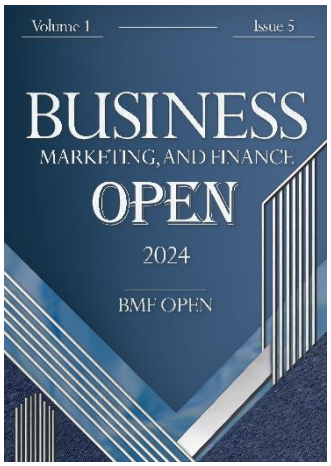
Providing a Model of Opportunities for Leveraging Blockchain Technology in Public Sector Accounting

Mahsa Ghasemi Toudeshkchoee[1], Gholamreza Kordestani[2,*] and Hossein Kazemi[3]



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[1] PhD Student, Department of Accounting, Qazvin Branch, Islamic Azad University, Qazvin, Iran;
[2] Professor, Department of Accounting, Imam Khomeini International University, Qazvin, Iran;
[3] Assistant Professor, Department of Accounting, Qazvin Branch, Islamic Azad University, Qazvin, Iran;
* Correspondence: Kordestani@soc.ikiu.ac.ir

Abstract: This research aims to provide a model of opportunities for leveraging blockchain technology in public sector accounting. The study adopts an applied research orientation and, from a research philosophy perspective, employs a mixed-method approach. In terms of objective, it falls under exploratory research. In the qualitative section, based on a content analysis approach, influential components were identified, coded, and categorized. In the quantitative part, a survey of 15 experts in this field was conducted using the fuzzy Delphi method to screen the identified components, and the final model was presented. Subsequently, the Fuzzy DEMATEL method was used to examine the influence and susceptibility of factors and determine the internal relationships. Finally, using the Fuzzy ANP method and pairwise comparisons, the most important opportunities were prioritized. The results indicate that the final model of blockchain opportunities in public sector accounting consists of six dimensions and thirty-two components. Improved control and accountability are the most influential dimensions and have the highest interaction with other studied factors. Among the opportunity components, fraud reduction in auditing is the most influential, and increasing the efficiency, effectiveness, and reliability of auditing has the highest interaction with other studied factors. In prioritizing the opportunities, improved control and accountability, followed by increased efficiency, effectiveness, and reliability of auditing, hold the highest priority in the dimensions and components, in accordance with expert opinions. Public accountants and government institutions, as major producers and consumers of information and holders of extensive information resources across various domains, have significant capacity for applying this innovation and benefiting from its advantages. Considering the goals of public sector accounting in public accountability responsibility and the importance of agility and quality in meeting the information needs of various stakeholders, as well as the necessity to focus on the sub-systems of public sector accounting composed of financial accounting, auditing, and managerial accounting, these results demonstrate that the opportunities created by this innovation can be extensive and simultaneously impact other branches of accounting. Therefore, the findings of this study are important in identifying the potential of this technology to improve public accounting and its role in macroeconomics, enhancing the democratic process for countries, reducing corruption, improving accountability responsibility, and ultimately enhancing the financial performance of companies and government organizations. Given the breadth of this field, which includes a wide range of services related to commercial and banking institutions, consulting, taxation, etc., the results can be utilized by practitioners in this domain.

Keywords: Public Sector Accounting, Blockchain, Opportunity

1. Introduction

The cornerstone of the public sector accounting system is accountability; therefore, the most important goal of the accounting and financial reporting system is to provide information that assists managers in effectively fulfilling accountability responsibilities [1]. The emergence of blockchain technology, due to its unique features in increasing transparency, security, and immutability, adds greater value to the provision and operation of public services. Therefore, it has the potential to improve the efficiency of public services and accountability, bridging the growing trust gap between individuals and governments, which is a long-term issue and a concern for democratic governance and public management [1]. Consequently, with the attention given to blockchain in the financial and accounting fields, this technology has demonstrated its potentials in the public management sector and public and governmental accounting [2]. In line with the potential of this technology in improving accountability, its role in assisting in the implementation of accrual accounting [3], improving corporate governance, enhancing the traceability of resources through identifying the origin of transactions and government funds, and reducing corruption and fraud [4], increasing transparency in public budget allocation [5], automating calculations and tax processing with smart contracts, and reducing tax evasion [6], and integrating accounting and tax information regarding taxes collected at various government levels (national, state, and local) [5], among many others, have been highlighted.

Another important aspect is that the sub-systems of public sector accounting consist of three sub-systems: financial accounting, managerial accounting, and auditing [7]. In each of these areas, blockchain technology has extensive potentials that can increase trust, savings, verifiability, security, etc., in the accounting cycle, and as a result, be used in connection with public sector accounting. For example, the verifiability feature of blockchain is expected to significantly impact corporate reporting and financial accounting, especially in measuring, presenting, and disclosing financial information, reducing disclosure errors and earnings management, improving the qualitative characteristics of information, and reducing information asymmetry [8]. In managerial accounting, blockchain accounting systems share immutable records and transaction data, and authorized users (such as business partners, suppliers, accountants, and auditors) are interconnected [9]. Additionally, integrating blockchain in managerial and financial accounting eliminates the disconnect between these two branches. Traditionally, these areas rely on separate information systems, leading to inefficiency and data reconciliation challenges. Blockchain technology provides an integrated platform that can meet both financial and managerial accounting needs, simplifying processes and improving data consistency [10]. In the auditing field, the real-time updating and distribution features of blockchain can enhance the efficiency, effectiveness, and reliability of auditing. Its features allow auditors to reconstruct auditing processes, procedures, and evidence collection processes. Continuous data flows enable all network participants to verify and receive real-time transaction updates, facilitating continuous and real-time audit testing [11].

