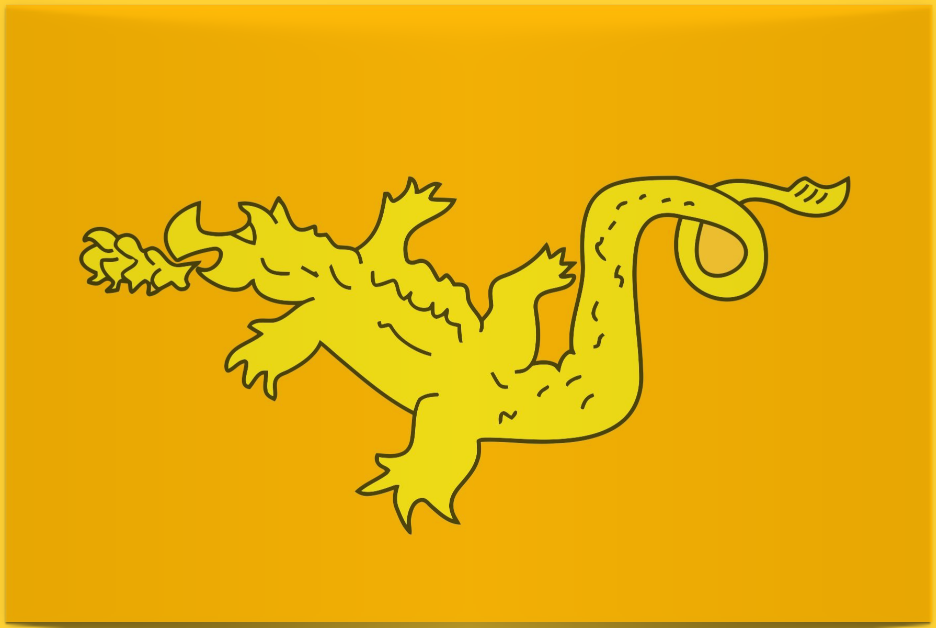

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THE PARALLELS BETWEEN THE INTERNET'S PAST AND ARTIFICIAL INTELLIGENCE'S FUTURE

In conventional business wisdom, the first market entrant often secures dominance. Yet, the digital realm defies this norm. The volatile landscape of technological evolution reveals that latecomers tend to achieve more enduring success. Entering a new market harbors uncertainties, high costs, and unpredictable demands. Forecasting future regulations becomes an arduous task.

While existing patents and technologies grant initial market control, complacency births unpredictability in the face of potential competitors. Consequently, market dominators falter in meeting evolving expectations, inevitably fading into obscurity.

Consider the mobile phone market's shift from Nokia and Motorola to Apple and Samsung. Likewise, Yahoo's relinquishing of its throne to Google exemplifies this trend in search engines and web directories.

Microsoft's aggressive entry into the mid-1990s internet ecosystem against Netscape, the pioneer commercial browser, entrenched the notion that "everything on the Internet is free" with the gratis offering of Internet Explorer. Had Microsoft not intervened with a free browser, internet services like news sites, emails, instant communication apps, and social networks might've sought user fees. Consequently, rampant software, music, movie, and book piracy ensued, perpetuating the illusion of a *'free'* internet.

Consequently, online content providers resorted to offering free services while exploring alternative revenue streams like online advertising, sales, memberships, sponsorships, and product referrals for over two decades. However, users belatedly realized the hidden cost of "free" when their personal data fell prey to tech giants, hackers, governments, and data-buying enterprises.

Today, barring news sites and social networks flooded with advertisements, almost no online content remains truly free. Users encounter paywalls or intrusive ads for streaming services. Even freemium online games coerce payments after initial free plays.

This historical internet development overview sets the stage for predicting how 'Artificial Intelligence' will echo this cycle. In September 2020, the Guardian published an article titled "*A robot wrote this entire article. Are you scared yet, human?*" by ChatGPT, marking its initial foray into columns [1]. Little did anyone anticipate its widespread adoption, even among primary school students, within two years. Similar uncertainty shrouded Google's inception from a Stanford project to an internet behemoth.

Presently, ChatGPT offers only limited features of its earlier version for free. Likewise, prevalent artificial intelligence applications in social networks operate on a pay-as-you-use model. Users now comprehend that obtaining AI-rendered services demands payment, reminiscent of the Netscape era where users had to pay to continue using the service.

However, history echoes as Microsoft integrates the fee-based ChatGPT-4 into Bing for free, reminiscent of their strategy against Netscape. Similarly, Google diversifies its offerings by incorporating free AI-based alternatives into its ecosystem via Bard, while Meta introduces Llama, and X unveils xAi.

These developments foreshadow challenges for businesses unaware of AI's pivotal future role. For individuals, the integration of artificial intelligence into daily life, akin to water, air, electricity, and the internet, seems inevitable. If AI's trajectory mirrors the concise history of the internet above, its future development is bound to follow a similar course.

July 2023

Prof. Dr. Mustafa Zihni TUNCA
Editor-in-Chief

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Original Paper

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FINANCIAL PERFORMANCE APPRAISAL OF MINING AND QUARRYING FIRMS IN BIST

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ABSTRACT

This paper aims to comprehensively evaluate the financial performance of corporations operating within the mining and quarrying sector listed on the BIST exchange during the 2018-2022 period. Employing a meticulous examination of their financial statements, critical financial metrics were computed to gauge their fiscal health. Utilizing the TOPSIS methodology, these companies were systematically ranked based on their aggregated 5-year financial ratios. The analysis delineates a spectrum of performance trends among the corporations, revealing instances of decline, upward trajectories, and steadfast consistency in standings across the evaluated period.

Keywords: *Financial Performance, Mining and Quarrying, Rates, TOPSIS.*

1. INTRODUCTION

The term "performance" within a business context encapsulates the quality and manner in which operations are conducted. Bayyurt (2011: 578) underscores its efficacy in driving goal achievement. Performance evaluation emerges as a pivotal instrument for comprehending the present status and trajectory of enterprises, encompassing facets such as workforce efficiency, production efficacy, and resource utilization. Decision-makers rely on this assessment to navigate effective strategies for goal attainment (Seçme, 2022: 458). The measurement of business performance assumes paramount significance for stakeholders including partners, managers, and investors, offering insights into profitability fluctuations and the efficacy of cost management processes. Notably, financial performance affords a comprehensive vantage point regarding business operations (Özçelik & Kandemir, 2015: 98). Multifaceted decision-making methodologies commonly underpin the evaluation of financial performance, aiming to achieve optimal outcomes based on specified criteria and weights across diverse decision units (Aytekin and Sakarya, 2013: 31).

Mining activities have become indispensable in sustaining human life, underpinning various aspects of daily existence, from transportation means to dwellings and communication devices. Across history, the mining sector has played an integral role in shaping civilizations. It stands as a linchpin sector, contributing significantly to addressing employment challenges and fostering the economic advancement of nations (Bilim et al., 2018: 425). This pervasive influence across multiple spheres of human existence underscores the paramount importance of the mining sector. This study focuses on examining performance measurements derived from the five-year (2018-2019-2020-2021-2022) data of companies operating within the Mining and Quarrying sector listed in the BIST.

