Development of a Concept for Managing National Resources in Accordance with Sustainable Development Goals in A Low-Carbon Economy

AIDA ZHAGYPAROVA[1], AIGUL ALIBEKOVA (*Corresponding author*)[2], MADINA SERIKOVA[3], DINMUKHAMMED SHAIKIN[4], OXANA KOPYLOVA[5], and MAIRA VALIEVA[6]

[1], Associate Professor, Deputy Dean for Science of the Faculty of Economics, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan, e-mail: Zhagyparova_Aida@mail.ru, ORCID ID: https://orcid.org/0000-0003-4792-9450

[2] Associate professor of "State Audit" Department L.N. GumilyovEurasian National University, Astana, Kazakhstan, e-mail: alibiekovaaiga87@mail.ru, ORCID ID: https://orcid.org/0000-0003-4001-1938

[3] PhD, L.N. Gumilev Eurasian National University, Astana, Kazakhstan, ORCID ID: https://orcid.org/ 0000-0002-9832-8885

[4] Candidate of Economic Sciences, L.N. Gumilev Eurasian National University, e-mail: shaikindimash@mail.ru, ORCID ID: http://orcid.org/0000-0001-7611-2787

[5] Candidate of Economic Sciences, L.N. Gumilev Eurasian National University, e-mail: oxana.kopylova@mail.ru, ORCID ID: http://orcid.org/0000-0002-0083-8570

[6] Candidate of Economic Sciences, North Kazakhstan University named after Manash Kozybayev, Petropavlovsk, Kazakhstan, e-mail: mvalieva1975@mail.ru, ORCID ID: http://orcid.org/0000-0002-0312-6245

ABSTRACT

Relevance of the study. In the modern conditions of public activity, characterized by constant changes in the economic environment, digitalization of processes and the need to ensure sustainable development, the role of effecttive management of public resources is increasing. At the same time, public audit is the most important mechanism of control, transparency and accountability in the management of public finances. The study is aimed at developing a new paradigm of public audit and recommendations for improving the system of assessing the management of public resources, contributing to the improvement of the efficiency of public administration and the sustainability of economic development. The purpose of the study is to develop a new paradigm and concept for the development of public audit aimed at increasing the efficiency of using public resources, improving the transparency and accountability of government agencies, and minimizing corruption risks. Research hypothesis. The introduction of a new paradigm of public audit based on international standards, modern technologies and best foreign practices will significantly increase the efficiency of public resource management, improve the transparency and accountability of government agencies, and reduce the level of corruption. The use of a risk-oriented approach, big data analytics and digitalization of audit processes in the national system of state audit will contribute to a more rational and targeted use of budget funds, which will have a positive impact on the eco-

nomic development of the country. Research results. As a result of the study, conclusions were obtained that confirm the hypothesis that the introduction of a new paradigm of state audit and the use of modern technologies can significantly improve the efficiency of public resource management and improve the quality of control.

INTRODUCTION

Public audit plays a key role in ensuring effective and transparent management of public resources, as well as maintaining public trust in public institutions. In the context of globalization and growing economic challenges associated with digitalization, sustainable development and economic crises, public audit systems require constant updating and adaptation to new realities. The development of technologies, including artificial intelligence and big data analysis, opens up new opportunities to improve the efficiency of audit processes and improve control over the use of budget funds. Many countries successfully implement innovative methods of audit and management of national resources, focusing on international standards and best practices. However, national audit systems often face unique challenges, such as lack of transparency, limited resources or political dependence of audit bodies. This makes it necessary to develop a new paradigm of public audit that will not only take into account global trends, but also effectively adapt to the specific conditions of a particular country. The purpose of this study is to develop a new concept of public audit and make recommendations for improving the system for assessing the quality of management and the effective use of national resources, based on international experience. The study aims to identify best foreign practices and integrate them into the national system of public audit in order to improve the transparency, efficiency and effectiveness of public funds management.

The study will include an analysis of existing approaches to public audit in countries with a developed financial control system, such as the United States, Germany, South Korea and Singapore. The experience of introducing modern technologies into the audit process, such as the use of big data analytics and a risk-oriented approach, will be studied, and the results of audit reforms aimed at increasing accountability and minimizing corruption will be assessed.Thus, the relevance of this study is due to the need to improve the efficiency of public administration in the context of modern challenges and opportunities. The development of a new paradigm of public audit will contribute to a more rational and transparent use of national resources, having a positive impact on economic development and strengthening citizens' trust in government institutions.

