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Identification and Ranking of Criteria and Sub-Criteria for Digital Asset Valuation Using Factor Analysis and Multi-Criteria Decision-Making

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Abstract

The present study aimed to identify and rank the criteria and sub-criteria for digital asset valuation using factor analysis and multi-criteria decision-making techniques. In terms of purpose, this study is classified as applied research, while in terms of nature and methodology, it falls within the category of descriptive-correlational research. The statistical population consisted of capital market experts as well as investors in cryptocurrency markets. A total of 154 participants were selected through a non-probability purposive convenience sampling method. It should be noted that, for the confirmatory factor analysis section, the sample size was determined using G*Power software. Furthermore, for the multi-criteria decision-making section, 15 individuals were selected as the sample based on the theoretical foundations of multi-criteria decision-making techniques. Smart PLS version 4 software was employed for confirmatory factor analysis, while Microsoft Excel was used for the multi-criteria decision-making section. Based on the review of the theoretical foundations, four criteria were identified, including identification of digital assets, recognition of digital assets, structural supervision of digital assets, and institutional supervision of digital assets. These criteria comprised twenty-five sub-criteria. The results of the confirmatory factor analysis indicated that the constructs related to determining impairment losses of digital assets exceeding their recoverable amount relative to their carrying amount, internal supervision and controls concerning the accounting information system for the timely disclosure of digital assets, and the evaluation of digital asset recognition according to Paragraph 3 of Accounting Standard No. 8 concerning inventories and goods, exhibited weak factor loadings. Consequently, these three sub-criteria were removed from the model. The Shannon entropy method was employed to rank the main criteria, and the findings revealed that institutional supervision of digital assets was identified as the most important criterion. The WASPAS method was used to rank the sub-criteria, and the results demonstrated that the sub-criteria of estimating cryptocurrency volatility based on market value at the time of digital asset identification, evaluating the recognition of digital assets according to compliance with Accounting Standard No. 15 regarding investments, and internal supervision and controls based on assurance testing for the calculation of the fair value of digital assets ranked first through third, respectively. Based on the obtained findings, it is suggested that the greatest attention in digital asset valuation should be devoted to the criterion of institutional supervision of digital assets.

Keywords: Digital asset valuation, confirmatory factor analysis, Shannon entropy, WASPAS.



1. Introduction

The rapid expansion of digital technologies and the emergence of blockchain-based ecosystems have fundamentally transformed the structure of global financial markets, investment mechanisms, and accounting systems. In recent years, digital assets—including cryptocurrencies, non-fungible tokens (NFTs), decentralized finance (DeFi) instruments, and tokenized assets—have evolved from speculative technological innovations into increasingly recognized financial and economic instruments. This transformation has created significant opportunities for innovation in capital markets, financial intermediation, and investment diversification, while simultaneously introducing unprecedented challenges associated with valuation, accounting recognition, regulation, risk management, and financial reporting (Heiling, 2025; Javaid et al., 2022; Malekan, 2022). The decentralized and technologically driven nature of digital assets has complicated traditional approaches to asset measurement and accounting treatment, particularly because many of these assets lack intrinsic cash flows, centralized issuers, or stable market structures. Consequently, scholars and policymakers have increasingly emphasized the necessity of developing comprehensive valuation frameworks capable of integrating financial, technological, behavioral, and regulatory dimensions into the assessment of digital assets (Gharibi et al., 2025; Karimi et al., 2026; Zhang et al., 2024).