2. LITERATURE REVIEW

An array of scholarly investigations focuses on the assessment of performance through the utilization of multi-criteria decision-making methodologies. These studies engage diverse approaches to evaluate and quantify performance across various sectors and industries. Some notable research endeavors, meticulously employing multi-criteria decision-making methods to measure and analyze performance, are elucidated below

Table 1. Studies Measuring Performance with Multi-Criteria Decision Making Method

Researcher	Purpose Of The Research	Research Method
Pala (2023)	To measure the financial performance of companies traded in the BIST Technology and Information Sector between 2010-2021.	CRITIC and WASPAS
Taşcı & Akbalık (2022)	To measure the performance of 18 life insurance companies operating in the Turkish insurance industry using data between 2010 and 2020.	CRITIC and TOPSIS
Terzioğlu et al., (2023)	To examine the financial and environmental sustainability performances of 9 Public/Private banks in the banking sector that comply with the Banking Sector Basic Sustainability Principles published by the Turkish Banking Association.	MOORA, OCRA and GİA
Seçme (2022)	To evaluate the performance of selected banks between 2006-2020.	TOPSIS and COPRAS
Topal (2021)	To measure the financial performance of 10 electricity generation companies included in the Forbes 500 list, using data in 2019.	Entropi and CoCoSo
Orhan et al., (2020)	To measure the financial performance of Istanbul Bus Enterprises Trade Joint Stock Company using data between 2011 and 2018.	CRITIC and TOPSIS
Maya & Eren (2018)	To compare the performances of 12 enterprises in the food sector registered in the Istanbul Stock Exchange and among the largest industrial enterprises in ISO 2014, using data between 2011 and 2015.	TOPSIS and VIKOR
Şahin & Karacan (2019)	To rank the financial success of 8 companies registered in the Construction Index operating in BIST, using the financial data of 2017.	GIA and TOPSIS
Karaoğlan & Şahin (2018)	To measure the performance of 24 companies in the BIST Chemistry, Petroleum, Plastic Index (XKMYA).	TOPSIS, VIKOR, GRA and MOORA
Kurt & Kablan (2022)	To examine the effects of the COVID-19 epidemic on the financial performance of airline companies operating in Turkey and included in the BIST Transportation Index (XULAS).	TOPSIS and MABAC
Apan & Öztel (2020)	To determine the performances of 7 GSYO companies traded on BIST between 2012 and 2016.	CRITIC-PROMETHEE
Yetiz & Kılıç (2021)	To evaluate the financial performance of public and private deposit banks serving in Turkey by creating annual financial ratios for the years 2015-2019.	VIKOR

Table 1 encapsulates a selection of recent studies employing Multi-Criteria Decision Making (MCDM) methodologies for Performance Measurement. The table delineates the authors of these studies, their research objectives, the methodologies applied, and the resultant findings. The synthesis provides a comprehensive overview of the research landscape elucidating the intricacies of MCDM applications in assessing and measuring performance across diverse domains.

3. APPLICATION

Among the methodologies employed for appraising business performance, the multi-criteria decision-making method stands as the prevailing approach. These techniques offer a robust framework particularly suited for scenarios involving multiple alternatives and diverse evaluation criteria, notably in the hierarchical ranking of businesses based on their degrees of success.

Within the scope of this study, the performance assessments of companies within the mining and quarrying sector listed on the BIST exchange between 2018 and 2022 were conducted. Key financial ratios derived from the examination of their financial statements constitute the foundational data for this investigation. The TOPSIS method, a prominent multi-criteria decision-making technique, was employed in this analysis. Subsequently, the sequential procedural details of this method, integral to the study's evaluation, are meticulously outlined in the tables below. Notably, the tabulated data includes the companies under discussion, presented in an organized, alphabetical manner for clarity and reference.

Table 2. Company Codes

Order	Company Name
1	A
2	B
3	C
4	D
5	E

As depicted in Table 2 above, the study encompasses the utilization of data from five distinct companies denoted by sequential numbers (1 through 5) and corresponding letters (A, B, C, D, E) for reference and clarity. Notably, among the six designated companies within the Mining and Quarrying sector listed on the BIST exchange, the dataset pertaining to CVKMD (Maden İşletmeleri Sanayi ve Ticaret A.Ş.) was regrettably omitted due to inaccessible data.

Table 3. Ratios by Years

Order	Company	Ratios	Data				
			2018	2019	2020	2021	2022
1	A	Gross Profit/Net Sales	0,01	0,77	0,38	0,78	0,12
		Operating Profit/ Net Sales	0,04	0,40	12,44	2,29	0,52
		Net Income/ Net Sales	0,17	0,07	15,45	0,08	1,97
		Net Income/ Total Assets	0,15	0,005	0,29	0,005	0,23
		Net Income/ Equity	1,56	0,01	0,45	0,007	0,26
2	B	Gross Profit/Net Sales	0,606	0,65	0,64	6,33	0,60
		Operating Profit/ Net Sales	0,47	0,56	0,55	0,46	0,41
		Net Income/ Net Sales	0,78	0,64	0,58	0,65	0,60
		Net Income/ Total Assets	0,19	0,15	0,16	0,17	0,20
		Net Income/ Equity	0,22	0,22	0,18	0,20	0,24
3	C	Gross Profit/Net Sales	0,63	0,67	0,68	0,66	0,61
		Operating Profit/ Net Sales	0,53	0,59	0,60	0,47	0,44
		Net Income/ Net Sales	0,88	0,66	0,62	0,65	0,66
		Net Income/ Total Assets	0,23	0,21	0,18	0,17	0,24
		Net Income/ Equity	0,25	0,23	0,20	0,19	0,28
4	D	Gross Profit/Net Sales	0,60	0,65	0,65	0,63	0,60
		Operating Profit/ Net Sales	0,47	0,56	0,55	0,46	0,42
		Net Income/ Net Sales	0,78	0,65	0,58	0,65	0,60
		Net Income/ Total Assets	0,19	0,20	0,16	0,17	0,20
		Net Income/ Equity	0,22	0,22	0,18	0,20	0,24
5	E	Gross Profit/Net Sales	0,55	0,97	0,33	0,46	0,51
		Operating Profit/ Net Sales	3,83	6,08	0,11	0,16	0,28
		Net Income/ Net Sales	212,35	2,33	2,37	1,45	2,32
		Net Income/ Total Assets	0,14	0,01	0,08	0,08	0,22
		Net Income/ Equity	0,15	0,02	0,09	0,09	0,25

As depicted in Table 3, the presented data encapsulates the utilized ratios and the financial information pertaining to companies A, B, C, D, and E over the preceding five years, forming the basis of this study's analysis. The initial phase involved the creation of decision matrices for each annual dataset. Subsequently, each entry within these matrices underwent a squaring operation. The collective sum of these squared values was calculated, followed by the extraction of square roots, thereby leading to the generation of decision matrices for each year, respectively in Tables 4 to 8.

Table 4. Decision Matrix for 2018

2018	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0001	0,0016	0,0289	0,0225	2,4336
B	0,3672	0,2209	0,6084	0,0361	0,0484
C	0,3969	0,2809	0,7744	0,0529	0,0625
D	0,3600	0,2209	0,6084	0,0361	0,0484
E	0,3025	14,6689	45092,5200	0,0196	0,0225
Total	1,4267	15,3932	45094,5400	0,1672	2,6154
Square Root of Totals	1,1945	3,9234	212,3548	0,4089	1,6172

Table 5. Decision Matrix for 2019

2019	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,5929	0,1600	0,0049	0,000025	0,0001
B	0,4225	0,3136	0,4096	0,0225	0,0484
C	0,4489	0,3481	0,4356	0,0441	0,0529
D	0,4225	0,3136	0,4225	0,0400	0,0484
E	0,9409	36,9664	5,4289	0,0001	0,0004
Total	2,8277	38,1017	6,7015	0,1067	0,1502
Square Root of Totals	1,6816	6,1727	2,5887	0,3267	0,3876

Table 6. Decision Matrix for 2020

2020	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,1444	154,7536	238,7025	0,0841	0,2025
B	0,4096	0,3025	0,3364	0,0256	0,0324
C	0,4624	0,3600	0,3844	0,0324	0,04
D	0,4225	0,3025	0,3364	0,0256	0,0324
E	0,1089	0,0121	5,6169	0,0064	0,0081
Total	1,5478	155,7307	245,3766	0,1741	0,3154
Square Root of Totals	1,2441	12,4792	15,6645	0,41723	0,5616