1. LITERATURE REVIEW

The effectiveness of public administration, including economic, is considered as the implementation of management, during which the set goals are achieved (solving a certain socially significant problem, satisfying the interests of the population, maintaining the digital competitiveness of the region and the country) while minimizing costs and complying with modern standards of digital maturity (Ortina et al., 2023; Bilan et al., 2023). Public sector auditing is associated with various institutional logics associated with three public sector paradigms: Public Administration (PA), NPM and NPG. In addition, the evolution of ECA audit methodology and standards has contributed to the overall improvement of the audit process over time (Talbot et al., 2023).

Public institutions will manage public finances in accordance with the principles of efficiency, effectiveness and economy (3E), and their activities are mainly scrutinized through performance auditing (Cordery&Hay, 2019). The debate on the emergence of performance audit and non-financial audit in the public sector has a certain gap in the literature on supranational audit institutions, which are discussed by authors such as (Bonollo, 2019; Mattei et al., 2021; Nerantzidis et al., 2022). In any organization, audit plays a key role in identifying whether there have been abuses in the decision-making process and resource allocation (Grossi et al., 2023; Moolkham, 2025). In a democratic system, there are checks and balances that ensure accountability for the decisions made by agents - those who hold public office (Cordery et al., 2022). Thus, the decision-making process and the allocation of public funds and other resources by

cabinet ministers and administrators should be audited (Hay and Cordery, 2021; Salienė et al., 2024), since their decisions and the way they use public funds and resources certainly affect not only the well-being of the current generation but also the well-being of future generations. The UN emphasizes the importance of sustainable production and consumption to ensure the conservation of renewable and non-renewable natural resources. In this regard, reports call on organizations to be accountable for intergenerational equity, which is related to poverty reduction through the equitable distribution of natural resources and anthropogenic wealth among individuals, while ensuring environmental sustainability (Kozubikova et al., 2024; Dvorsky et al., 2024). As a result, the debate has focused on sustainability mainstreaming (Bebbington and Unerman, 2018) and sustainability auditing (Celone et al., 2022).

Public sector organizations are increasingly adopting innovative principles and implementing digital governance strategies to improve service delivery (Grossi and Argento, 2022). Increased transparency, improved efficiency, and improved communication and engagement with users are among the key benefits of implementing smart services (Argento et al., 2020),(Spicer et al., 2021). Around 80 countries claim to conduct some form of performance auditing, and there should be scope to explore this function in countries, which differs significantly from previous studies in the UK, Europe, Australia and New Zealand. Country experiences show that successful implementation of e-government models promotes good governance and is an important factor in creating effective, distinct and inclusive institutions at all levels of government (Dreshpak, 2022). With the development of digital technologies and innovative public services, it becomes important for governments to use them strategically to improve the quality of services provided and ensure sustainable development. This can be a key factor in improving the efficiency and openness of government agencies (Eom and Lee, 2022). Researchers Ramsetty & Adams (2020) examine these issues in detail and are likely to provide analysis and examples demonstrating how open data and innovative technologies can be used to achieve e-participation and public engagement.

2. RESEARCH DESIGN

The research design provides a comprehensive approach to studying the current state of public audit and assessing the management of national resources. The use of both quantitative and qualitative methods will provide a deeper understanding of existing problems and develop recommendations for their solution based on international standards and practices. *Research limitations*: a) difficulties in gaining access to full data from government reports and statistics; b) limited number of experts willing to participate in interviews and share inside information; and c) limited applicability of international standards and practices in the national context due to the specifics of legal and economic systems.

Expected results: a) Development of a new paradigm of public audit, including elements of a risk-oriented approach, sustainable development audit and the use of modern technologies (e.g. big data); b) Development of recommendations for the implementation of a system for assessing the quality of management and the effective use of national resources, based on international standards and successful examples; and c) Increasing transparency and accountability in the management of public resources through improving audit processes and using international best practices.

