Central Bank of Yemen's headquarters in Aden and its branches. The study's findings led to several recommendations and identified future research opportunities, emphasizing the study's importance as a foundational effort in this area.

Keywords: *Big data, Central Banking, Data Utilization, SPSS Analysis.*

الاستفادة من البيانات الضخمة في القطاع المصرفي: تحليل التحديات والفرص في البنك المركزي بعدن

شيماء عبدالرحمن محسن[1،*]
د. نصر محمد السقاف [2]
أ.د. محمد فضل عبدالله [3]
د. علي صالح بلعيد [4]

الملخص:

تناولت هذه الدراسة التحديات التي يواجهها المترجمون المتدربون في ترجمة النصوص العلمية والتقنية بين اللغتين العربية والإنجليزية باستخدام منهجية الأساليب المتعددة. تم إجراء استبيان على 46 متدربًا من ثلاث جامعات يمنية لجمع بيانات حول تجاربهم في الترجمة والتحديات التي يواجهونها. بعد ذلك، تم إجراء اختبار ترجمة مع 40 متدربًا للحصول على مجموعة من عينات الترجمة، تتضمن مقتطفات من النصوص العلمية والتقنية. تم تحديد إجمالي 724 خطأ من خلال تحليل الأخطاء لهذه الترجمات، منها 228 خطأ في الترجمات من الإنجليزية إلى العربية و496 خطأ في الترجمات من العربية إلى الإنجليزية. أشارت النتائج إلى أن الأخطاء المعجمية كانت الأكثر تكرارا، إلى جانب الأخطاء النحوية والإملائية. وتشير النتائج إلى أن العوامل اللغوية والثقافية والمعرفية تساهم في هذه التحديات. وكشف التحليل أن تعزيز المفردات والمهارات النحوية، إلى جانب التدريب الخاص بالوسائط، أمر بالغ الأهمية لتحسين دقة الترجمة. تؤكد الدراسة على الحاجة إلى برامج تدريبية متخصصة تتناول هذه المجالات المحددة، مؤكدة على أن الجهود المتضافرة من كل من مؤسسات التدريب والباحثين ضرورية لتعزيز كفاءات المتدربين المترجمين العاملين مع اللغتين العربية والإنجليزية.

الكلمات المفتاحية: *البيانات الضخمة، البنوك المركزية، استخدام البيانات، البنك المركزي اليمني، تحليل* SPSS

[1] باحثة نظم المعلومات، جامعة العلوم والتكنولوجيا، اليمن، عدن
[2] أستاذ نظم المعلومات المساعد، جامعة العلوم والتكنولوجيا، اليمن، عدن – البريد الالكتروني: n.alsakkaf@ust.edu
[3] أستاذ تقنية المعلومات دكتور، جامعة العلوم والتكنولوجيا، اليمن، عدن - البريد الالكتروني: m.albadwi@ust.edu
[4] أستاذ تقنية المعلومات المساعد، جامعة العلوم والتكنولوجيا، اليمن، عدن - البريد الالكتروني: a.Baleed@ust.edu
عنوان المراسلة: s.yahya@student.ust.edu

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Introduction

In light of the technological advancement occurring in the world today, and the widespread use of electronic devices, smartphones, tablets, and others, this has facilitated the production of data on a large and wide scale, which has opened the door for scientists to think about exploiting these unstructured and structured data, and converting them into purposeful data that can be utilized in various political, economic, social, and financial fields. Central banks are the most important financial institutions on which countries rely. Whereas central banks are responsible for formulating and implementing monetary policy, supervising financial institutions, and managing a country's foreign exchange reserves, playing a vital role in a country's economic stability and growth, in recent years, the surge in digital technologies and the exponential growth in data volumes have brought both challenges and opportunities to central banks in fulfilling their responsibilities.

Despite the rapid development of information and communication technology, many central banks in developing countries still face challenges in leveraging big data to improve supervision and monetary policy, there is a gap between the available potential of big data and the actual practices of these central banks, which affects their ability to extract valuable insights from big data to make better decisions and improve financial and monetary stability. The strategies for banks to address market challenges beyond cost-cutting initiatives is explored in (Giebe et al., 2022). A research gap of the notable advancements and latest implementations of data mining DM in the banking sector after 2013 is addressed by (Hassani et al., 2018; Sharhan et al., 2022).