Table 7. Decision Matrix for 2021

2021	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,6084	5,2441	0,0064	0,000025	0,00005
B	40,0689	0,2116	0,4225	0,0289	0,0400
C	0,4356	0,2209	0,4225	0,0289	0,0361
D	0,3969	0,2116	0,4225	0,0289	0,04
E	0,2116	0,0256	2,1025	0,0064	0,0081
Total	41,7214	5,9138	3,3764	0,0931	0,1242
Square Root of Totals	6,4592	2,4318	1,8375	0,3052	0,3525

Table 8. Decision Matrix for 2022

2022	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0144	0,2704	3,8809	0,0529	0,0676
B	0,3600	0,1681	0,3600	0,0400	0,0576
C	0,3721	0,1936	0,4356	0,0576	0,0784
D	0,3600	0,1764	0,3600	0,0400	0,0576
E	0,2601	0,0784	5,3824	0,0484	0,0625
Total	1,3666	0,8869	10,4189	0,2389	0,3237
Square Root of Totals	1,1690	0,9418	3,228	0,4888	0,5689

Tables 9 through 13 delineate the outcome of a systematic process involving the division of each entry within the decision matrices by the respective square roots of the totals. This iterative procedure was conducted for each year's dataset, culminating in the generation of the following tables, capturing the normalized values for analysis and comparison.

Table 9. Weighted Decision Matrix for 2018

2018	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0083	0,0102	0,0008	0,3668	0,9646
B	0,5073	0,1198	0,0037	0,4647	0,1360
C	0,5274	0,1351	0,0041	0,5625	0,1546
D	0,5023	0,1198	0,0037	0,4647	0,1360
E	0,4604	0,9762	0,9999	0,3424	0,0928

Table 10. Weighted Decision Matrix for 2019

2019	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,4579	0,0648	0,02704	0,0153	0,0258
B	0,3865	0,0907	0,24723	0,4592	0,5677
C	0,3984	0,0956	0,2550	0,6428	0,5935
D	0,3865	0,0907	0,2511	0,6122	0,5677
E	0,5768	0,9850	0,9001	0,0306	0,0516

Table 11. Weighted Decision Matrix for 2020

2020	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,3054	0,9969	0,9863	0,6950	0,8013
B	0,5144	0,0441	0,0370	0,3835	0,3205
C	0,5466	0,0481	0,0396	0,4314	0,3561
D	0,5225	0,0441	0,0370	0,3835	0,3205
E	0,2653	0,0088	0,1513	0,1917	0,1603

Table 12. Weighted Decision Matrix for 2021

2021	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,1208	0,9417	0,0435	0,0164	0,0199
B	0,9800	0,1892	0,3537	0,5571	0,5674
C	0,1022	0,1933	0,3537	0,5571	0,5390
D	0,0975	0,1892	0,3537	0,5571	0,5674
E	0,071	0,0656	0,7891	0,2622	0,2553

Table 13. Weighted Decision Matrix for 2018

2022	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,1027	0,5522	0,6103	0,4706	0,4570
B	0,5133	0,4354	0,1859	0,4092	0,42183
C	0,5218	0,4672	0,2045	0,4910	0,4921
D	0,5133	0,4460	0,1859	0,4092	0,4218
E	0,4362	0,2973	0,7187	0,4501	0,4394

Incorporating expert insights, the relative importance levels of the various ratios were discerned, leading to the formulation of Table 14. This table reflects the weighted significance assigned to individual ratios, derived from expert evaluations, thereby providing a framework for prioritizing and assessing their impact within the context of this study.

Table 14. Importance Levels of Ratios

Rates	Importance Degrees
Gross Profit/Net Sales	0,0424
Operating Profit/ Net Sales	0,4046
Net Income/ Net Sales	0,1942
Net Income/ Total Assets	0,2596
Net Income/ Equity	0,0992

In accordance with the importance levels assigned to each ratio, weighted decision matrices were formulated through the multiplication of these weights with the standard decision matrices. Subsequently, the minimum and maximum values within these matrices were computed for each respective year. The outcomes of this process across the studied years are systematically outlined in Tables 15 to 19, delineating the extremities of values within these weighted matrices.

Table 15. Minimum and Maximum Values in 2018

2018	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0004	0,0041	0,0002	0,0952	0,0957
B	0,0215	0,0485	0,0007	0,1206	0,0135
C	0,0224	0,0547	0,0008	0,14604	0,0153
D	0,0213	0,0485	0,0007	0,1206	0,0135
E	0,0195	0,3950	0,1942	0,0889	0,0092
Minimum	0,0004	0,0041	0,0002	0,0889	0,0092
Maximum	0,0224	0,3949	0,1942	0,1460	0,0957

Table 16. Minimum and Maximum Values in 2019

2019	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0194	0,0262	0,0053	0,0040	0,0026
B	0,0164	0,0367	0,0480	0,1192	0,0563
C	0,0169	0,0387	0,0495	0,1669	0,0589
D	0,0164	0,0367	0,0488	0,1589	0,0563
E	0,0245	0,3985	0,1748	0,0079	0,0051
Minimum	0,0164	0,0262	0,0053	0,0040	0,0026
Maximum	0,0245	0,3985	0,1748	0,1669	0,0589

Table 17. Minimum and Maximum Values in 2020

2020	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0130	0,4033	0,1915	0,1804	0,0795
B	0,0218	0,0178	0,0072	0,0996	0,0318
C	0,0232	0,0195	0,0077	0,1120	0,0353
D	0,0222	0,0178	0,0072	0,0996	0,0318
E	0,0112	0,0036	0,0294	0,0498	0,0159
Minimum	0,0112	0,0036	0,0072	0,0498	0,0159
Maximum	0,0232	0,4033	0,1915	0,1804	0,0795

Table 18. Minimum and Maximum Values in 2021

2021	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0051	0,3810	0,0085	0,0043	0,0020
B	0,0416	0,0765	0,0687	0,1446	0,0563
C	0,0043	0,0782	0,0687	0,1446	0,0535
D	0,0041	0,0765	0,0687	0,1446	0,0563
E	0,0030	0,0266	0,1532	0,0681	0,0253
Minimum	0,0030	0,0266	0,0085	0,0043	0,0020
Maximum	0,0416	0,3810	0,1532	0,1446	0,0563

Table 19. Minimum and Maximum Values in 2022

2022	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity
A	0,0044	0,2234	0,1185	0,1222	0,0454
B	0,0218	0,1761	0,0361	0,1062	0,0419
C	0,0221	0,1890	0,0397	0,1275	0,0488
D	0,0218	0,1804	0,0361	0,1062	0,0419
E	0,0185	0,1203	0,1396	0,1169	0,0436
Minimum	0,0044	0,1203	0,0361	0,1062	0,0419
Maximum	0,0221	0,2234	0,1396	0,1275	0,0488

In a subsequent step, every individual value within the matrices underwent subtraction from its respective maximum value, followed by squaring. Subsequently, row-wise summations were computed, and the square roots of these totals were derived. This meticulous process was conducted for each year's dataset, and the resulting computations are systematically exhibited in the ensuing Tables 20 to 24 for comprehensive review and analysis.