3. FOREIGN EXPERIENCE IN CONDUCTING STATE AUDIT

State audit is an independent inspection and assessment of the activities of state bodies, budgetary institutions and organizations, carried out in order to ensure the legal, effective, efficient and targeted use of state funds and property. The main objective of state audit is to guarantee transparency and accountability in the management of public resources, as well as to ensure proper control over the implementation of state programs and projects. Foreign experience in conducting state audit includes various approaches, methodologies and practices that are used in different countries (Figure 1).

This experience can serve as a basis for improving the government audit system in other countries, including the introduction of best practices and innovative approaches. Government auditing in the United States is carried out through various government and independent audit bodies, the most famous of which

is the U.S. Office of the Auditor General (GAO). Here are the main aspects of government auditing in the United States:

A. Structure and Independence. GAO is an independent agency reporting to Congress, ensuring its independence from the executive branch and allowing GAO to conduct objective and impartial audits.

B. Types of Audits:

- Financial Audit - examining the financial statements of federal agencies for compliance with standards and rules;

- Compliance Audit - assessing how agencies comply with laws, rules, and regulations.
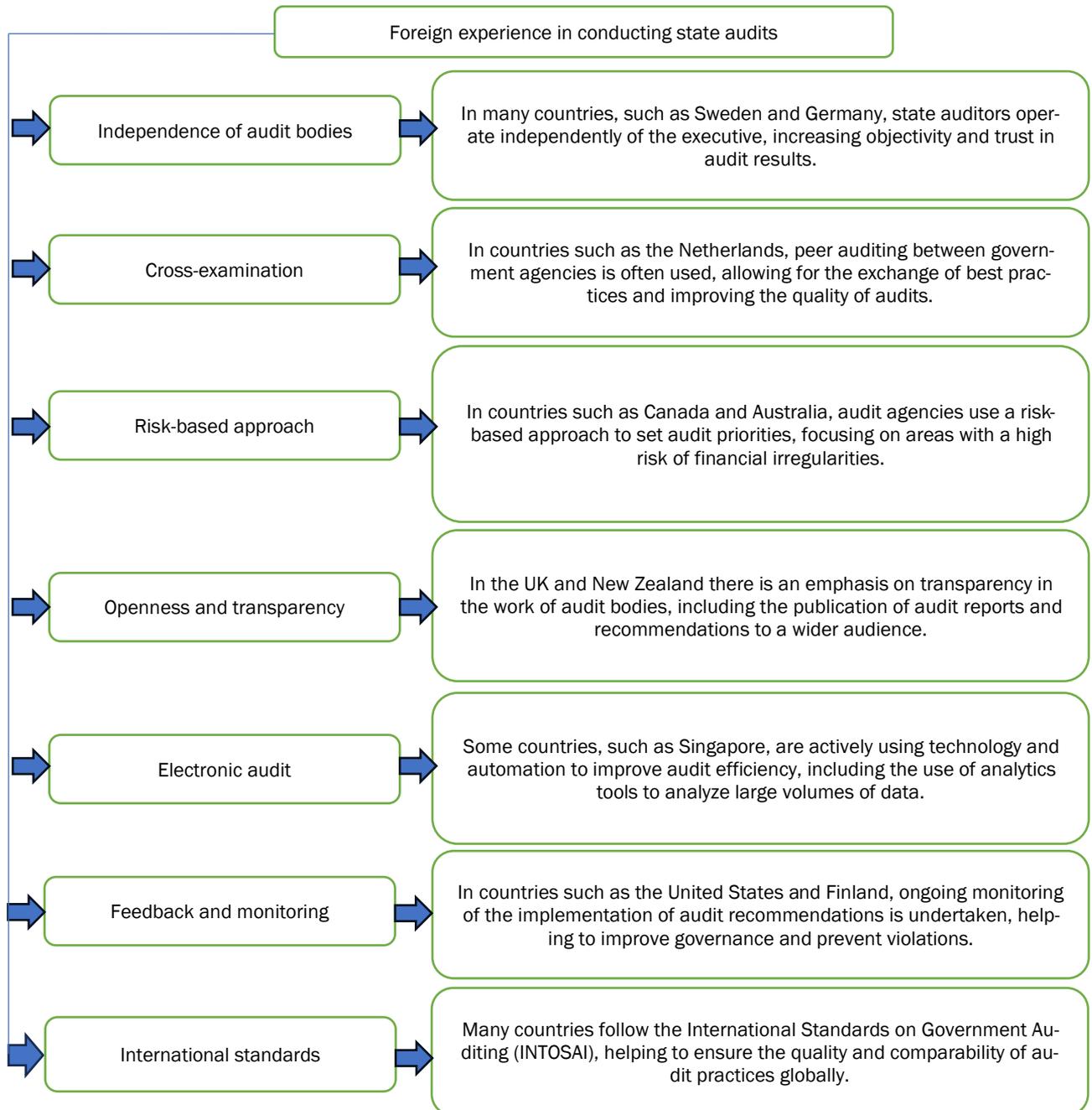
Foreign experience in conducting state audits	
Independence of audit bodies	In many countries, such as Sweden and Germany, state auditors operate independently of the executive, increasing objectivity and trust in audit results.
Cross-examination	In countries such as the Netherlands, peer auditing between government agencies is often used, allowing for the exchange of best practices and improving the quality of audits.
Risk-based approach	In countries such as Canada and Australia, audit agencies use a risk-based approach to set audit priorities, focusing on areas with a high risk of financial irregularities.
Openness and transparency	In the UK and New Zealand there is an emphasis on transparency in the work of audit bodies, including the publication of audit reports and recommendations to a wider audience.
Electronic audit	Some countries, such as Singapore, are actively using technology and automation to improve audit efficiency, including the use of analytics tools to analyze large volumes of data.
Feedback and monitoring	In countries such as the United States and Finland, ongoing monitoring of the implementation of audit recommendations is undertaken, helping to improve governance and prevent violations.
International standards	Many countries follow the International Standards on Government Auditing (INTOSAI), helping to ensure the quality and comparability of audit practices globally.