However, despite these extensive potentials in the attention given to blockchain, investments in other areas of accounting and auditing have received more focus, and fewer studies have been conducted on blockchain in public sector accounting. Meanwhile, public accountants and government institutions, as major producers and consumers of information and holders of extensive information resources across various domains, have greater capacity for applying innovation and benefiting from its advantages. Therefore, considering that public sector accounting also

seeks agility, quality, and accountability in responding to stakeholder needs, the results of this research are significant in identifying the potentials of this technology to improve public accounting and its role in macroeconomics, enhancing the democratic process for countries, reducing corruption, improving accountability responsibility, and ultimately enhancing the financial performance of companies and government organizations. Given the breadth of this domain, which includes a wide range of services related to commercial and banking institutions, consulting, taxation, etc., the results can be utilized by practitioners in this field.

Therefore, in this study, by simultaneously considering the objectives of public sector accounting (public accountability responsibility and meeting the information needs of various stakeholders), the public accounting cycle, the sub-systems of public sector accounting composed of financial accounting, managerial accounting, and auditing, and the future research orientations of public sector accounting in Iran based on previous research findings and linking them, first through literature review and extracting effective codes, then screening them through experts, followed by examining the interaction of these factors using the Fuzzy DEMATEL method and weighting them using the ANP method, this study addresses the following questions: What are the opportunities for adopting blockchain in the public accounting sector? Additionally, it examines: How intense are the influence and susceptibility of the opportunities for utilizing blockchain technology in public sector accounting? And, how are the opportunities for utilizing blockchain technology in public sector accounting prioritized?

2. Methodology

The research adopts an applied research orientation and, from a research philosophy perspective, employs a mixed-method approach. In terms of objectives, it falls under exploratory research. In the qualitative section, based on a content analysis approach, influential components were identified, coded, and categorized. In the quantitative section, a survey was conducted with 15 experts in this field using the fuzzy Delphi method to screen the identified components, and the final model was presented. Subsequently, the Fuzzy DEMATEL method was used to examine the influence and susceptibility of factors and determine the internal relationships. Finally, using the Fuzzy ANP method, the weights of pairwise comparisons were first calculated using the geometric mean method and then placed in the ANP supermatrix to obtain the final weights. In this study, 15 experts (including professors and specialists in public accounting and accounting professionals with an emphasis on their familiarity with modern technologies such as blockchain) were selected as group members through judgmental sampling, which is a subset of purposive sampling.

The Delphi technique is effective for the "identification" and "screening" of the most important decision-making indicators. The Delphi method is typically conducted over a minimum of two rounds. Usually, the objective of the first round is to identify topics related to the research issue. The first-round questionnaire was developed by the researcher based on an extensive and comprehensive literature review. After collecting and reviewing the questionnaires in the first round, the components on which the experts agreed remained in the study, and other items were eliminated. In the second round, a new questionnaire (common components were added to the previous stage's questionnaire) was distributed to evaluate their opinions. These stages continue until all studied experts agree on all components. The procedure is as follows: first, an appropriate fuzzy spectrum was created for fuzzifying the respondents' linguistic terms. This spectrum is based on a five-point Likert scale.

After selecting the appropriate method and defuzzifying the values for screening the items, a tolerance threshold of 0.7 was considered. Finally, to prioritize the identified dimensions and components, the Fuzzy ANP method and pairwise comparisons using a nine-point scale were utilized.

3. Findings and Results

To address the first research question, literature review and content analysis were employed. For this purpose, all relevant domestic and international articles and studies related to the topic from the years 2008 to 2024 Gregorian and 2011 to 2024 Shamsi were reviewed. In the third step, existing codes were identified through the study of available literature. In the fourth step, the codes were linked into a category (component) and main concepts (primary dimensions) were created. Subsequently, a fuzzy Delphi method was conducted in two rounds based on the opinions of experts in this field. After defuzzifying the values for screening the items and considering a tolerance threshold of 0.7, some factors were either removed or added. Table 1 displays the fuzzy and defuzzified values for each question in the second round of the fuzzy Delphi.

Table 1. Results of Screening Indicators Using Fuzzy Delphi for Opportunities in the Second Round

Indicator	L	M	U	Defuzzified	Result
Assisting in fulfilling accountability responsibilities	0.65	0.90	1.00	0.85	Approved
Controlling public budget and funds	0.63	0.88	1.00	0.83	Approved
Traceability of resources	0.55	0.80	0.95	0.77	Approved
Reducing corruption and fraud	0.55	0.80	0.90	0.75	Approved
Integration of accounting and tax information	0.55	0.80	0.93	0.76	Approved
Improving tax inspection capacity	0.60	0.85	1.00	0.82	Approved
Enhancing the tax compliance process	0.53	0.75	0.90	0.73	Approved
Accessibility to cross-border taxes	0.50	0.75	0.88	0.71	Approved
Increasing timeliness	0.63	0.88	0.95	0.82	Approved
Enhancing impartiality	0.60	0.83	0.93	0.78	Approved
Increasing verifiability	0.65	0.90	1.00	0.85	Approved
Usefulness in evaluation	0.40	0.65	0.85	0.63	Rejected
Usefulness in forecasting	0.45	0.70	0.90	0.68	Rejected
Integrity in presentation	0.60	0.83	0.90	0.78	Approved
Understandability	0.38	0.55	0.70	0.54	Rejected
Comparability	0.60	0.83	0.90	0.78	Approved
Completeness	0.55	0.75	0.83	0.71	Approved
Cost and time savings (simplifying processes)	0.60	0.85	0.98	0.81	Approved
Automation of operations	0.63	0.88	1.00	0.83	Approved
Enhancing the security of accounting information	0.53	0.78	0.90	0.73	Approved
Improving the quality and transparency of accounting information	0.60	0.85	1.00	0.82	Approved
Enhancing data recording quality	0.65	0.90	1.00	0.85	Approved
Increasing the efficiency, effectiveness, and reliability of auditing	0.78	0.98	0.95	0.90	Approved
Reducing auditing control risk	0.38	0.55	0.70	0.54	Rejected
Increasing audit trail	0.45	0.63	0.78	0.62	Rejected
Facilitating real-time and continuous auditing	0.53	0.78	0.95	0.75	Approved
Reducing auditor report delays	0.60	0.85	0.98	0.81	Approved