The big data with its various classifications and characteristics cannot be processed using traditional technology to fully leverage its potential benefits. In Yemen, the central bank is facing many challenges in leveraging the large and complex datasets to improve its internal auditing and supervision policy, using the available traditional applications which affects their ability to extract valuable insights from this data to make better decisions and improve financial and monetary stability.

Currently, many applications are used by the central bank of Yemen in Aden, each one is being installed in a separate server and working in two essential modes, the Store, and the Alive mode. Besides these local installed applications, there are other essential applications running in the cloud and belong to some external application service providers, namely;

- **Coor banking:** An old application for the bank's internal operations.
- **Swift:** Application for the internal and external correspondences between banks.
- **DMFAS:** Application for all the bank's internal and external debts.
- **Scope Swift:** To prepare and deliver monitoring reports.
- **Refinitiv:** Electronic bidding trading platform that contains global exchange rates.

The objective of the study is to investigate and analyze the impact of big data concept on the development of internal auditing by the central bank in Aden, Yemen and to identify challenges that need to be addressed, and provides insights into how big data can be effectively used to improve decision-making, economic analysis, financial stability, policy formulation, and supervisory functions. It contributes to the advancement of knowledge and practice in the field of central banking in the era of big data. The importance of this work lies in many important effects and benefits that big data will add and help the Central Bank in its external and internal operations, including contributing to decision-making, establishing ethical and legal principles, and improving employee performance.

Big Data Definition

Big Data is an enormous or huge data-set, with a massive and complex volume so as to make it extremely difficult to process in the way traditional datasets are being managed as of today, the huge dataset pose excessive challenges in terms of analyzing, capturing, storing, sharing, visualizing, presenting and securing, as it is unwieldy. Big Data is also defined as a collection of data that exceeds the processing capacity of traditional database tools in terms of capturing, sharing, transferring, storing, managing, and analyzing the data within an acceptable timeframe (Bassiouni, 2021; Maliani et al., 2019; Chandani, 2015). Based on (Giacalone et al., 2016), big Data is known for five characteristics, known as 5Vs:

- Volume: Refers to a huge among of data.
- Velocity: The peed of data production and processing
- Variety: Data exhibits a highly heterogeneous nature.
- Veracity: The quality, reliability, and trustworthiness of the data.
- Value: The advantage of big data is that it extracts valuable insights from data collected.

Research Methodology

1. Research Population

This study used a descriptive research design to collect data on the impact, challenges, and opportunities presented by big data in the context of Yemeni central bank in Aden city. Thus, the major participants in this study were IT employees in the head office of the central bank in Aden city and its branches. The study sent out a total of 45 questionnaire and 42 were answered, therefore this research used a sample size of 42 participants, selected through purposive sampling. It included IT employees with different qualifications and specializations to ensure a diverse representation.

2. Data Analysis Procedures

The Statistical Package for Social Sciences (SPSS 26) was used to analyze the data. Data were subjected to mapping through frequencies on the descriptive statistics. participant's demographic data were provided; this included: gender, age, as well as the

background information such as the qualification, specialization, and experience. Descriptive statistics were used in the form of frequency tables to present categories of variables. In this process of mapping out the data through frequencies, one critical problem which emerged was that of missing data. Missing data were also detected by means of visual scanning. The researchers did not make average, or used list wise or pairwise deletion methods for the reason that this was a small-scale evaluation of a pilot project that needed to be captured as is.

Results and Analysis

Part 1: Personal Data

In this section the personal data are characterized as the following:

Gender

The survey results presented reveal a significant gender imbalance within the IT department of the Central Bank, with males comprising (81%) of the sample, while females account for only (19%). This disparity is likely due to the demanding nature of the IT work, which may require longer hours and frequent travel across provinces. However, the data also shows the presence of female employees in the department, indicating some level of gender diversity. The gender distribution highlights the need to further explore the factors influencing the recruitment and retention of female IT professionals within the central banking sector.

Table (1): Frequencies and Percentages According to Gender Variable

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	34	81.0	81.0	81.0
Female	8	19.0	19.0	100.0
Total	42	100.0	100.0	

Qualification

The educational background of the survey respondents is dominated by those holding bachelor's degrees, accounting for 73.8% (31 individuals) of the sample. Master's degree holders make up 16.7% (7 individuals), while there is one respondent with a doctor degree (2.4%) and two with high school diplomas (4.8%). Additionally, one participant has other qualifications (2.4%). The preponderance of higher education qualifications among the respondents, particularly bachelor's and master's degrees, aligns with the specialized nature of the questionnaire and the IT focus of the Central Bank's operations.