Figure 1. Foreign experience in conducting state audit

Source: Compiled by the authors

C. Performance Evaluation. Analyzing the effectiveness of programs and operations to determine whether goals are being achieved.

D. Risk-Based Approach. GAO uses a risk-based approach to focus on areas where financial irregularities or poor performance are most likely.

E. Publication of Reports. GAO regularly publishes audit reports that are available to the public and used by Congress to make funding and legislative decisions.

F. Monitoring Implementation of Recommendations. GAO monitors how federal agencies are implementing its recommendations and includes this information in its subsequent reports.

G. Collaborating with Other Agencies. GAO actively collaborates with other state and local audit agencies, as well as with international organizations, to share best practices.

H. Technology Approach. GAO implements new technologies and analytical tools to improve the efficiency of its audits and data analysis.

I. Program Audits. GAO audits a variety of federal programs to evaluate their effectiveness and appropriateness and to identify areas for improvement.

J. Training and Professional Development. GAO also invests in the training and development of its staff to maintain a high level of professionalism and audit knowledge.

Government auditing in the United States plays a key role in ensuring accountability and transparency in the use of federal funds, which contributes to more efficient management and improved government services. The assessment of the efficiency of budget use can vary significantly across countries depending on the methodology and indicators used for the analysis. In the context of studies by the Organisation for Economic Co-operation and Development (OECD), efficiency assessment is often carried out using methods such as frontier efficiency analysis (DEA). This approach allows identifying potential for efficiency improvements, for example in health and education (Table 1).

Table 1. Examples of assessing the effectiveness of using budget funds

№	Country	Usage	Opportunity
1	United Kingdom	Performance-Based Budgeting (PBB)	the approach aims to improve efficiency through rigorous monitoring and evaluation of programs with the goal of achieving better results at the same or lower cost
2	France	The performance audit conducted by the Accounts Chamber is widely used	allows identifying areas where public spending can be optimized and offers specific recommendations for improvement
3	South Korea	A system for assessing the effectiveness of budget expenditures has been introduced, including regular reviews of programs and projects to ensure their cost-effectiveness and efficiency	helps to reduce unnecessary expenses and direct funds to more productive areas
4	Germany	Strict audit and control mechanisms are applied to assess the effectiveness of the use of public funds	includes both internal and external audits, as well as the use of a system of indicators for monitoring and evaluating the implementation of budget programs

Source: compiled by the authors

Evaluation of the effectiveness of budget funds abroad involves the use of various metrics and indicators. Here are some examples from other countries:

A. Return on investment (ROI) in healthcare.

In the UK, £100 million was invested in a cardiovascular disease prevention program, which reduced hospitalizations by 20%. If the average cost of hospitalization is £5,000 and the number of hospitalizations prevented was 10,000, then:

ROI = (10,000 x 5,000) - 100,000,000 / 100,000,000 x 100% = -50%

This shows that, despite the high social effect, the short-term financial results were negative.