Built-in authentication in the audit trail	0.60	0.83	0.90	0.78	Approved
Automating auditing operations	0.48	0.73	0.88	0.69	Rejected
Audit tracking	0.53	0.75	0.85	0.71	Approved
Using blockchain smart contracts and oracles as intelligent auditing procedures	0.58	0.80	0.88	0.75	Approved
Limiting Group 51% attack	0.48	0.70	0.83	0.67	Rejected
Reducing fraud in auditing	0.63	0.88	1.00	0.83	Approved
Integrating managerial and financial accounting and creating an integrated platform for both financial and managerial accounting needs	0.58	0.83	0.95	0.78	Approved
Eliminating intermediaries, direct customer interaction, and saving overhead costs	0.38	0.55	0.78	0.57	Rejected
Immediate corrective decisions due to real-time access to performance data	0.58	0.83	0.95	0.78	Approved
Automatic transaction/data verification	0.68	0.93	1.00	0.87	Approved
Error information tracking	0.45	0.68	0.90	0.68	Rejected
Enabling real-time accounting	0.60	0.80	0.90	0.77	Approved
Retrieving segregated information for reports and financial statements based on the needs of auditors, stakeholders, and managerial accountants	0.55	0.78	0.88	0.73	Approved
Analyzing and supporting financial and non-financial information for users	0.55	0.78	0.93	0.75	Approved

Finally, in Figure 1, the pattern of existing opportunities after screening and consolidating expert opinions is presented.

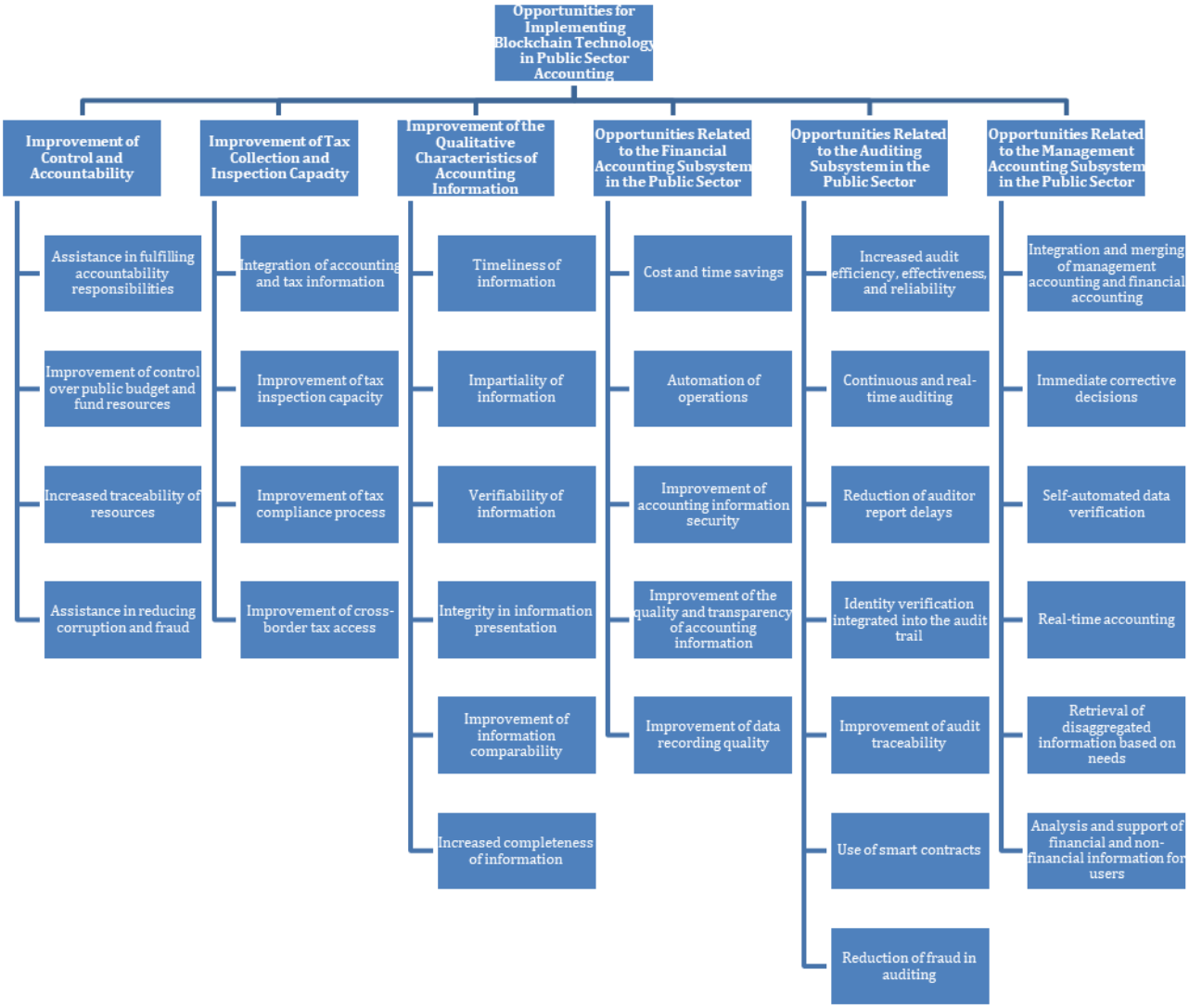

Figure 1. The Conceptual Model

This section addresses the implementation of the DEMATEL technique for the criteria and non-criteria indicators of the research (derived from the developed model).