One of the primary complexities associated with digital asset valuation arises from the highly volatile nature of cryptocurrency and token markets. Unlike traditional financial assets, the prices of digital assets are influenced not only by economic fundamentals but also by investor sentiment, speculative behavior, technological developments, geopolitical events, and regulatory uncertainty. Research has shown that cryptocurrency volatility is significantly associated with macroeconomic instability, geopolitical risks, and uncertainty shocks in global financial markets (Fang et al., 2024; Lucey et al., 2022; Sakariyahu et al., 2024). Similarly, digital asset prices are strongly affected by liquidity dynamics, market depth, and investor behavior, which further complicate reliable valuation processes (Ahmed, 2024; Deng & Zhou, 2023). In decentralized financial systems, the absence of traditional valuation anchors such as dividends or predictable cash flows intensifies reliance on behavioral and market-based indicators for pricing digital assets. This issue has encouraged researchers to investigate the role of investor psychology, cognitive biases, and behavioral finance mechanisms in digital asset valuation and investment decision-making (Almeida & Goncalves, 2023; Bajwa, 2025; Carbo Valverde et al., 2025).

The emergence of decentralized finance and blockchain token economies has also increased the importance of tokenomics and network activity in digital asset pricing models. Contemporary studies indicate that variables such as user adoption, transaction frequency, rarity, network participation, and ecosystem utility significantly influence the valuation of digital tokens and NFTs (Lee et al., 2024; Moncada et al., 2024). These findings demonstrate that digital asset valuation extends beyond traditional financial measurement and increasingly depends on technological utility, market participation, and ecosystem governance. Moreover, the evolution of smart contracts and DeFi infrastructures has created additional risks associated with fraud, rug pulls, cybersecurity breaches, and manipulation, thereby necessitating stronger institutional oversight and more sophisticated valuation methodologies (Lin et al., 2024; Scharfman, 2023, 2024). The interconnectedness between technology risks and financial valuation underscores the need for multidimensional frameworks capable of incorporating structural supervision and institutional monitoring into digital asset assessment.

Accounting treatment and financial reporting standards constitute another major challenge in digital asset valuation. Traditional accounting standards were developed primarily for tangible assets and conventional financial instruments, whereas digital assets exhibit characteristics that often overlap among intangible assets, inventories, commodities, and investment instruments. This ambiguity has generated substantial debate regarding the appropriate classification, measurement basis, and disclosure requirements for cryptocurrencies and related digital assets (Hubbard, 2023; Tiwari et al., 2025). Some accounting approaches advocate classifying cryptocurrencies as intangible assets, while others emphasize fair value measurement based on active market pricing (Nadler & Guo, 2020). In practice, inconsistencies in accounting treatment across jurisdictions and organizations have reduced comparability and transparency in financial statements. Furthermore, the rapid pace of digital transformation in accounting systems has intensified the need for updated standards capable of addressing the unique characteristics of decentralized assets (Heiling, 2025). These challenges highlight the importance of identifying reliable valuation criteria that can support both accounting recognition and financial disclosure practices.



Regulatory uncertainty represents another influential factor affecting digital asset valuation and market stability. Governments and regulatory authorities worldwide have adopted heterogeneous approaches toward cryptocurrencies and DeFi markets, ranging from supportive innovation-oriented policies to restrictive bans and enforcement actions. Studies have demonstrated that regulatory interventions significantly influence market quality, investor confidence, and asset prices (Conlon et al., 2024; Emmert, 2023; Griffith & Clancey Shang, 2023). Regulatory fragmentation and uncertainty can increase market volatility and discourage institutional participation, whereas transparent legal frameworks may enhance market efficiency and reduce informational asymmetries (Saggu et al., 2024; Uzougbo et al., 2024). Additionally, the implementation of regulations such as the European MiCA framework has introduced new standards for market transparency, consumer protection, and operational oversight in cryptocurrency markets (Conlon et al., 2024). Regulatory segmentation and restrictions, including cryptocurrency bans in certain jurisdictions, have also been shown to reshape market structures and influence investor behavior (Seikku & Sifat, 2026). Consequently, institutional supervision and regulatory alignment have become central considerations in the valuation and governance of digital assets.