B. Effectiveness of educational programs.

In the USA, a teacher training program cost $20 million and covered 10,000 teachers. As a result, the level of student achievement increased by 15%. If the economic benefit of improving academic performance was $50 per student and the number of students was 200,000:

Savings = 200,000 x 50 = $10,000,000

So the net savings were:

Net savings = 10,000,000 – 20,000,000 = -$10,000,000

This highlights the need for long-term analysis of the effects of such programs.

C. Comparison of infrastructure costs.

In Australia, a bridge cost AUD 200 million, reducing travel time by 30 minutes for 10,000 users per day. If the average cost per hour of time is AUD$25:

Annual savings = 10,000 x 30 min x 25/60 x 365 = AUD$1,562,500

Payback period estimate:

Payback period = 200,000,000 / 1,562,500 ≈ 128 years

This demonstrates a long payback period that may not justify the investment.

D. Efficiency of social assistance programs.

In Canada, 50 million Canadian dollars were spent on a program to support the unemployed, allowing 5,000 people to find jobs. If the average salary is 40,000 Canadian dollars per year, then:

Tax savings = 5,000 × 40,000 × 0.2 = 40,000,000 Canadian dollars

Thus, the efficiency of the program can be estimated as:

Net savings = 40,000,000 – 50,000,000 = - 10,000,000 Canadian dollars

E. Environmental performance indicators.

In Norway, a water purification program costing 30 million Norwegian kroner was implemented, which reduced pollution by 40%. If the economic benefit from improving the ecosystem is estimated at 50 million crowns:

Net benefit = 50,000,000 – 30,000,000 = 20,000,000 crowns

This demonstrates the positive result and effectiveness of the program.

These examples show how different countries evaluate the effectiveness of the use of budget funds in different areas, which allows us to analyze whether the goals are being achieved and how appropriate the use of resources was.

4. ANALYSIS AND RESULTS

Let us consider the activities of state audit in the Republic of Kazakhstan, where the main performance indicators are presented by the Supreme Audit Chamber (Table 2).

Table 2. Key performance indicators of the Supreme Audit Chamber for the period 2015-2022, mil. tenge

Year	Number of audit events	Number of objects	Volume of funds	Total established violations	Amount of established financial violations	Volume of funds subject to recovery	Recovered and reimbursed funds
2016	11	116	2635305	562662	4 850,5	512	65062,5
2017	7	56	1297792,4	612549,9	10 946,5	1 121,1	62 783,1
2018	23	179	5195,8	429,2	771,0	138,1	130,1

2019	20	207	34177,5	1203,8	173,0	35,7	21,5
2020	18	117	47278781,2	1852710,3	689,3	80 648,9	15723
2021	21	155	32363548,8	1723035,6	11 116	397 166,6	390155
2022	20	124	4958499	271100,9	2186,3	34 188,1	16905,1

Source: compiled by the authors according to https://www.gov.kz/memleket/entities/esep?lang=ru.

Based on the presented data on the activities of the Supreme Audit Chamber, we can conclude that the coverage of budget funds by audit activities has expanded. To assess the effectiveness of audit activities and identify the main trends for the period 2016–2022, we will conduct the following calculations and analysis:

A. Funds recovery rate

The recovery rate shows how effectively the identified financial violations are returned to the budget. We will calculate it for each year as the ratio of recovered funds to the amount of funds subject to recovery (Table 3, Figure 2).