Table 2. Values of D and R for Main Criteria

Criterion Name	Code	(Di) Defuzzy	(Ri) Defuzzy	Di + Ri	Di - Ri
Improvement of control and accountability	S1	7.520	7.533	15.053	-0.014
Improvement of tax imposition, inspection, and collection capacity	S2	6.926	6.940	13.866	-0.014
Opportunities for improving the qualitative features of accounting information	S3	7.391	7.374	14.765	0.017
Opportunities related to the financial accounting subsystem in the public sector	S4	7.162	7.141	14.304	0.021
Opportunities related to the auditing subsystem in the public sector	S5	6.798	6.798	13.596	0.000
Opportunities related to the management accounting subsystem in the public sector	S6	6.921	6.932	13.853	-0.011

According to Table 2, the most influential criterion is "Improvement of control and accountability" (S1). The sum of the elements in column (R) for each factor indicates the extent to which the factor is influenced by other system

factors. Accordingly, "Improvement of control and accountability" (S1) has a significant level of influence. The horizontal vector (Di + Ri) represents the extent of impact and influence of the factor in the system. In other words, the higher the Di + Ri value for a factor, the more interaction it has with other factors in the system. Therefore, "Improvement of control and accountability" (S1) has the greatest interaction with other factors in the study. The vertical vector (Di - Ri) shows the power of influence for each factor. Generally, if Di - Ri is positive, the variable is considered a cause, while if it is negative, the variable is seen as an effect. In **Figure 2**, the criteria above the horizontal axis are considered causes, and those below are considered effects.

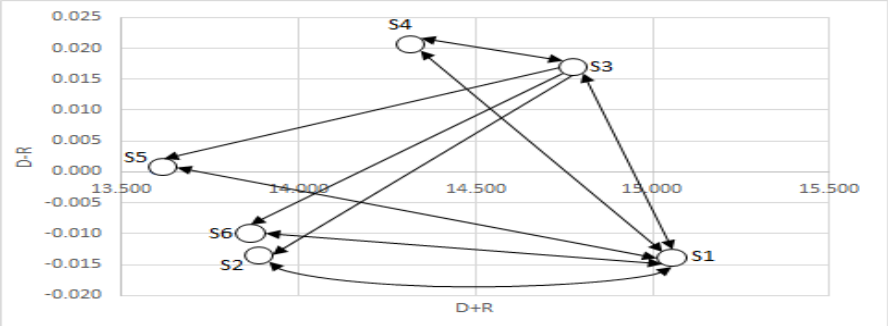

Figure 2. Causal Diagram of Main Criteria

In this section, the intensity of the impact and susceptibility of the sub-criteria of the opportunities was examined. The results are presented in Table 3.

Table 3. Values of D and R for Sub-Criteria of Opportunities

Criterion Name	Code	(Di) Defuzzy	(Ri) Defuzzy	Di + Ri	Di - Ri	Type of Factor
Help with accountability fulfillment	S11	4.539	4.742	9.281	-0.203	Susceptible
Improvement of control over public budget and funds	S12	4.625	4.637	9.262	-0.012	Susceptible
Increase in resource traceability	S13	4.868	4.720	9.588	0.147	Influential
Help in reducing fraud and corruption	S14	4.447	4.959	9.406	-0.511	Susceptible
Integration of accounting and tax information	S21	4.950	4.739	9.689	0.212	Influential
Improvement of tax inspection capacity	S22	4.963	4.842	9.805	0.120	Influential
Improvement of tax compliance process	S23	4.947	4.712	9.659	0.234	Influential
Improvement of cross-border tax access	S24	4.699	4.132	8.831	0.566	Influential
Increase in timeliness of information	S31	4.976	4.960	9.936	0.017	Influential
Increase in impartiality of information	S32	4.930	4.638	9.568	0.292	Influential
Increase in verifiability of information	S33	4.989	4.894	9.884	0.095	Influential
Integrity in data presentation	S34	4.583	4.903	9.486	-0.321	Susceptible
Improvement in comparability of information	S35	4.297	4.975	9.271	-0.678	Susceptible
Increase in completeness of information	S36	4.584	4.991	9.575	-0.408	Susceptible