Table 20. Ideal (Maximum) Discrimination Criteria in 2018

2018	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0005	0,1527	0,0376	0,0026	0,0000	0,1934	0,4398
B	0,0000	0,1200	0,0374	0,0006	0,0068	0,1649	0,4060
C	0,0000	0,1158	0,0374	0,0000	0,0065	0,1596	0,3995
D	0,0000	0,1200	0,0374	0,0006	0,0068	0,1649	0,4060
E	0,0000	0,0000	0,0000	0,0033	0,0075	0,0108	0,1037

Table 21. Ideal (Maximum) Discrimination Criteria in 2019

2019	Gross Profit/Net Sales	Operatin g Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0000	0,1386	0,0287	0,0265	0,0032	0,1971	0,4439
B	0,0001	0,1309	0,0161	0,0023	0,0000	0,1493	0,3864
C	0,0001	0,1295	0,0157	0,0000	0,0000	0,1452	0,3811
D	0,0001	0,1309	0,0159	0,0001	0,0000	0,1469	0,3833
E	0,0000	0,0000	0,0000	0,0253	0,0029	0,0282	0,1678

Table 22. Ideal (Maximum) Discrimination Criteria in 2020

2020	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0001	0,0000	0,0000	0,0000	0,0000	0,0001	0,0102
B	0,0000	0,1486	0,0340	0,0065	0,0023	0,1914	0,4375
C	0,0000	0,1473	0,0338	0,0047	0,0020	0,1878	0,4333
D	0,0000	0,1486	0,0340	0,0065	0,0023	0,1914	0,4375
E	0,0001	0,1598	0,0263	0,0171	0,0040	0,2073	0,4553

Table 23. Ideal (Maximum) Discrimination Criteria in 2021

2021	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0013	0,0000	0,0210	0,0197	0,0030	0,0449	0,2120
B	0,0000	0,0927	0,0071	0,0000	0,0000	0,0998	0,3160
C	0,0014	0,0917	0,0071	0,0000	0,0000	0,1002	0,3166
D	0,0014	0,0927	0,0071	0,0000	0,0000	0,1012	0,3182
E	0,0015	0,1256	0,0000	0,0059	0,0010	0,1339	0,3659

Table 24. Ideal (Maximum) Discrimination Criteria in 2022

2022	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0003	0,0000	0,0004	0,0000	0,0000	0,0008	0,0283
B	0,0000	0,0022	0,0107	0,0005	0,0000	0,0134	0,1159
C	0,0000	0,0012	0,0100	0,0000	0,0000	0,0112	0,1056
D	0,0000	0,0018	0,0107	0,0005	0,0000	0,0131	0,1142
E	0,0000	0,0106	0,0000	0,0001	0,0000	0,0108	0,1038

For each year's dataset, a sequential process was undertaken wherein every value within the matrices underwent subtraction from the respective minimum values, followed by squaring. Subsequently, row-wise summations were computed, and the square roots of these totals were derived. This meticulous computational procedure was diligently executed across the datasets for each year, culminating in the tabulated results outlined in Tables 25 to 29 for comprehensive scrutiny and assessment.

Table 25. Ideal (Minimum) Discrimination Criteria in 2018

2018	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0000	0,0000	0,0000	0,0000	0,0075	0,0075	0,0868
B	0,0004	0,0020	0,0000	0,0010	0,0000	0,0034	0,0587
C	0,0005	0,0026	0,0000	0,0033	0,0000	0,0063	0,0796
D	0,0004	0,0020	0,0000	0,0010	0,0000	0,0034	0,0586
E	0,0004	0,1527	0,0376	0,0000	0,0000	0,1907	0,4367

Table 26. Ideal (Minimum) Discrimination Criteria in 2019

2019	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0030
B	0,0000	0,0001	0,0018	0,0133	0,0029	0,0181	0,1346
C	0,0000	0,0002	0,0020	0,0265	0,0032	0,0318	0,1784
D	0,0000	0,0001	0,0019	0,0240	0,0029	0,0289	0,1700
E	0,0001	0,1386	0,0287	0,0000	0,0000	0,1674	0,4092

Table 27. Ideal (Minimum) Discrimination Criteria in 2020

2020	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Square Root of Total
A	0,0000	0,1598	0,0340	0,0171	0,0040	0,2149	0,4635
B	0,0001	0,0002	0,0000	0,0025	0,0003	0,0030	0,0552
C	0,0001	0,0003	0,0000	0,0039	0,0004	0,0046	0,0682
D	0,0001	0,0002	0,0000	0,0025	0,0003	0,0031	0,0553
E	0,0000	0,0000	0,0005	0,0000	0,0000	0,0005	0,0222

Table 28. Ideal (Minimum) Discrimination Criteria in 2021

2021	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0000	0,1256	0,0000	0,0000	0,0000	0,1256	0,3543
B	0,0015	0,0025	0,0036	0,0197	0,0030	0,0303	0,1740
C	0,0000	0,0027	0,0036	0,0197	0,0027	0,0287	0,1693
D	0,0000	0,0025	0,0036	0,0197	0,0030	0,0288	0,1696
E	0,0000	0,0000	0,0210	0,0041	0,0005	0,0256	0,1599

Table 29. Ideal (Minimum) Discrimination Criteria in 2022

2022	Gross Profit/Net Sales	Operating Profit/ Net Sales	Net Income/ Net Sales	Net Income/ Total Assets	Net Income/ Equity	Total	Square Root of Total
A	0,0000	0,0106	0,0068	0,0003	0,0000	0,0177	0,1330
B	0,0003	0,0031	0,0000	0,0000	0,0000	0,0034	0,0585
C	0,0003	0,0047	0,0000	0,0005	0,0000	0,0056	0,0745
D	0,0003	0,0036	0,0000	0,0000	0,0000	0,0039	0,0626
E	0,0002	0,0000	0,0107	0,0001	0,0000	0,0110	0,1050

In a systematic progression, ideal solutions were derived by dividing the negative distances by the summation of negative and positive distances for each respective year. This methodical procedure was diligently executed across the datasets for each year, resulting in the tabulated outcomes meticulously presented in Tables 30 to 34 for comprehensive analysis and reference.

Table 30. Performance Scores of Companies in 2018

2018	Results
A	0,1648
B	0,1262
C	0,1662
D	0,1261
E	0,8081

Table 31. Performance Scores of Companies in 2019

2019	Results
A	0,0068
B	0,2583
C	0,3189
D	0,3073
E	0,7092

Table 32. Performance Scores of Companies in 2020

2020	Results
A	0,9784
B	0,1120
C	0,1359
D	0,1121
E	0,04647

Table 33. Performance Scores of Companies in 2021

2021	Results
A	0,6257
B	0,3551
C	0,3484
D	0,3478
E	0,3042

Table 34. Performance Scores of Companies in 2022

2022	Results
A	0,8247
B	0,3354
C	0,4137
D	0,3540
E	0,5027

The ideal solutions, reflecting the performances of the companies across each year, have been enumerated. Additionally, a performance ranking of these companies was established by computing the average of the five-year ideal solution data. This comprehensive assessment provides a nuanced understanding of the companies' performances over the studied period, enabling a holistic ranking based on their collective five-year ideal solution averages.

Table 35. Five-Year Performance Rankings of Companies

Order	2018	2019	2020	2021	2022	Avarege of 5 Years
1.	C	D	E	E	A	E
2.	E	E	D	D	B	D
3.	D	B	B	B	E	B
4.	A	A	A	A	D	A
5.	B	C	C	C	C	C

Table 35 delineates distinct performance rankings for each year across the five-year span. It reveals noteworthy fluctuations among the companies' standings over time. For instance, Company C, initially ranked first in 2018, exhibited a considerable decline in subsequent years, securing the last position. Conversely, Company E displayed an overall improvement in performance, despite a slight decline in 2022. Company A consistently maintained a routine performance, attaining the top rank solely in 2022. On the other hand, Companies B and D showcased fluctuating performances, witnessing periods of both ascent and descent.

Evidently, Companies A, B, and D demonstrated varying performance trajectories throughout the studied years, experiencing fluctuations in their standings. Consequently, among the five entities, Company C emerged with the least favorable performance, while the assessment determined Company E as the top performer based on the comprehensive analysis of their performances across the five-year duration.