Table (2): Frequencies and Percentages According to Qualification

Qualification	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Higher Diploma	2	4.76	4.76	**4.76**

Bachelor	31	73.81	73.81	**78.57**
Master	7	16.67	16.67	**95.24**
PhD	1	2.38	2.38	**97.62**
Other	1	2.38	2.38	**100**
Total	**42**	**100**	**100**	

Specialization

The survey respondents represent a diverse range of specialties within the Central Bank's IT department, with the largest group (66.7%) being from the Information Technology specialty. Other notable specialties include Networking (9.5%), Accounting and Business (7.1%), Business Administration (4.8%), and Accounting (2.4%), along with a small percentage (9.5%) of other unspecified specialties. This distribution of specialties among the participants provides valuable insights into the breadth of expertise within the IT department, which is relevant to the study's focus on big data utilization.

Table (3): Frequencies and Percentages According to Specialization

Specialization	Frequency	Percent	Valid Percent	Cumulative Percent
Networks	4	9.52	9.52	9.52
Information technology	28	66.67	66.67	76.19
Finance and banking	3	7.14	7.14	83.33
Business Administration	2	4.76	4.76	88.09
Accounting	1	2.38	2.38	90.47
Other	4	9.52	9.53	100
Total	42	100	100	

Job Description

The survey sample includes employees from various hierarchical levels within the Central Bank's organizational structure. The largest group is employees, representing 42.9% (18 individuals), followed by Heads of Department (26.2%, 11 individuals) and Department Managers (14.3%, 6 individuals). The sample also includes General Managers (7.1%, 3 individuals), Deputy Directors of Administration (4.8%, 2 individuals), a Deputy General Manager (2.4%, 1 individual), and a Senior Manager (2.4%, 1 individual). This distribution of job titles and seniority levels provides insights into the diverse perspectives represented in the study.

Table (4): Frequencies and Percentages According to Job Description

Job Description	Frequency	Percent	Valid Percent	Cumulative Percent

Senior management	1	2.38	2.38	2.38
General Manager	3	7.14	7.14	9.52
Deputy General Manager	1	2.38	2.38	11.90
Department Manager	6	14.29	14.29	26.19
Deputy Director of Administration	2	4.76	4.76	30.95
Head of Department	11	26.19	26.19	57.14
Employee	18	42.86	42.86	100
Total	**42**	**100**	**100**	

Experience

The survey respondents have a range of professional experience, with the majority (40.5%) having 5 to 10 years of experience. There is also a significant proportion (33.3%) with less than 5 years of experience. The remaining participants have 11 to 20 years (19.0%), 20 to 30 years (4.8%), and more than 30 years (2.4%) of experience. This distribution of experience levels among the sample provides insights into the diverse perspectives and knowledge bases that inform the study findings.

Table (5): Frequencies and Percentages According to Experience

Experience	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 5 years	14	33.3	33.3	33.3
From 5 - 10 years	17	40.5	40.5	73.8
From 11 – 20 years	8	19.0	19.0	92.8
From 20 – 30 years	2	4.8	4.8	97.6
30 years and over	1	2.4	2.4	100
Total	**42**	**100**	**100**	

Big Data awareness:

Descriptive Analysis of the Respondents' Answers about "How familiar are you with the concept of big data?"

Table (6): Responses to the question Responses to the question "How familiar are you with the concept of big data"?