Cost and time savings (process simplification)	S41	4.475	4.833	9.308	-0.359	Susceptible
Automation of operations	S42	4.675	4.539	9.214	0.135	Influential
Help with improving the security of accounting information	S43	4.669	4.427	9.096	0.242	Influential
Help with improving the quality and transparency of accounting information	S44	4.813	4.963	9.776	-0.150	Susceptible
Help with improving the quality of data registration	S45	4.918	4.879	9.798	0.039	Influential
Increase in auditing efficiency, effectiveness, and reliability	S51	5.272	5.208	10.480	0.063	Influential
Real-time and continuous auditing	S52	4.529	4.496	9.025	0.033	Influential
Reduction of auditor report delays	S53	4.405	4.724	9.128	-0.319	Susceptible
Authentication in the auditing trail	S54	4.690	3.345	8.034	1.345	Influential
Improvement in audit trail tracking	S55	4.839	4.329	9.168	0.510	Influential
Use of smart contracts and oracles as intelligent auditing procedures	S56	4.810	3.920	8.729	0.890	Influential
Reduction of fraud in auditing	S57	5.010	4.813	9.823	0.198	Influential
Integration and merging of management accounting and financial accounting	S61	4.739	4.789	9.528	-0.050	Susceptible
Immediate corrective decisions due to real-time access to performance data	S62	4.059	4.308	8.367	-0.248	Susceptible
Self-verifying transactions/data	S63	4.206	4.314	8.519	-0.108	Susceptible
Real-time accounting	S64	4.653	4.497	9.149	0.156	Influential
Recovery of disaggregated information based on the needs of auditors, stakeholders, and management accountants	S65	3.698	4.607	8.305	-0.908	Susceptible
Analysis and support of financial and non-financial information for users	S66	3.731	4.751	8.482	-1.019	Susceptible

In Table 3, the criterion "Reduction of fraud in auditing" (S57) has the highest influence, while "Increase in auditing efficiency, effectiveness, and reliability" (S51) is highly susceptible to other factors. The horizontal vector (Di + Ri) shows the degree of interaction between factors in the system. The higher the value of Di + Ri, the more interaction a factor has with other system components. As such, "Increase in auditing efficiency, effectiveness, and reliability" (S51) has the highest interaction with other factors under study. The vertical vector (Di - Ri) indicates the power of influence for each factor. Generally, if Di - Ri is positive, the variable is considered a cause, while if negative, it is seen as an effect. In Figure 3, the criteria above the horizontal axis are causal, while those below the axis are considered effects.

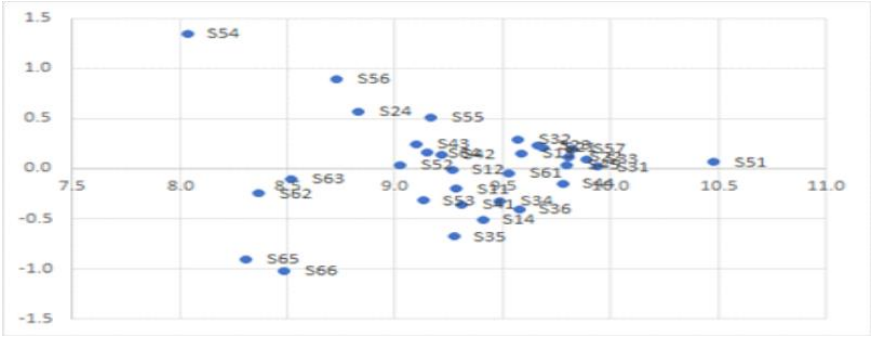

Figure 3. Causal Diagram of Sub-Criteria

To implement the fuzzy ANP method, the weights in pairwise comparisons are first obtained using the geometric mean method of Buckley. Then, by placing these weights in the initial ANP supermatrix, the weighted and limiting supermatrix are calculated to derive the final fuzzy ANP weights. Additionally, the total relationship matrix of DEMATEL is normalized column-wise (each entry is divided by the sum of the entries in its column), and then these are used as internal relationships of the factors in the ANP supermatrix. The results after these steps are presented in the table below. After responding to the pairwise comparisons, the inconsistency rates of the tables were calculated, all of which were less than 0.1, indicating that the stability and reliability of the pairwise comparisons are at an acceptable level.

Table 4. Pairwise Comparisons of Criteria

	S1	S2	S3	S4	S5	S6
S1	(1,1,1)	(2.169,3.2,4.216)	(1.097,2.016,2.897)	(1,1.26,1.442)	(1.925,2.953,3.966)	(1.149,1.977,2.745)
S2	(0.237,0.312,0.461)	(1,1,1)	(0.298,0.428,0.773)	(0.257,0.348,0.544)	(0.864,1.203,1.552)	(0.463,0.655,1.056)
S3	(0.345,0.496,0.912)	(1.294,2.334,3.351)	(1,1,1)	(0.517,0.66,1)	(1.32,2.352,3.366)	(1.284,2.104,2.964)
S4	(0.693,0.794,1)	(1.838,2.874,3.89)	(1,1.516,1.933)	(1,1,1)	(1.32,2.352,3.366)	(0.973,1.708,2.455)
S5	(0.252,0.339,0.52)	(0.644,0.831,1.158)	(0.297,0.425,0.758)	(0.297,0.425,0.758)	(1,1,1)	(0.472,0.613,0.955)
S6	(0.364,0.506,0.871)	(0.947,1.528,2.161)	(0.337,0.475,0.779)	(0.407,0.585,1.027)	(1.047,1.631,2.12)	(1,1,1)

Table 5. Pairwise Comparisons of Sub-Criteria for Opportunities to Improve Control and Accountability

	S11	S12	S13	S14
S11	(1,1,1)	(0.557,0.831,1.34)	(0.732,1.118,1.594)	(1.203,1.54,1.803)
S12	(0.746,1.203,1.797)	(1,1,1)	(0.693,1.149,1.797)	(0.947,1.6,2.326)
S13	(0.627,0.894,1.366)	(0.557,0.871,1.442)	(1,1,1)	(1.019,1.459,1.932)
S14	(0.555,0.649,0.831)	(0.43,0.625,1.056)	(0.518,0.686,0.981)	(1,1,1)

Table 6. Pairwise Comparisons of Sub-Criteria for Improving the Tax Imposition, Inspection, and Collection Capacity