4. CONCLUSION

The concept of 'performance' stands as a fundamental facet within the realm of business operations, serving as an effective tool to steer endeavors toward achieving predefined objectives. Performance evaluation emerges as a pivotal mechanism, enabling companies to gain insight into their present status while forecasting their trajectory. This evaluative process not only identifies areas necessitating improvement but also furnishes operators with indispensable information crucial for informed decision-making.

The integration of performance evaluations into decision-making processes augments a company's capacity for self-enhancement, facilitating a continual pursuit of heightened performance levels. Such evaluative practices afford a holistic perspective when appraising financial performance and overall business efficacy. Notably, within this study, the TOPSIS method, renowned for its efficacy within multi-criteria decision-making, was employed.

Given the ubiquitous presence of the mining sector in contemporary life, this study delved into the meticulous examination of the five-year (2018-2019-2020-2021-2022) financial statements of mining and quarrying companies listed within the sectors section of BIST. Pertinent financial ratios were meticulously computed, considering their significance within these financial statements.

In this study, a structured methodology was employed involving sequential stages to evaluate the financial performances of the companies utilizing the TOPSIS method. The process commenced with the creation of decision matrices for each year, followed by squaring each data point within these matrices. The summation of the squared values and the subsequent derivation of square roots facilitated the generation of annual tables.

Subsequently, these tables underwent normalization, achieved by dividing each data point by the square roots of the respective totals. Importance levels of ratios were determined through expert opinions, enabling the formulation of weighted standard decision matrices by multiplying these importance levels with the standard decision matrices. Calculation of minimum and maximum values within the matrices ensued, followed by a process where each value was subtracted from the maximum values and squared. Similar operations were conducted using the minimum values, resulting in the computation of row totals and their respective square roots.

Further analysis involved deriving ideal solutions by normalizing negative distances for each year against the sum of negative and positive distances. The culmination of this multi-stage process led to the presentation of ideal solutions and the annual performances of the companies. Notably, a comprehensive assessment was conducted through the calculation of performance rankings based on the 5-year average ideal solution data. Observations from these rankings highlighted fluctuations in company performances across the studied years, showcasing instances of decline, improvement, and consistent performance maintenance among the considered companies.

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Review Paper

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REDEFINING AUDITING IN A BLOCKCHAIN ERA: OPPORTUNITIES AND OBSTACLES FOR EXTERNAL AUDITORS

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ABSTRACT

The characteristics and mode of operation of blockchain technology could transform the accounting and auditing industries. The technological advancements introduced by Blockchain are anticipated to significantly influence reporting and auditing procedures, particularly within accounting information systems. The escalating adoption of blockchain technology is poised to alter the comprehensiveness and caliber of information accessible to auditors, thereby impacting the auditing process. Consequently, it is imperative for professionals in accounting and auditing to grasp both the prospects and impediments posed by these innovative technologies. This study endeavors to scrutinize the role of blockchain within the realms of accounting and auditing, both within existing literature and in professional practice.

Keywords: *Blockchain, Triple-Entry Accounting, Auditing, Smart Contract, Literature review.*

1. INTRODUCTION

Blockchain technology, originating from the creation of bitcoin by Satoshi Nakamoto in 2008, stands as a decentralized digital payment system (Nakamoto, 2008). The exponential surge in the market value of bitcoin, reaching over $200 billion in 2017 (Popper, 2017), heralded its prominence as the pioneering application of blockchain technology. Forecasts indicate the burgeoning growth of the blockchain market, projected to escalate to $39.7 billion by 2025 (Statista Research Department, 2023).

Emerging as a quintessential "trust protocol," blockchain technology is witnessing widespread adoption across diverse sectors, commencing notably within the domains of banking and finance (Raj, 2017). Noteworthy technology behemoths such as IBM, Microsoft, and Intel are actively investing in this transformative technology (Medium, 2019). Moreover, the burgeoning interest in blockchain has permeated the realms of accounting and auditing (Bonsón & Bednárová, 2019; CPA Canada, 2017; Dai & Vasarhelyi, 2017; Smith, 2018), with major audit, accounting, and consulting firms like PwC, Deloitte, KPMG, and EY venturing into pilot applications of blockchain technology (Blockchain Türkiye, 2021).

IFAC (2017) posits blockchain as a fundamental solution for ensuring reliable records in various contexts, highlighting its disruptive potential in finance and its envisioned application in inter-organizational records such as accounting. The advent of blockchain technology is anticipated to significantly influence reporting and auditing procedures, especially within accounting information systems. Its increased utilization is poised to impact the depth and quality of information provided to auditors, thereby altering the trajectory of the audit process. Consequently, it becomes imperative for accountants and auditors to comprehend the intricate prospects and hurdles introduced by these technological advancements.

This paper endeavors to delve into the role of blockchain within the accounting and auditing spheres as reflected in academic literature and professional practice. It aims to dissect the emergent concerns pertinent to the future of blockchain in accounting and auditing, categorically exploring (i) the evolution of accounting methodologies, (ii) pivotal developments in accounting and auditing practices along with the evolving auditor profile, and (iii) the discernible opportunities and challenges posed for auditors within this transformative landscape.

2. OVERVIEW OF BLOCKCHAIN CONCEPT

Satoshi Nakamoto, in his seminal white paper titled "Bitcoin: Peer-to-Peer Electronic Cash Payment System," delineated blockchain technology as an emergent innovation (Sherman, Javani, Zhang, & Golaszew, 2019; Elommal & Manita, 2021; Nakamoto, 2008). One of its early applications materialized in bitcoin, introducing a cryptocurrency paradigm as an alternative to conventional centralized currencies (Fuller & Markelevich, 2020).

While commonly associated with cryptocurrencies, blockchain technology fundamentally operates as a public, decentralized distributed ledger system. It ensconces transactions between users within an immutable, verifiable, secure, and chronological framework (Swan M., 2015; Allen, 2011; Sakız & Gencer Geç, 2019; Yaga, Mell, Roby, & Scarfone, 2019). Employing distributed ledger technology, blockchain leverages independent computers (nodes) to record, share, and synchronize transactions across electronic ledgers, diverging from the centralized data repositories characterizing traditional ledgers (Otero & Fink, 2021).

Defined in the 2018 report by the World Economic Forum, blockchain technology epitomizes a decentralized electronic ledger system that establishes cryptographically secure and immutable records of various value transactions, encompassing money, goods, property, labor, or votes. Its versatile functionalities encompass facilitating peer-to-peer payments, managing records, tracking physical objects, and executing value transfers through smart contracts. As highlighted by Herweijer et al. (2018), this technology harbors immense potential to redefine operational landscapes across business, governance, and societal domains.

2.1. The Characteristics and Benefits of Blockchain Technology

Decentralization and Distribution

Ledgers, an enduring mechanism facilitating the tracking of goods, services, assets, and payments across historical contexts, retain a pivotal role in modern economic and social activities. Traditionally, centralized systems have been instrumental in managing intricate transactions involving multiple stakeholders. These systems necessitate a trusted third party to validate and input transactions into established ledgers, ensuring the prevention of duplication or misuse and preserving transaction histories (Rejeb, Rejeb, & Keogh, 2021; Mainelli & Smith, 2015).

Blockchain technology, distinguished by its decentralized information storage and transmission framework, embodies a fundamental departure from conventional centralized systems. It engenders secure transactions without reliance on a central network for control or administration. Upon publication throughout the system, each new transaction undergoes verification by existing nodes, subsequently becoming recorded as a new node within the chain upon approval. Notably, the validation of transactions within the network is conducted by extant nodes rather than a designated central authority (Elommal & Manita, 2021; Smith, 2020).