Job Description	Frequency	Percent	Valid Percent	Cumulative Percent
Completely Unfamiliar	0	0	0	0
Somewhat Unfamiliar	6	11.9	11.9	11.9
Somewhat Familiar	24	57.1	57.1	69.0
Completely Familiar	12	28.6	28.6	97.6
Total	**42**	**100**	**100**	

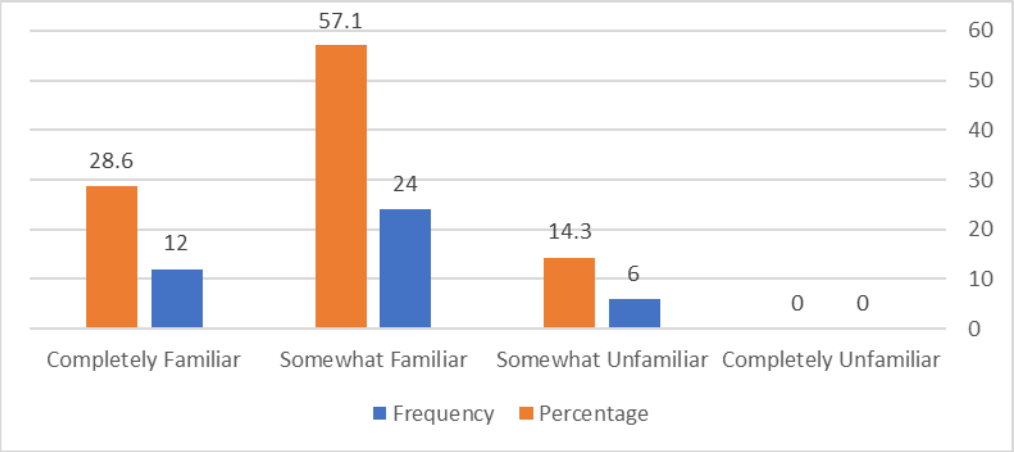

Figure (1): Responses to the question "How familiar are you with the concept of big data"?

The survey results show that the majority of the study participants have a good level of familiarity with the concept of big data. The largest group, 57.1% of the sample, indicated they are "Somewhat familiar" with big data. Additionally, 28.6% reported being "Completely familiar," suggesting a considerable number have the ability to work with big data and its analytics. On the other hand, a smaller proportion of the sample reported being less familiar, with 11.9% saying they are "Somewhat unfamiliar" and 2.4% (1 individual) being "Completely unfamiliar." Overall, the results indicate that over 85% of the study participants are at least somewhat familiar with the concept of big data, which suggests they possess the necessary knowledge and understanding to provide meaningful insights on the use of big data in central banking.

Table (7): Responses to the question "Do you have any experience working with big data "?

Job Description	Frequency	Percent	Valid Percent	Cumulative Percent
No	23	54.8	54.8	54.8
Yes	19	45.2	45.2	100
Total	**42**	**100**	**100**	

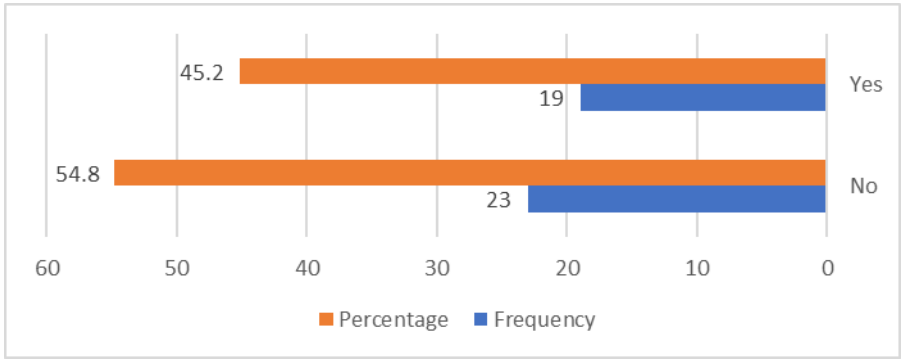

Figure (2): Responses to the question "Do you have any experience working with big data analytics in the context of central banks"?

The survey results reveal that the majority of the study participants, 54.8%, do not have any experience in working with data analysis. In contrast, 45.2% of the respondents answered "Yes" to having such experience. This finding presents a challenge, as despite the majority of participants indicating a good level of familiarity with the concept of big data in the previous responses, a larger proportion of them lack specific experience in big data analysis within the banking sector. The discrepancy between the participants' general familiarity with big data and their limited experience in applying big data analytics in a central banking context suggests a need to further develop the necessary skills and expertise among the study sample to fully leverage the benefits of big data for central banks. **The Challenges facing the use of Big Data in Central Banks**

Table (8): Arithmetic Means, Standard Deviations for " Challenges facing the use of Big Data in Central Banks"