	S21	S22	S23	S24
S21	(1,1,1)	(0.803,1.516,2.408)	(1.6,2.531,3.413)	(1.487,2.307,3.066)
S22	(0.415,0.66,1.246)	(1,1,1)	(1.294,1.94,2.5)	(1.149,1.888,2.731)
S23	(0.293,0.395,0.625)	(0.4,0.515,0.773)	(1,1,1)	(0.644,0.912,1.34)
S24	(0.326,0.433,0.673)	(0.366,0.53,0.871)	(0.746,1.097,1.552)	(1,1,1)

Table 7. Pairwise Comparisons of Sub-Criteria for Improving the Qualitative Features of Accounting Information

	S31	S32	S33	S34	S35	S36
S31	(1,1,1)	(1.68,2.75,3.0)	(0.857,1.24,1.76)	(2.246,3.276,4.29)	(1.203,2.128,3.01)	(1.613,2.334,2.98)
S32	(0.264,0.363,0.592)	(1,1,1)	(0.257,0.348,0.544)	(0.781,1.18,1.702)	(0.28,0.392,0.66)	(0.297,0.425,0.758)
S33	(0.565,0.803,1.167)	(1.838,2.874,3.89)	(1,1,1)	(1.689,2.754,3.784)	(1.32,2.246,3.128)	(1.047,1.708,2.281)

S34	(0.233,0.305,0.445)	(0.588,0.847,1.28)	(0.264,0.363,0.592)	(1,1,1)	(0.315,0.461,0.871)	(0.286,0.403,0.691)
S35	(0.332,0.47,0.831)	(1.516,2.551,3.565)	(0.32,0.445,0.758)	(1.149,2.169,3.178)	(1,1,1)	(0.565,0.732,1.008)
S36	(0.336,0.428,0.62)	(1.32,2.352,3.366)	(0.438,0.585,0.955)	(1.447,2.483,3.497)	(0.992,1.366,1.769)	(1,1,1)

Table 8. Pairwise Comparisons of Sub-Criteria for the Financial Accounting Subsystem in the Public Sector

	S41	S42	S43	S44	S45
S41	(1,1,1)	(0.973,1.631,2.281)	(1.487,2.417,3.299)	(0.929,1.382,1.797)	(1.127,1.631,2.039)
S42	(0.438,0.613,1.027)	(1,1,1)	(1.088,1.903,2.852)	(0.662,0.831,1.127)	(0.973,1.873,2.842)
S43	(0.303,0.414,0.673)	(0.351,0.525,0.919)	(1,1,1)	(0.37,0.561,0.944)	(0.841,1.294,1.831)
S44	(0.557,0.724,1.076)	(0.887,1.203,1.51)	(1.059,1.783,2.702)	(1,1,1)	(1.382,2.203,2.964)
S45	(0.49,0.613,0.887)	(0.352,0.534,1.027)	(0.546,0.773,1.189)	(0.337,0.454,0.724)	(1,1,1)

Table 9. Pairwise Comparisons of Sub-Criteria for the Auditing Subsystem in the Public Sector

	S51	S52	S53	S54	S55	S56	S57
S51	(1,1,1)	(1.26,2.186,3.069)	(0.588,0.847,1.28)	(1.097,2.111,3.117)	(0.632,0.809,1.105)	(0.94,1.51,2.289)	(1.149,2.032,2.93)
S52	(0.326,0.457,0.794)	(1,1,1)	(0.291,0.414,0.724)	(0.947,1.676,2.502)	(0.266,0.364,0.585)	(0.377,0.525,0.854)	(0.62,1.019,1.625)
S53	(0.781,1.18,1.702)	(1.382,2.417,3.431)	(1,1,1)	(2.087,3.128,4.147)	(1.203,1.769,2.404)	(1.149,1.803,2.371)	(1.149,1.977,2.745)
S54	(0.321,0.474,0.912)	(0.4,0.597,1.056)	(0.241,0.32,0.479)	(1,1,1)	(0.251,0.337,0.525)	(0.266,0.364,0.585)	(0.447,0.625,0.981)
S55	(0.905,1.236,1.582)	(1.708,2.745,3.76)	(0.416,0.565,0.831)	(1.903,2.964,3.991)	(1,1,1)	(0.599,0.758,1.076)	(1,1.708,2.389)
S56	(0.437,0.662,1.064)	(1.171,1.903,2.651)	(0.422,0.555,0.871)	(1.708,2.745,3.76)	(0.929,1.32,1.67)	(1,1,1)	(0.818,1.056,1.393)
S57	(0.341,0.492,0.871)	(0.615,0.981,1.613)	(0.364,0.506,0.871)	(1.019,1.6,2.236)	(0.419,0.585,1)	(0.718,0.947,1.222)	(1,1,1)

Table 10. Pairwise Comparisons of Sub-Criteria for the Management Accounting Subsystem in the Public Sector

	S61	S62	S63	S64	S65	S66
S61	(1,1,1)	(1.925,2.953,3.966)	(0.922,1.431,2.048)	(1.203,1.94,2.6)	(1.888,2.93,3.949)	(1.613,2.681,3.712)
S62	(0.252,0.339,0.52)	(1,1,1)	(0.392,0.53,0.871)	(0.379,0.534,0.955)	(0.693,1.203,1.933)	(0.386,0.574,1.076)
S63	(0.488,0.699,1.084)	(1.149,1.888,2.551)	(1,1,1)	(1.047,1.873,2.641)	(1.345,2.264,3.25)	(1.109,1.67,2.461)
S64	(0.385,0.515,0.831)	(1.047,1.873,2.641)	(0.379,0.534,0.955)	(1,1,1)	(0.803,1.26,1.797)	(0.955,1.6,2.307)
S65	(0.253,0.341,0.53)	(0.517,0.831,1.442)	(0.308,0.442,0.743)	(0.557,0.794,1.246)	(1,1,1)	(0.857,1.366,2.048)
S66	(0.269,0.373,0.62)	(0.929,1.741,2.591)	(0.406,0.599,0.901)	(0.433,0.625,1.047)	(0.488,0.732,1.167)	(1,1,1)