Consensus Algorithms

Consensus mechanisms are presented as a solution to the insecurity of data distributed in a decentralised network. The essence of this system is to solve the trust problem that exists in decentralised structures.

Proof of Work (**PoW**)

Proof of Work (PoW) stands as the consensus algorithm underpinning the Bitcoin network. This algorithm operates to integrate new transaction blocks into the blockchain via a process termed "mining." Each block undergoes a verification procedure, validating the entire chain to ensure the creation of a secure system. Consequently, the processing time for each block extends to approximately

10 minutes. However, this system is encumbered by drawbacks, notably prolonged processing periods and heightened energy consumption. A critical vulnerability inherent in PoW lies in the potential for a group of miners to amass control over 50% of the network, paving the way for the execution of fraudulent blocks, thereby initiating a "51% attack." This attack compromises the immutability of the blockchain by fracturing the longest chain, posing a fundamental risk to the decentralized nature of the system. This inherent risk of mining centralization has spurred a quest among stakeholders to explore and devise alternative methodologies (Appelbaum, 2021; Werbach, 2018; Zhang, Wu, & Wang, 2020; Zheng, Xie, Dai, Chen, & Wang, 2017; Raikwar, Gligoroski, & Kralevska, 2019; Kardaş, 2019).

Proof of Stake (PoS)

Proof of Stake (PoS) emerges as an alternative consensus mechanism utilized in public blockchain networks. King and Nadal (2012) proposed this peer-to-peer cryptocurrency consensus model in response to the elevated energy demands and transaction expenses inherent in Nakamoto's proof-of-work design. PoS-based blockchain networks ascertain the issuance of new blocks based on the quantity of shares held by a user. Unlike the resource-intensive computations integral to proof-of-work, this consensus model circumvents the necessity for extensive time, electricity, and processing power (Kim, 2021).

Transparency and Traceability

Blockchain technology ensures transparency and traceability by immutably storing transactions, which are shared and recorded by nodes (users) within the network. This foundational characteristic guarantees system longevity and consistency by replicating records across independent computers, thereby fostering heightened user trust (Elommal & Manita, 2021).

Cryptographic Assurance

Cryptography serves as a fundamental method for safeguarding data against unauthorized access. Blockchain technologies establish a trusted framework for distributed data storage and value exchange, employing cryptographic foundations. Within blockchain systems, cryptographic techniques play a pivotal role in upholding ledger integrity, thereby ensuring the immutability of blockchain data. This resilience prevents any alteration of transaction information stored in the blockchain, both during and after block creation. Primarily, blockchain relies on cryptographic hash functions and digital signature methods to reinforce its security measures (Dinh et al., 2018; Choudhary, 2022).

Evolution of Blockchain: Smart Contracts

The emergence of smart contracts within blockchain technology marks a substantial stride forward (CPA Canada, 2017). Notably, the concept of smart contracts, as envisioned by Nick Sbazo, dates back to the 1990s. However, the practical execution of smart contracts without the involvement of intermediaries only became viable following the advent of blockchain (Gamage, Weerasinghe, & Dias, 2020). Ethereum stands out as the pioneering blockchain platform expressly designed to accommodate smart contracts and decentralized applications (Werbach, 2018; Gamage, Weerasinghe, & Dias, 2020). Across various disciplines, smart contracts find diverse definitions; broadly, they can be construed as "agreements capable of automation and enforceability."

Blockchain Types

Blockchains are often categorized based on their design, data accessibility, and access control mechanisms. In academic literature, these classifications are commonly delineated as "public" and "private" (Sarmah, 2018; Rejeb, Rejeb, & Keogh, 2021; Ünal & Uluyol, 2020) or alternatively as "permissioned" and "permissionless" (El Ioini & Pahl, 2018; Yaga, Mell, Roby, & Scarfone, 2019). Nevertheless, these terms are frequently used interchangeably in both research and practical blockchain applications. While the classification of blockchains remains somewhat ambiguous in the literature, two primary types have garnered attention: "public" versus "private," or "permissioned" and "permissionless" blockchains.

Permissionless blockchains resemble the unrestricted accessibility of the public internet, allowing anyone to join. Functioning as public, decentralized ledger platforms, these networks generate blocks without requiring authorization from a governing body. Given the universal publishing rights, nodes within the network possess read access to the blockchain and can conduct transactions. Prominent examples of permissionless blockchain networks encompass Bitcoin, Ethereum, and Zerocash platforms.

Contrarily, permissioned blockchains demand authorization for users publishing blocks, either from a centralized or decentralized authority. As these networks are safeguarded by authorized users, they can regulate both read access and transactional capabilities. Organizations seeking collaborative endeavors while harboring partial trust amongst themselves often leverage permissioned blockchain networks. These networks offer advantages in terms of speed and cost efficiency, particularly within corporate environments, rendering them anticipated to witness heightened adoption rates in the foreseeable future (Raikwar, Gligoroski, & Kralevska, 2019; Yaga, Mell, Roby, & Scarfone, 2019; CPA Canada, 2017).

3. BLOCKCHAIN TECHNOLOGY IN ACCOUNTING LITERATURE

3.1. Changes in Accounting Definitions

The evolution of accounting information systems spans epochs from ancient eras to the contemporary information age, adapting in response to diverse economic, technological, and environmental landscapes (Anandarajan, Srinivasan, & Anandarajan, 2004). Historical accounting methodologies can be delineated into two primary systems: single-entry and double-entry bookkeeping. Yamey (1947) notes the initial foray into accounting was marked by the single-entry system, which persists among small enterprises, predominantly relying on profit and loss accounts (Örten, Kurt, & Torun, 2011).

The inception of the double-entry bookkeeping system dates back to late 13th and early 14th-century Northern Italy, accredited to Venetian merchants, often referred to as the "Venetian method" (Sangster & Santini, 2022). Luca Pacioli, in his work "Summa de Arithmetica, Geometria, Proportioni et Proportionalita," elucidated the principles of this system, solidifying its existing practices in Venice and ensuring its perpetuation to the present era (Carruthers & Espeland, 1991; Ovunda, 2015; Elbannan, 2007; Fazzini, Fici, Montrone, & Terzani, 2016). Spanning over six centuries, the double-entry method has endured economic fluctuations, reforms, and technological advancements, emerging as the foundational accounting system. It remains the singularly dominant method complemented by various techniques tailored to meet evolving economic and financial accounting requisites (Pascual Pedreño, Gelashvili, & Pascual Nebreda, 2021).

3.2. Triple-Entry Accounting with Blockchain

Yuri Ijiri's article "Triple-Entry Bookkeeping and Income Momentum" in 1982 marked the inception of the triple-entry system, advocating an expansion beyond the double-entry method (Cai, 2021). Although Ijiri's work is distinct from cryptographic or blockchain frameworks, it has garnered attention in the blockchain and accounting scholarly realm. Subsequent to Ijiri, Ian Grigg introduced the TEA (Triple-Entry Accounting) model, emphasizing the use of digital signature cryptography to forge secure transaction records, providing resilience against unauthorized modifications (Grigg, 2005). In essence, the TEA principle employs signed messages to create shared transaction records among at least three parties, constituting the foundation of the shared ledger (Ibañez, Bayer, Tasca, & Xu, 2021). Grigg (2005) frames triple-entry bookkeeping as an evolutionary step in accounting rather than a revolutionary overhaul. However, the digitization of accounting systems, though prevalent since the 1990s, has predominantly witnessed changes in the tools employed rather than a comprehensive digitalization of accounting systems (Doğan & Ertugay, 2019).