Recovery Ratio = Recovered Funds / Amount of Funds to be Recovered x 100

Table 3. Calculation of the recovery coefficient

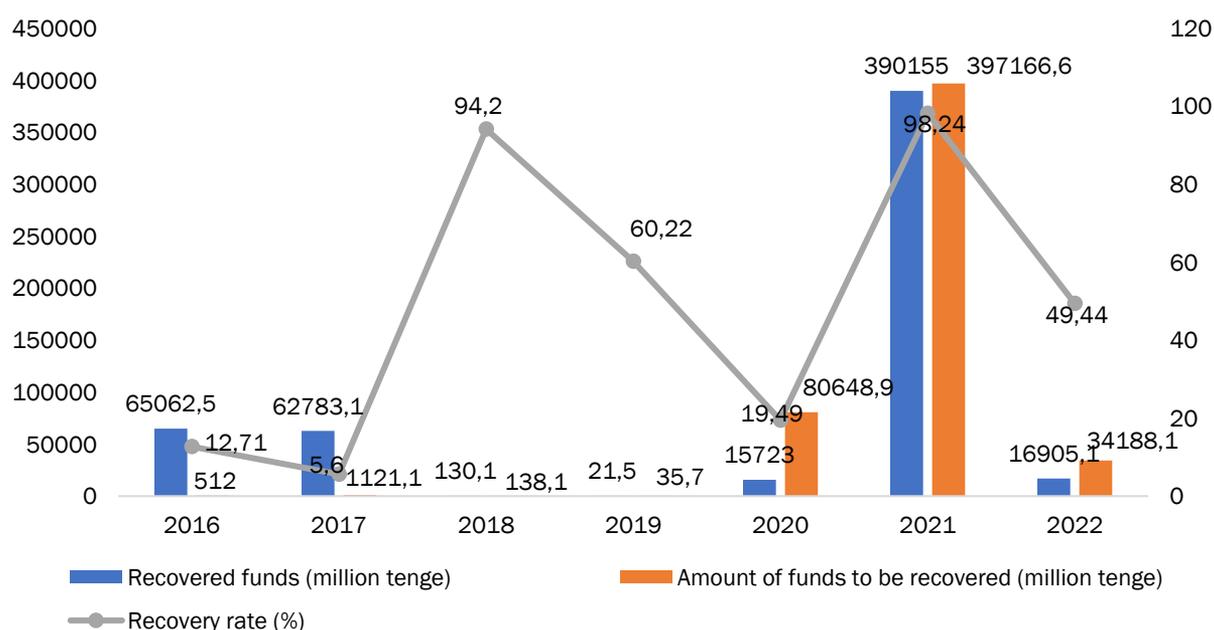| Year	Recovered funds (million tenge)	Amount of funds to be recovered (million tenge)	Recovery rate (%)
2016	65062,5	512,0	12,71
2017	62783,1	1121,1	5,60
2018	130,1	138,1	94,20
2019	21,5	35,7	60,22
2020	15723,0	80648,9	19,49
2021	390155,0	397166,6	98,24
2022	16905,1	34188,1	49,44

Source: compiled and calculated by the authors

Figure 2. Indicators characterizing the recovery coefficient

Source: Compiled and calculated by the authors

B. Growth rate of the volume of verified funds

The growth rate shows how the volume of verified funds has changed. We will calculate it as a percentage change compared to the previous year (Table 4).

Growth rate = Current year's verified funds volume - Last year's verified funds volume / Last year's verified funds volume x 100

Table 4. Calculation of the growth rate of the volume of verified funds

Year	Volume of verified funds (million tenge)	Growth rate (%)
2016	2,635305	-
2017	1297792,4	-50,75
2018	5195,8	-99,60
2019	34177,5	+557,70
2020	47278781,2	+137271,83
2021	3236358,8	-31,56
2022	4958499	-84,68

Source: compiled by the authors

C. Share of financial violations from the volume of funds checked

Shows what part of the checked funds was subject to violations. We will calculate it as a percentage of the amount of financial violations to the volume of funds checked (Table 5).

Share of violations = Amount of financial violations / Volume of funds checked × 100

Table 5. Calculation of the share of financial violations

Year	Volume of verified funds (million tenge)	Amount of financial violations (million tenge)	Percentage of violations (%)
2016	2635305	4 850,5	0,18
2017	1297792,4	10 946,5	0,84
2018	5,195.8	771,0	14,84
2019	34177,5	173,0	0,51
2020	47278781,2	689,3	0,0015
2021	3236358,8	11 116	0,034
2022	4958499	2186,3	0,044

Source: compiled by the authors

D. Trends and Findings

The recovery rate varied, with the highest in 2021 (98.24%) and the lowest in 2017 (5.60%). This may indicate an increase in the efficiency of recovery since 2018, despite a decline in 2020.