	Statements	Mean	Std. Deviation	Sig.	Rank	Impact of Degree
1	Privacy and security issues	3.69	1.22	.000	3	High
2	Difficulty in data analysis	3.42	1.25	.000	10	High
3	Inability to achieve a balance between innovation and organization	3.66	.98	.000	4	High
4	Lack of skills and expertise in big data field	3.52	1.37	.000	8	High
5	Failure to achieve integration and compatibility with existing infrastructure	3.57	1.47	.000	7	High
6	Lack of infrastructure capable of keeping up with big data requirements	3.64	1.56	.000	6	High

7	Non-compliance with ethical issues	3.51	1.25	.000	9	High
8	Absence of legal and regulatory frameworks	3.71	1.20	.000	1	High
9	Lack of understanding of cultural challenges	3.64	1.14	.000	5	High
10	Poor data quality and reliability	3.71	1.22	.000	2	High
	Challenges facing the use of Big Data in Central Banks	3.60	1.01	.000	-	High

The survey results indicate a high level of agreement among participants regarding the various challenges hindering the application of big data in central banking. The overall mean across all items ranged from 3.42 to 3.71, suggesting a largely positive and consistent response from the sample.

The two highest-ranked challenges were:

1. Absence of legal and regulatory frameworks (mean = 3.71, SD = 1.19523)
2. Poor data quality and reliability (mean = 3.71, SD = 1.21546)

These findings suggest that the participants view the lack of a clear legal and regulatory environment, as well as issues related to data quality and reliability, as the most significant obstacles to the effective implementation of big data in central banking. Other highly-ranked challenges include privacy and security concerns (mean = 3.69, SD = 1.2195), the inability to balance innovation and organizational constraints (mean = 3.66, SD = 0.97946), and the lack of understanding of cultural challenges (mean = 3.64, SD = 1.14384).

The overall high level of agreement, as indicated by the low standard deviations, demonstrates a consistency in the sample's perceptions of the key challenges facing the adoption of big data in the central banking context.

Table (9): The result of the First Question "Challenges facing the use of Big Data in Central Banks"

Axis	Mean	St. Deviation	Sig.
Challenges facing the use of Big Data in Central Banks	3.60	1.00768	.000

The overall mean of the sample respondents' opinions regarding the challenges and obstacles hindering the implementation of big data is (3.60), which is higher than the average of 3 for the question, there is consistency as indicated by the standard deviation of (1.00768), and it was found that there is statistical significance (one-sample t-test), suggesting the existence of challenges for the central bank, these challenges significantly hinder the use of big data. However, it indicates that the challenges faced by the central

bank require a serious approach and radical solutions. The researcher proposed some solutions to overcome these challenges, which will be discussed in another section.

Table (10): Arithmetic Means, Standard Deviations for
" Strategies to Overcome Challenges of use Big Data in Central Banks"

	Statements	Mean	Std. Deviation	Sig.	Rank	Impact of Degree
1	Dealing with data securely	3.73	1.43237	.002	7	High
2	Ability to analyze data	3.85	1.38854	.000	3	High
3	Achieving a balance between innovation and organization	3.80	1.43561	.001	4	High
4	Availability of expertise in big data field	3.75	1.52939	.003	5	High
5	Achieving integration and compatibility with existing infrastructure	3.73	1.46670	.003	8	High
6	Availability of infrastructure capable of keeping up with big data requirements	3.95	1.58037	.000	1	High
7	Compliance with ethical issues	3.53	1.55077	.032	10	High
8	Availability of legal and regulatory frameworks	3.75	1.54565	.003	6	High
9	Understanding cultural challenges	3.69	1.42261	.003	9	High
10	Data quality and reliability	3.90	1.54303	.000	2	High
Strategies to Overcome Challenges of use Big Data in Central Banks		3.77	1.35787	.001	-	High

The text presents the results of a survey on the strategies to overcome challenges for a central bank in adopting big data. The key findings are:

- The overall degree of agreement among respondents was high, with a mean between (3.53) and (3.95) on a 5-point scale.
- The top-rated items were:
  - Availability of infrastructure capable of keeping up with big data requirements (mean 3.95)
  - Data quality and reliability (mean 3.90)
  - Ability to analyze data (mean 3.85)

Other highly rated items included:

- Achieving a balance between innovation and organization
- Availability of skills and expertise in big data

- Availability of legal/regulatory frameworks
- Dealing with data securely
- Achieving integration with existing infrastructure
- The lowest rated item was compliance with ethical issues, though it still had a relatively high mean of (3.53).