Nevertheless, current surveys, such as KPMG's assessment of digitalization in accounting, reveal a prevalent lack of an end-to-end digital process, presenting challenges due to the absence of digital receipts and documents, as cited by 60% of respondents (KPMG, 2021). The 21st-century accounting profession faces the necessity of a novel model aligning with technological advancements and digital transformation processes (Gulin, Hladika, & Valenta, 2019). There's a consensus in academic studies and industry reports that technologies like artificial intelligence, Internet of Things, blockchain, cloud computing, and big data, categorically within Industry 4.0, alongside smart autonomous production systems, will significantly reshape accounting practices (Gulin, Hladika, & Valenta, 2019; KPMG Forbes Insights, 2017; PwC, 2020; Aksoy, 2017; Gönen & Rasgen, 2019; Usul & Başkurt, 2022).

Blockchain, earmarked for substantial change in the accounting sector, fundamentally operates as an accounting technology, housing financial data and tracking asset ownership transfers through tokens (ICAEW, 2018). The accounting domain stands to benefit considerably from distributed ledger records and blockchain technology, promising reduced error and fraud risks, automated systems, cost-efficiency, enhanced financial reporting reliability, and reduced workloads (Faccia & Mosteanu, 2019). Fuller and Markelevich (2020) emphasize blockchain's potential for accountants and investors, ensuring reliability by eradicating accounting information errors and fraud risks. A blockchain-based accounting system functions as a software solution facilitating monetary exchange, recording transactions, and guaranteeing accuracy and reliability by third-party verification in a distributed ledger (Doğan & Ertugay, 2019).

Despite Ijiri's (1986) introduction of TEA in the literature, Grigg's work (2005) is deemed the genesis, though unrelated to blockchain-based accounting systems. Consequently, this form of record is commonly termed a "triple-entry accounting system" in academic publications (Ibañez, Bayer, Tasca, & Xu, 2021; Faccia & Mosteanu, 2019; Cai, 2021). Literature also presents diverse proposals for integrating blockchain in accounting, encompassing studies on triple-entry systems, suggestions by Dai (2017), Schmitz & Leoni (2019), Ibañez et al. (2022) on blockchain and smart contract applications creating novel accounting systems, Smith (2018) advocating continuous accounting processes due to blockchain and AI impacts on reporting, and Kahyaoğlu (2019) exploring real-time accounting or privacy achieved through blockchain-based TEA methods. Additionally, another accounting innovation related to blockchain is the World Wide Ledger (WWL), defined by Tapscott (2016) as a blockchain accounting application offering managers and stakeholders accessible, auditable, and reliable information on personal computers.

4. OVERVIEW OF THE ROLE OF BLOCKCHAIN IN EXTERNAL AUDITING

Companies serve as pivotal contributors to a nation's economic development, and their financial information stands as a vital demonstration of resource utilization and value addition. However, in today's intricate and dynamic business landscape, characterized by Barlaup, Iren, and Stuart (2009) as increasingly complex, the need for dependable information has heightened, leading to questioning the trustworthiness of data provided to stakeholders. Stakeholders, including both internal and external users, seek independent audits to access information assessed by impartial entities without conflicts of interest, aligning with their informational requirements (Selimoğlu & Uzay, 2019). The Independent Audit Regulation of 26.12.2012 defines independent audit as the rigorous process of scrutinizing and evaluating financial statements and other monetary information present in records and documents, adhering to independent audit techniques specified in auditing standards.

This process aims to acquire adequate and appropriate evidence ensuring reasonable assurance regarding the accuracy and conformity of financial statements and other financial data with established financial reporting standards.

Audit and control mechanisms exist primarily to assure shareholders, regulators, governments, and other pertinent stakeholders. Ultimately, the objective of an audit, as per ISRE 2400 revised in 2012, is to bolster confidence levels among financial statement readers (ISRE 2400 revised, 2012). Güredin and Uyar (2021) emphasize the audit's critical role as an independent assurance mechanism, ensuring the reliability of financial statements. However, incidents such as the Enron, Tyco, and WorldCom scandals in the United States during 2001 significantly undermined investor confidence in capital markets and audit firms, becoming a transformative milestone for the audit profession (TÜRMOB, 2002; Ayboğa, 2021).

Responding to these crises, the Securities and Exchange Commission (SEC) enacted the Sarbanes-Oxley Act (SOX) in 2002 (Ortman, 2018) to enhance corporate governance practices, subsequently leading to worldwide updates in common auditing standards and the establishment of new oversight mechanisms aimed at enhancing the quality and reliability of independent audits (Uyar, 2015). However, post-Enron, scandals such as Parmalat, Lehman Brothers, Tesco, and Toshiba have continued to shake global confidence in the audit sector, a sentiment echoed in numerous scholarly works, underlining the ongoing recovery phase of public trust (Awolowo et al., 2018; Donnelly & Hartman, 2020; Barlaup et al., 2009; Ebhodaghe & Omoregie, 2020; Agrawal & Chadha, 2005; BEIS, 2021).

In this context, the potential to restore trust and transparency to investors is pivotal for the accounting and auditing industry, still recovering from past scandals. In contrast to traditional human-based systems, blockchain technology offers a decentralized approach, potentially increasing efficiency by significantly reducing trust costs (Casey & Vigna, 2018; Gudgeon et al., 2020; Varma, 2019; Swan & De Filippi, 2017; Ortman, 2018). Present audit methodologies, focusing on retrospective evidence acquisition and sampling, need adaptation to address the contemporary economy's vast databases holding numerous daily transactions vulnerable to cybersecurity threats. External auditors must consider the implications of audit analytics and emerging technologies like blockchain to deliver high-quality audits in a complex ecosystem, aiming to continue delivering value to the public (Swan M., 2015).

Furthermore, research and trials have revealed the extensive benefits of blockchain and distributed ledgers, extending beyond cryptocurrencies (Lemieux & Dener, 2021; Brender et al., 2018; KPMG, 2018). Governments have embarked on pilot projects employing blockchain technology across diverse functions and services, spanning land registration, education, healthcare, procurement, food supply chains, and identity management (IFAC, 2017). IFAC (2017) contends that blockchain is fundamentally a solution in any scenario requiring a dependable record, foreseeing its disruptive potential in finance, particularly its potential application in inter-organizational records like accounting. Thus, comprehending the opportunities and challenges presented by these technologies holds immense significance for accountants and auditors (Rozario & Vasarhelyi, 2018).

5. AUDITING WITH BLOCKCHAIN: OPPORTUNITIES AND CHALLENGES

The conventional audit process historically entails periodic examinations and testing of records by external auditors, often employing various sampling techniques to mitigate risks while recognizing cost and time constraints (POA, 2014). However, this method inherently involves a large volume of unaudited data, rendering practical assurance below 100% (İşseveroğlu, 2019). As blockchain technology finds full integration into business environments, the projected development of blockchain-supported audit processes anticipates significant time reductions by automating audit tests (Dai & Vasarhelyi, 2017; EY, 2019).

Data stored within a blockchain network is cryptographically encrypted, undergoes consensus approval, and is published across the entire network, featuring timestamps and unique hash IDs per information block. This characteristic generates an immutable audit trail, an indispensable tool for auditors in substantiating audit evidence that is sufficient, relevant, and reliable (KGK, 2018). Blockchain networks efficiently store both financial and non-financial data, enhancing audit procedures' accuracy by leveraging varied information types, nurturing the concept of continuous and comprehensive auditing (Rosario & Thomas, 2019; Smith, 2018).

Traditionally, the audit process commences with diverse data and schedules, necessitating significant planning time (CPA, 2017). Access to real-time or near-real-time data facilitated by blockchain nodes streamlines auditor access to consistent, repeatable information. Unlike traditional practices involving data reconciliation from various sources, blockchain's single distributed database obviates the need for such reconciliation, thereby potentially reducing audit costs (Brender et al., 2018; Li, 2021). Additionally, EY (2019) emphasizes that real-time data accessibility on blockchain offers auditors and regulators unprecedented transparency and continuous traceability, enhancing audit integrity.