The volume of funds inspected increased significantly in 2020 (by 137,271.83%), which may be due to increased government oversight in the context of the pandemic and economic crisis. However, there has been a sharp decline in the volume of funds inspected in 2021 and 2022.

The share of financial violations is generally small (less than 1% for most years), but there was a sharp jump to 14.84% in 2018. This may indicate significant problems this year or increased scrutiny. 5. Effectiveness of measures

The effectiveness of audit measures can be assessed by calculating the ratio between the number of objects and the violations identified, as well as the amount of funds recovered (Figure 3).

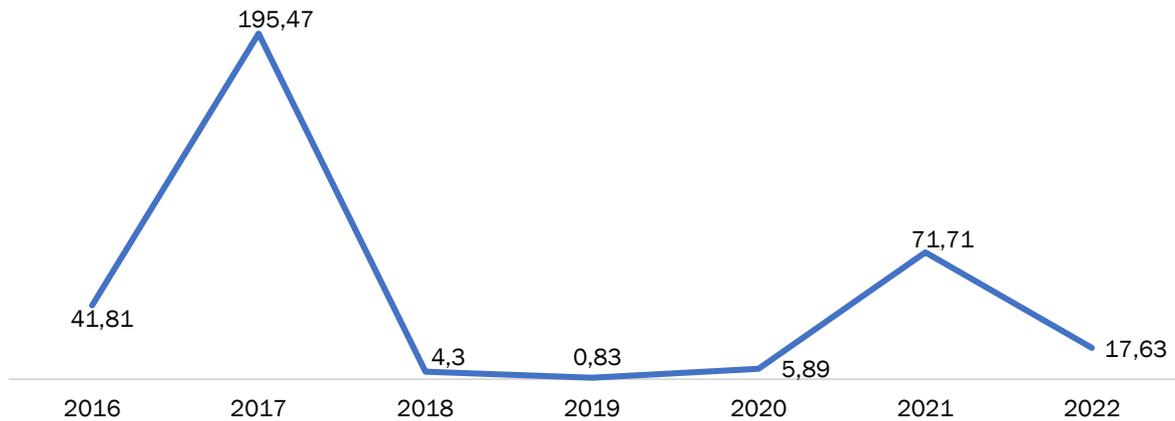Efficiency of measures = Amount of funds recovered / Number of objects

Figure 3. Assessment of the effectiveness of audit activities, million tenge

Source: Compiled on the basis of calculations made

For example, the Supreme Audit Chamber summed up the results of 20 audit activities conducted at 124 facilities in 2022. The volume of funds covered by the audit amounted to 4,958.5 billion tenge. During the audits, 271.1 billion tenge of violations were identified, including 34.2 billion tenge of financial violations, 236.9 billion tenge of ineffective planning and use of budget funds and state assets.

E. Calculate the average values for the budget deficit and debt to GDP using the formula:

Average value = $\sum$ Indicator values / Number of years

Data:

- budget deficit: [−4.1,−2.8,−2.4,−3.1,−3.4,−3.8,−4.7,−15.0,−12.4,−5.8]
- government debt to GDP:
[100.3,102.4,100.2,105.4,105.0,105.8,107.2,128.4,127.0,129.5]
Calculations:

A. Average budget deficit:

- sum of values:
[−4.1, −2.8, −2.4, −3.1, −3.4, −3.8, −4.7, −15.0, −12.4, −5.8]
Number of years: 10

B. Average value of public debt:

- sum of values: [100.3+102.4+100.2+105.4+105.0+105.8+107.2+128.4+127.0+129.5]
Number of years: 10

Next, we will carry out calculations:

A. Average value of budget deficit

$\sum$ =−4.1−2.8−2.4−3.1−3.4−3.8−4.7−15.0−12.4−5.8=−58.7
Average=−58.7 / 10=−5.87%

B. Average public debt to GDP

$\sum$=100.3+102.4+100.2+105.4+105.0+105.8+107.2+128.4+127.0+129.5=1,189.2
Average=1,189.2 / 10=118.92%

Thus, the main trends are the growth of the efficiency of recovery of funds and a significant increase in the volume of inspections in certain periods:

- recovery of funds has become much more efficient by 2021 year, which may indicate an improvement in the quality of audit activities;
- 2020 stands out for its sharp increase in the volume of audited funds, which may be due to special circumstances (e.g., combating the consequences of the pandemic);
- the share of financial violations remains relatively low, which may indicate a high level of compliance with financial discipline or effective management in most cases.