Table 11. Fuzzy and Non-Fuzzy Weights of the Main Criteria

Criterion Name	Geometric Mean	Fuzzy Weight (W)	Non-Fuzzy Weight	Normalized Weight
S1	(1.319,1.903,2.401)	(0.146,0.285,0.506)	0.306	0.276
S2	(0.44,0.576,0.826)	(0.049,0.086,0.174)	0.099	0.089
S3	(0.855,1.248,1.767)	(0.095,0.187,0.373)	0.210	0.190

S4	(1.086,1.55,1.99)	(0.12,0.232,0.42)	0.251	0.227
S5	(0.435,0.561,0.831)	(0.048,0.084,0.175)	0.098	0.088
S6	(0.606,0.84,1.213)	(0.067,0.126,0.256)	0.144	0.130
Total	(4.741,6.679,9.029)	-	-	-

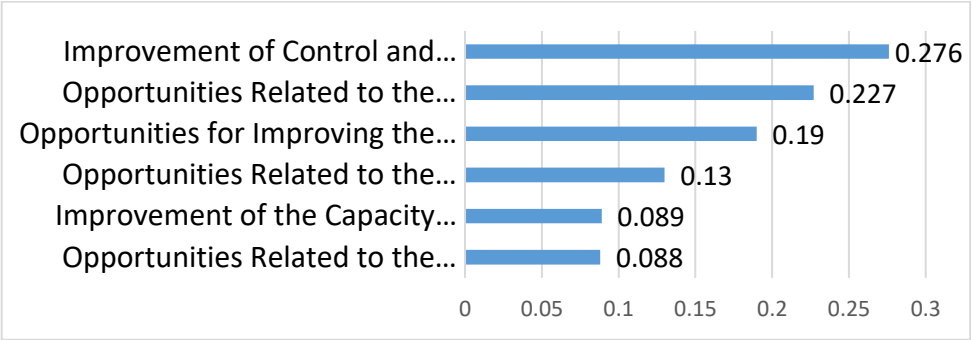

Figure 4. Weights of Main Criteria

According to Figure 4, the improvement of control and accountability, with a weight of 0.276, ranks first. Opportunities related to the financial accounting subsystem in the public sector, with a weight of 0.227, rank second, and opportunities for improving the qualitative features of accounting information, with a weight of 0.19, rank third. Similarly, pairwise comparisons for other sub-criteria are carried out, as shown in Table 12.

Table 12. Integrated Matrix of Sub-Criteria Weight Coefficients

Main Criteria	Sub-Criteria
Improvement of Control and Accountability	S11 (0.265), S12 (0.299), S13 (0.255), S14 (0.180)
Improvement of Tax Assessment and Collection Capacity	S21 (0.390), S22 (0.289), S23 (0.154), S24 (0.167)
Opportunities for Improving the Qualitative Features of Accounting Information	S31 (0.281), S32 (0.083), S33 (0.245), S34 (0.079), S35 (0.146), S36 (0.165)
Opportunities Related to the Financial Accounting Subsystem in the Public Sector	S41 (0.283), S42 (0.215), S43 (0.136), S44 (0.239), S45 (0.128)
Opportunities Related to the Auditing Subsystem in the Public Sector	S51 (0.180), S52 (0.092), S53 (0.228), S54 (0.068), S55 (0.172), S56 (0.150), S57 (0.109)
Opportunities Related to the Management Accounting Subsystem in the Public Sector	S61 (0.295), S62 (0.102), S63 (0.218), S64 (0.155), S65 (0.113), S66 (0.117)

In the fuzzy ANP method, after calculating the weight of factors, three supermatrices—initial, weighted, and limit—are formed to obtain the final weights. Using the weights obtained from the limit supermatrix, the research factors can be prioritized, as the weights in this supermatrix represent the final weights of the factors. Based on this, the improvement of audit efficiency, effectiveness, and reliability, with a weight of 0.03548, ranks first. The reduction of fraud in auditing, with a weight of 0.03373, ranks second, and the enhancement of information verifiability, with a weight of 0.03354, ranks third. The priority of other criteria is shown in Figure 5.