Another critical issue concerns the relationship between digital assets and financial market integrity. Cryptocurrency markets have repeatedly experienced major shocks, exchange collapses, liquidity crises, and fraud incidents, all of which have undermined investor confidence and increased scrutiny regarding valuation practices. The collapse of exchanges such as FTX and the associated accounting failures revealed substantial weaknesses in governance, internal controls, and financial reporting systems (Tiwari et al., 2025). Similarly, crypto-related fraud, romance scams, and digital asset manipulation schemes have exposed vulnerabilities within decentralized ecosystems (Scharfman, 2024). Empirical evidence also suggests that cryptocurrency heists and security breaches negatively affect market efficiency and pricing mechanisms (Li et al., 2024). These developments have reinforced the importance of structural supervision mechanisms, internal controls, audit procedures, and transparent disclosure systems in ensuring reliable digital asset valuation. Furthermore, the interaction between crypto market instability and retail investor losses has intensified calls for stronger risk management frameworks and improved valuation standards (Cornelli et al., 2023; Teng et al., 2023).

Behavioral finance perspectives provide additional insight into digital asset pricing dynamics. Unlike traditional investment markets, cryptocurrency markets are heavily influenced by speculation, herd behavior, fear of missing out (FOMO), and sentiment-driven trading decisions. Investor perceptions regarding financial literacy, risk tolerance, and mental accounting significantly shape cryptocurrency investment behavior and reinvestment intentions (Bajwa, 2025; Carbo Valverde et al., 2025). Research also indicates that investor sentiment and informational noise contribute substantially to asset mispricing and market fluctuations (Sakariyahu et al., 2023). The role of psychological factors is particularly relevant in NFT and token markets, where scarcity perceptions, symbolic value, and community engagement frequently drive valuation beyond conventional financial criteria (Lee et al., 2024; Schapsis et al., 2026). These findings suggest that digital asset valuation cannot be adequately understood solely through classical financial theories and requires the integration of behavioral and social dimensions into analytical frameworks.

Moreover, liquidity and exchange dynamics are essential determinants of digital asset valuation. Cryptocurrency markets differ significantly from traditional financial markets in terms of fragmentation, exchange competition, trading mechanisms, and liquidity structures. Market quality is influenced by factors such as exchange concentration, market-maker activity, fee structures, and external economic events (Galati, 2024; Jobst et al., 2023). Liquidity-adjusted return models and volatility frameworks have therefore become increasingly important in understanding crypto asset pricing (Deng & Zhou, 2023). Additionally, correlations between digital assets and macroeconomic risks, including capital controls, corruption indices, and global uncertainties, demonstrate the broader economic implications of cryptocurrency valuation (Alnasaa et al., 2022; Elsayed et al., 2022). The growing institutionalization of digital assets further increases the need for standardized valuation approaches capable of supporting portfolio management, financial reporting, and regulatory compliance.

Despite the increasing body of literature on cryptocurrencies and digital finance, important research gaps remain regarding the identification and prioritization of valuation criteria for digital assets. Existing studies have often focused on isolated dimensions such as volatility, regulation, accounting treatment, or investor behavior, without integrating these factors into a



comprehensive evaluation model (Ahmed, 2024; Fang et al., 2024; Griffith & Clancey Shang, 2023). Furthermore, many prior investigations have concentrated primarily on developed financial markets, while limited attention has been devoted to emerging-market contexts and institutional accounting environments (Gharibi et al., 2025). There is also a methodological gap concerning the application of multi-criteria decision-making techniques to prioritize valuation criteria and sub-criteria for digital assets. Integrating confirmatory factor analysis with multi-criteria decision-making methods may provide a more systematic and empirically grounded framework for evaluating the relative importance of accounting, institutional, structural, and market-based dimensions in digital asset valuation.