The development of a new paradigm and concept of public audit, based on foreign experience, involves a more integrated, transparent and effective approach that takes into account both modern challenges and the needs of society. Implementation of these recommendations will help create a more effective public audit system that will contribute to better management of national resources and increase trust in government institutions. Development of a new paradigm and concept for the development of public audit requires taking into account modern challenges, such as transparency, accountability, use of technology and the need for sustainable development. Here are some key recommendations for improving the system for assessing the quality of management and effective use of national resources in the Republic of Kazakhstan:

A. New paradigm of public audit:

a) Integration with risk management:
- introduce a risk-oriented approach to auditing, focused on assessing the risks associated with financial and operational processes, helping to more effectively direct resources to audit checks.
b) Focus on results:
- change the emphasis from compliance with formal procedures to assessing the results and impact of programs. Audits should evaluate how effectively funds are used to achieve goals and results that benefit society.
c) Use of modern technologies:
- implement automation of audit processes, big data analysis and the use of analytical tools to increase the efficiency of audits and improve the quality of reporting.

B. The concept of developing public audit:

a) Increasing transparency:
- develop and implement openness standards in auditing activities, including the publication of reports available to a wide audience and the use of interactive platforms to inform citizens about audit results.
b) Feedback and engagement:
- create mechanisms for feedback from citizens and stakeholders to take their opinions into account when conducting audits and improving the management system.
c) Partnership with other organizations:
- establish partnerships with non-governmental organizations, academic institutions and international organizations to share experiences and best practices.

C. Recommendations for improving the management quality assessment system:

a) Development of key performance indicators (KPIs):
- define KPIs for assessing the results of state programs and initiatives, taking into account both quantitative and qualitative parameters.
b) Periodic review and updating of standards:
- regularly review and update audit standards and methodologies to ensure that they comply with modern requirements and international practices.
c) Personnel training and development:
- invest in training and advanced training of audit staff so that they can effectively use new technologies and methodologies.

D. Efficient use of national resources:

a) Sustainable development:
- include sustainable development principles in the assessment of the efficiency of resource use, paying attention to ecology, social responsibility and economic feasibility.

b) Optimization of budget processes:
- implement systems for monitoring and analyzing budget expenditure in real time to quickly respond to possible deviations and violations.

c) Evaluation of programs and projects:
- conduct comprehensive assessments of existing programs and projects for their effectiveness, identify successful practices and opportunities for improvement.

This new paradigm and concept for the development of public audit implies a more dynamic, flexible and results-oriented approach that allows for increasing public confidence in government institutions and ensuring more efficient use of national resources. The implementation of these recommendations will help create a sustainable management system that promotes social and economic development.

CONCLUSION

Public audit helps improve the quality of public resource management, identify weaknesses in the public control system, and increase public confidence in public institutions.

The relevance of improving public audit systems is especially obvious in conditions where countries face problems of corruption, misuse of budget funds and low efficiency of government programs.

In recent years, the introduction of new technologies, such as artificial intelligence, big data analytics and digitalization of audit processes, can significantly improve the quality and speed of audits, as well as reduce the cost of their implementation. However, the use of these technologies requires a significant revision and update of the concept of public audit, which should be adapted to current challenges and opportunities. The relevance of the study is also associated with the need to adapt international standards and best practices in the field of audit for their effective application in various national conditions. In addition, in the context of growing international competition and the increasing role of global economic factors, each country seeks to improve the efficiency of its resources. Public audit plays a key role in ensuring the rational use of public funds, reducing corruption and increasing citizens' trust in government institutions. Updating the methodology and concept of state audit will lead to:

- Increasing the efficiency of using state resources through more accurate detection of violations and misuse of funds.
- Reducing corruption risks through the introduction of transparent and automated audit processes.
- Increasing the accountability of government agencies through the introduction of international standards and stricter control over the implementation of state programs.
- Optimizing audit costs through the introduction of digital tools and data analytics.

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