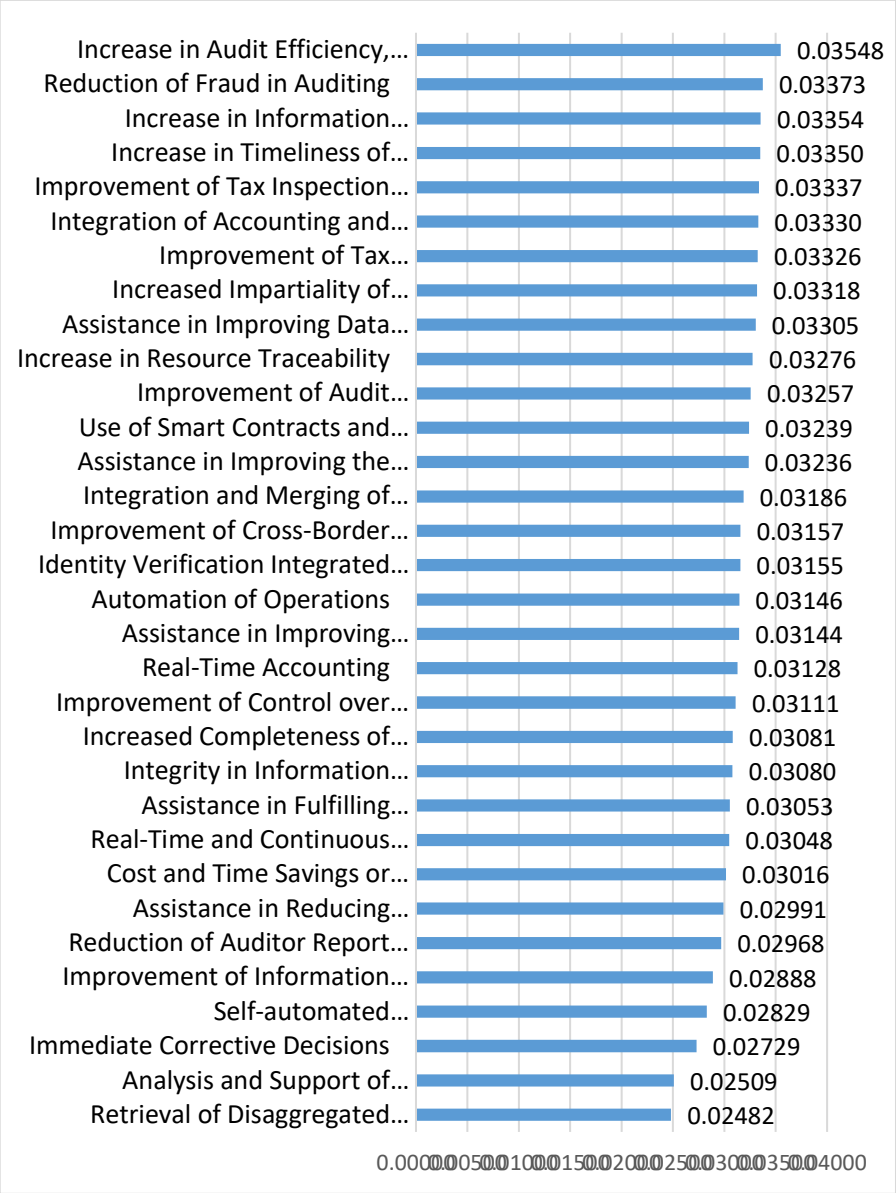

Figure 5. Final Weights of Sub-Criteria

4. Discussion and Conclusion

According to the results, there is a positive and constructive relationship between the use of blockchain and public accounting. This technology impacts social, productive, and organizational dynamics through newly created tools to address existing problems. Most blockchain applications in the public sector are related to data processing and security, new models of government regulation, and new organizational procedures. Overall, the literature review and expert screening, along with their ratings in terms of influence and susceptibility, as well as the prioritization of their dimensions and components, indicate that the potential of this innovation can improve a wide range of issues, such as accountability, budgeting, enhancing the capacity for tax assessment and collection, and improving the qualitative features of information. These findings align with the objectives of public sector accounting in ensuring public accountability and meeting the information needs of various stakeholders. Furthermore, they highlight the necessity of focusing on the public sector accounting subsystems, which consist of

three sub-systems: financial accounting, management accounting, and auditing. The results suggest that the opportunities created by this innovation can be quite broad and simultaneously affect other branches of accounting. In terms of the impact and susceptibility of the opportunity dimensions, the results indicate that improving control and accountability, followed by improving the qualitative features of accounting information, have the most interaction with other factors. This suggests that leveraging this innovation's potential to make organizations more accountable, create transparency, aid in accrual accounting, and, in general, increase trust between the public and the government, has the greatest impact and susceptibility, with other factors being influenced by the creation of this opportunity. Regarding the prioritization of dimensions, the results indicate that improving control and accountability is still the most important opportunity that experts hope this innovation can bring to public sector accounting. Regarding the components, improving the efficiency, effectiveness, and reliability of auditing has also received significant attention. This result suggests that in the auditing subsystem, due to the emphasis on transparency and timeliness, this innovation is expected to yield the greatest benefits. This is promising given the broad scope of public sector accounting, the time-consuming nature of its reporting and auditing processes, and the potential for significant improvements.

In general, the results of this study align with the prior findings [5, 12] that specifically examined the opportunities for applying blockchain in public sector accounting. Irovan and Arifin (2024) showed that blockchain, as a public sector accounting program, represents a major transformation in traditional accounting systems, leading to corrective outcomes that result in high performance in achieving timely, efficient, and secure information processing [12]. Prux et al. (2021) demonstrated that this technology offers advantages such as trust, security of information, and control against fraud and corruption [5].

Given that accountability is the cornerstone of the public sector accounting system, and it was identified as the most significant opportunity in this study, it is recommended that the Parliament and other legislative bodies, especially through specialized committees such as the Research Center of the Parliament, engage in more lenient and cooperative efforts with academics and researchers in examining the feasibility of implementing this innovation. The positive outcomes of realizing this opportunity could extend beyond academia and affect the broader public accounting system. Additionally, since the public sector accounting subsystems include auditing, financial reporting, and management accounting, it is suggested that experts and academics in these areas also examine the identified opportunities relevant to their fields and explore the best solutions for implementing this technology, particularly in public sector accounting. Finally, it is recommended that future research explore methodologies such as meta-synthesis or meta-analysis to examine the factors identified in this study or other existing factors to gain a quantitative understanding of the most influential global factors in this area, and to compare the findings with expert opinions in Iran.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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