The survey results highlight the key organizational, technical, regulatory and ethical considerations that the central bank needs to address in order to successfully adopt and leverage big data capabilities.

Table (11): The result of the Second Question
" Strategies to Overcome Challenges of use Big Data in Central Banks"

Axis	Mean	St. Deviation	Sig.
Strategies to Overcome Challenges of use Big Data in Central Banks	3.77	1.35787	.001

The overall mean of the respondents' views on the strategies to overcome the challenges facing the central bank in implementing big data is (3.77), which is higher than the average question score of (3). There is consistency where the standard deviation was (1.35787), and a one-sample t-test found it to be statistically significant.

Table (12): Arithmetic Means, Standard Deviations and Results
of One Sample for "Opportunities of use Big Data in central banks"

.	Factors	Mean	Std. Deviation	Sig.	Rank	Impact of Degree
1	Promoting innovation in banking services	3.54	1.59576	.032	4	High
2	Improving risk management	3.42	1.61007	.092	8	High
3	Maximizing the use of data resulting from daily transactions	3.50	1.59649	.049	7	High
4	Easy monitoring of employee performance	3.33	1.67720	.205	10	High
5	Enhancements in internal processes	3.54	1.54923	.027	3	High
6	Enhancing dealing with large no. customers	3.50	1.46920	.033	6	High
7	Supporting strategic decision-making	3.38	1.60718	.132	9	High
8	Improving economic analysis & forecasting	3.57	1.51646	.019	1	High
9	Combating and preventing fraud	3.52	1.56545	.036	5	High
10	Data quality and reliability	3.57	1.59485	.025	2	High
	Opportunities of use Big Data in central banks	3.49	1.47049	.037	-	High

The results indicate a high degree of agreement among the respondents, with the arithmetic mean ranging between (3.33) and (3.57) across the various items discussed. The overall arithmetic mean for all items is (3.49), suggesting the respondents generally view the importance of these items positively. However, the relatively high standard deviation of (1.47) indicates significant variation in the levels of response, implying the presence of some divergent or extreme opinions despite the overall upward trend. Specific items that received high agreement include improving economic analysis and forecasting, providing diverse data sources, promoting innovation in central banking services, enhancing internal processes, combating fraud, maximizing use of transaction data, and improving risk management and strategic decision-making, highlighting the perceived benefits of leveraging big data in central banking operations.

Table (13): The result of the Third Question "Opportunities of use Big Data in Central Banks

Axis	Mean	St. Deviation	Sig.
Opportunities of use Big Data in Central Banks	3.49	1.47049	.037

The overall mean of the sample's opinions on the opportunities available for central banks to benefit from big data was (3.49), which is higher than the average score of (3) for the question. There is consistency in the responses, as the standard deviation was (1.47049). Using a one-sample t-test, it was found that the result is statistically significant. This means that the research participants have a strong positive attitude towards the opportunities available for central banks to benefit from big data, and this finding can be reliably generalized to the broader population. In other words, the participants strongly agreed that central banks have important opportunities to leverage big data, and this consensus is statistically valid and can be applied beyond the sample group.

Conclusion

This research study examined the challenges and opportunities associated with the use of big data analytics at central banking, focusing on the Central Bank of Aden. In the final section, the researchers evaluate the limitations of the current study, such as scope, data, and methodological constraints, which may have influenced the results. Building on these limitations, the study proposes recommendations for future research to understand a big data application and their implications for central banking practices, both within Aden context and more broadly. The insights gained from this discussion of limitations and future research directions are crucial, as they can inform the development of more robust, comprehensive, and impactful studies on the subject. Furthermore, these insights may guide central banks, including the Central Bank of Aden, in their strategic planning and decision-making around the integration of big data analytics into their operations and policy frameworks.

The study proposes a set of recommendations for the central bank of Aden to activate harness power of big data, which can be summarized as; establishing a comprehensive big data strategy aligned with the bank's mission and goals to enhance data governance and management practices, ensuring data integrity and security. Investing in data management infrastructure and tools to support effective governance and building robust big data analytics capabilities, including advanced tools and talent. Finally, cultivating a data-driven organizational culture through training and incentives.

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