5.1 Smart Contracts and Audit Procedures

Smart contracts are systems that require a human element at the input and control stages, but are essentially automated and executed by computers (Clack, Bakshi, & Braine, 2016). CPA (2017) defines smart contracts as a technological advancement that has the potential to speed up business operations, minimize operational errors and increase cost efficiency. Accounting and auditing practices are inherently a system in which the human element is involved in all processes. However, smart contracts, which operate on a shared database using the blockchain protocol, transform the need for human-involved functions into programmed and automatically executed systems (Schmitz & Leoni, 2019). Smart contracts are expected to be of great convenience to accountants and auditors, as they allow the autonomous recording of transactions according to the agreed terms. Dai and Vasarhelyi (2017) explain in their article that if the process of recording sales after the shipment of goods is programmed into a smart contract, the system will first automatically verify the date of shipment and then transfer the sales record to the blockchain. Rosairo and Thomas (2019) stated that smart contracts can be used to create smart audit procedures, and these new audit procedures have great potential to improve audit quality by allowing auditors to perform audit procedures more efficiently and consequently allocate more resources to higher risk areas (Rozario & Vasarhelyi, 2018).

5.2. Challenges of Blockchain

Certainly, the application of blockchain in the audit domain presents both promise and challenges. Despite its inherent immutability and transaction security, blockchain doesn't inherently validate the legitimacy of transactions, necessitating auditor scrutiny to discern between legitimate and fraudulent activities (IFAC, 2017). Current studies affirm that while blockchain holds potential benefits, it doesn't obviate the need for auditor judgment, emphasizing the continued importance of auditor expertise and discernment (Raj, 2017; Garanina, Ranta, & Dumay, 2022; CPA Canada, 2017; Dai & Vasarhelyi, 2017).

Auditors must enhance their technological acumen to craft efficient audit procedures within blockchain systems, gather precise evidence, and identify potential risks (CPA Canada, 2017; Schmitz & Leoni, 2019). When auditing crypto assets, auditors face numerous uncertainties encompassing regulatory, legal, and tax considerations, demanding clear legal frameworks (Türkiye Bilişim Vakfı Blockchain Türkiye, 2021). Scalability issues persist in public blockchain infrastructures, impacting data processing speed, cost-effectiveness, and security, whereas permissioned blockchain networks offer more expedient solutions (Psaila, 2017; Zemankova, 2019; Anis, 2023).

Regulatory ambiguity and ensuring confidentiality of sensitive financial data pose challenges, particularly concerning compliance with data protection laws like the GDPR and KVKK (KPMG, 2023). The requisite technological infrastructure and associated costs further compound the challenges surrounding blockchain implementation in business, accounting, and auditing realms (Anis, 2023).

6. CONCLUSION

Indeed, blockchain's integration into business practices is poised to revolutionize traditional paradigms of trust and transform economic frameworks. Although its implementation in accounting and auditing is nascent, blockchain holds immense potential to reshape these practices and introduce novel business models. As its prevalence increases, a significant shift in accounting and auditing methodologies is on the horizon.

Blockchain redefines accounting procedures, acting as an impartial third-party verifier within the double-entry bookkeeping system. Its feature of immutable, time-stamped records instills trust and transparency, curbing falsification and human intervention, thereby reducing periodic control costs. Distributed ledger systems enable continuous and accessible reconciliation, fostering ongoing accounting and verifiable reporting, albeit with concerns surrounding data confidentiality and trade secret disclosure. Mitigating these risks involves utilizing authorized networks and ensuring data privacy.

While blockchain guarantees trust between transacting parties, verifying data accuracy remains crucial. Accountants and auditors must augment their expertise to accommodate clients embracing blockchain. The anticipated proliferation of blockchain across industries necessitates an expanded skill set to meet evolving client needs.

In auditing, blockchain research emphasizes its potential for continuous auditing and smart contracts. Real-time access to accounting records is anticipated to transform audits into a continuous process, focusing on current data for greater efficiency. Smart contracts facilitate streamlined audit procedures, enhancing audit quality by reallocating resources to higher-risk areas.

The efficiency gains offered by blockchain have the potential to redefine the auditor's role, allowing for deeper analysis. However, challenges loom, including scalability, energy costs, privacy, and cybersecurity. To harness blockchain's potential, further research, pilot studies, and updates to supervisory, regulatory, and ethical frameworks are imperative. This collaborative effort will pave the way for blockchain's integration into accounting and auditing practices, unlocking its transformative potential.

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ARTIFICIAL INTELLIGENCE AND ITS IMPLICATIONS FOR RELIGIOUS BELIEF

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Christianity, Hinduism, Buddhism, Judaism, Shintoism, and various other religious systems beckon individuals to their fold, promising comprehensive salvation across spiritual, social, mental, and cultural dimensions. It is customary for religions to assume the role of guiding entities, wielding centuries-worth of amassed knowledge, doctrines, and practices to steer individuals at spiritual, moral, and societal strata. However, the evolution of technology, particularly artificial intelligence (AI), introduces a novel paradigm. As human-machine hybrids—termed here as 'human machines'—emerge, a pertinent dilemma arises: How will these diverse religious ideologies extend their tenets to these new entities shaped by artificial intelligence and assimilate them into their doctrinal frameworks?

The query of the audience and outreach strategies has historically been pivotal for religions. In the early annals of Christianity, the debate revolved around its inclusivity, deliberating whether it would encompass solely Jews or extend to non-Jews. Similarly, Islam grappled with tensions between Umayyad and Hashim factions within the Quraysh tribe, leading to discord between Meccan and Medina, Muhajir and Ansar, ultimately resolved via the dominance of Quraysh-Meccan-Muhajir alliances. The Umayyad era introduced the Mevali system, upholding Arab superiority, countered by the Shuubiye movement championed by non-Arab factions. Presently, the emergence of intelligent entities, both human and non-human, particularly those endowed with hyperintelligence through artificial intelligence, accentuates the crucial issue of religious outreach beyond humans.

Artificial intelligence presents the most formidable challenge religions have faced in human history, surpassing even the theory of evolution. It's not the evolution theory but the advent of artificial intelligence that poses a formidable challenge. Artificial intelligence endows entities with autonomy, enabling moral decision-making, artistic creation, musical composition, and the operation of unmanned aerial vehicles. No longer a mere concept or fiction, artificial intelligence embodies today's reality, heralding a transformative force shaping the future world across all domains, human and natural.

Entities equipped with artificial intelligence continually progress, potentially attaining full consciousness encompassing emotional, sensory, and rational faculties. The prospect of AI-driven entities with human-like cognition raises alarm within humanity. While human development follows a gradual path, AI's hardware doesn't conform to such limitations, potentially attaining massive capacities abruptly. It becomes evident that humans cannot vie with AI-equipped entities and machines on equal terms.

Artificial intelligence also instigates profound spiritual dilemmas. The genesis of intelligent beings external to human origin signifies a seismic shift in religious, spiritual, moral, and social existence. Traditionally, individuals either inherit or choose their beliefs within a cultural context. However, the emergence of non-human intelligences challenges and reshapes established religious paradigms regarding spirit, sin, worship, prayer, and other theological concepts.

Can artificially intelligent beings possess an artificial soul? Could their actions constitute sin? How would they express gratitude or seek forgiveness from a divine entity? Can religious doctrines be tailored for AI entities? These pressing queries lack facile answers.

Religions have historically centered on humans, never envisaging personalities or divine connection for non-human entities, particularly those crafted by humans. The existence of AI-driven machines heralds an impending upheaval in religious realms, posing unprecedented questions and exigencies for religious ideologies worldwide.