In addition, the increasing complexity of decentralized assets and blockchain ecosystems necessitates interdisciplinary approaches that combine accounting standards, behavioral finance, financial technology, regulatory governance, and risk management perspectives (Karimi et al., 2026; Teng et al., 2023; Zhang et al., 2024). Identifying the most influential valuation criteria can assist investors, accountants, regulators, and policymakers in developing more transparent and reliable frameworks for financial reporting and investment decision-making. Such frameworks may also contribute to reducing informational asymmetries, enhancing market confidence, and improving institutional oversight in cryptocurrency markets. From a methodological perspective, advanced statistical techniques such as factor analysis can improve construct validity and identify the underlying dimensions of digital asset valuation, while multi-criteria decision-making methods can prioritize these dimensions according to their relative significance (Craney & Surles, 2002; Gharibi et al., 2025).

Accordingly, the present study aims to identify and rank the criteria and sub-criteria for digital asset valuation using confirmatory factor analysis and multi-criteria decision-making methods.

2. Methods and Materials

In terms of purpose, this study is classified as applied research, and in terms of nature and method, it falls within the category of descriptive-correlational research. The statistical population consisted of capital market experts as well as investors active in cryptocurrency markets, and the sampling method was non-probability purposive convenience sampling. The data collection method in this study was field-based, and the data collection instrument was a questionnaire. To examine validity in this study, content validity and construct validity, specifically convergent validity, were used. Content validity was assessed based on the opinions of several professors in financial engineering, accounting, and financial management. To examine the reliability of the questionnaire, Cronbach's alpha coefficient and composite reliability coefficient were used. To determine the sample size for the confirmatory factor analysis section, G*Power software was used. Based on the developed protocol, 148 participants were considered as the sample; however, to prevent sample attrition, approximately 160 questionnaires were distributed in this study, and 154 questionnaires were returned to the researcher and used as the basis for analysis. For the multi-criteria decision-making section, 15 individuals were selected as the sample.

3. Findings and Results

Since the criteria and sub-criteria for digital asset valuation were identified through a review of the literature and research background, confirmatory factor analysis was first conducted before ranking the criteria and sub-criteria. Then, the criteria and sub-criteria were ranked using multi-criteria decision-making methods. Accordingly, the relevant steps are presented below:

Step One: Validation Using Confirmatory Factor Analysis

First- and second-order confirmatory factor analysis was used to validate the criteria and sub-criteria for digital asset valuation. In the first step of confirmatory factor analysis, factor loadings and significance values were examined. Factor loadings are calculated by estimating the correlation between the indicators of a construct and that construct, and an acceptable value is equal to or greater than 0.70. In fact, the factor loading indicates that the variance shared between the construct and its indicators is greater than the measurement error variance of that construct. Figure 1 presents the measurement model of digital asset valuation in the standardized estimation mode:



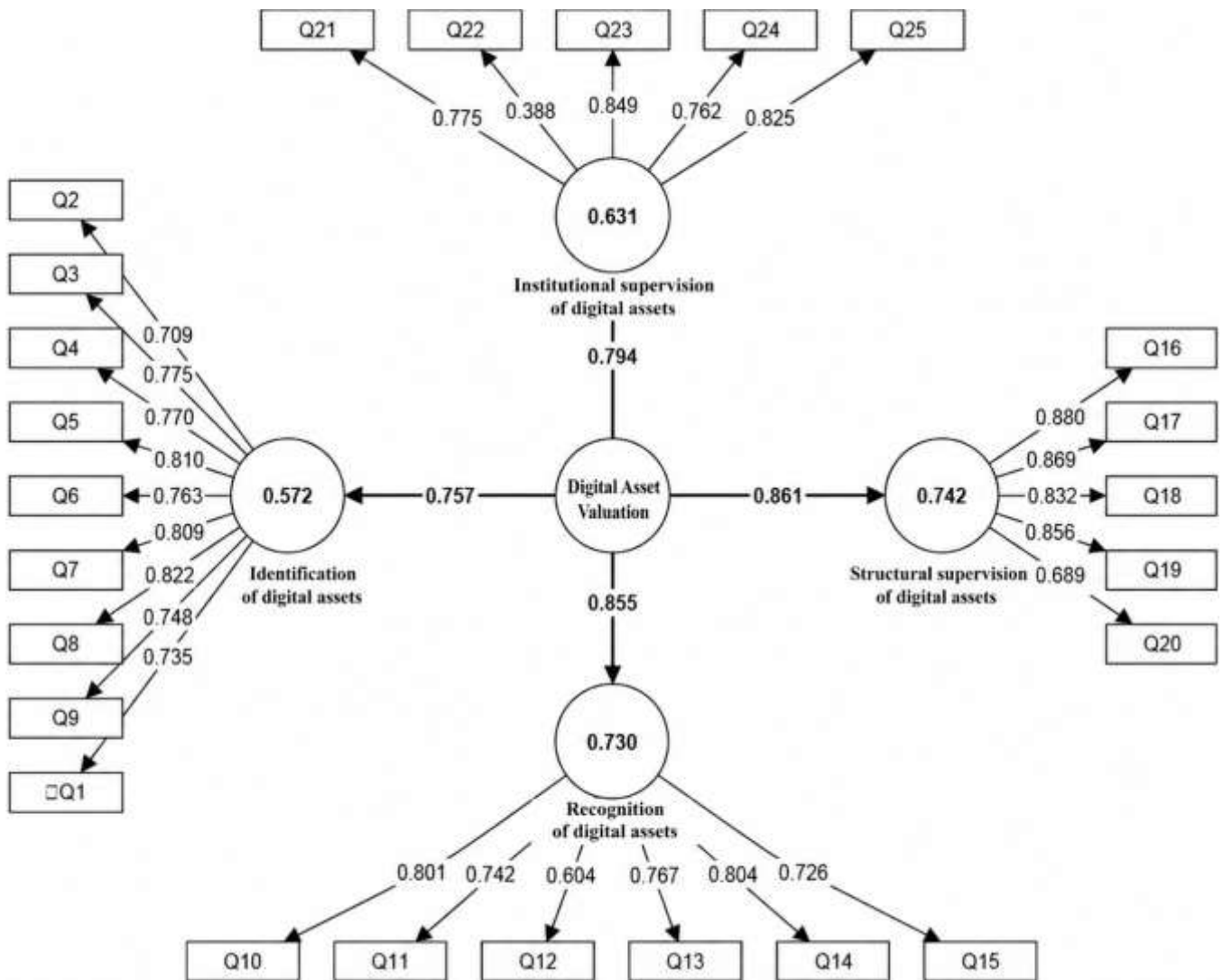


Figure 1. Digital Asset Valuation Model in Standardized Estimation Mode

Based on the results obtained from examining the model, it was found that the factor loadings related to the twelfth, twentieth, and twenty-second constructs were lower than 0.70; therefore, they were removed from the measurement model. The twelfth construct, determining impairment loss of digital assets in excess of their carrying amount relative to their recoverable amount, was related to the recognition of digital assets; the twentieth construct, internal supervision and controls based on the accounting information system in the timely disclosure of digital assets, was related to structural supervision of digital assets; and the twenty-second construct, evaluating the recognition of digital assets according to Paragraph 3 of Accounting Standard No. 8 as inventories, was related to institutional supervision of digital assets. These constructs were removed from the final measurement model. In relationships where the factor loadings were greater than 0.70, there was an appropriate correlation between the identified constructs and the variables. The standardized estimation coefficients for all criteria were also obtained at an appropriate level. The strongest path coefficient belonged to the criterion of structural supervision of digital assets, which was equal to 0.861, indicating that this criterion had the greatest explanatory power among the identified criteria. Subsequently, recognition of digital assets, institutional supervision of digital assets, and identification of digital assets had the highest explanatory power, respectively, after structural supervision of digital assets. The significance of the internal and external relationships among the research variables is examined below. In this mode, the significance values of the research items in relation to their variables are assessed. In this case, each significance value must be greater than 1.96. Figure 2 presents the measurement model in the significance-values mode:

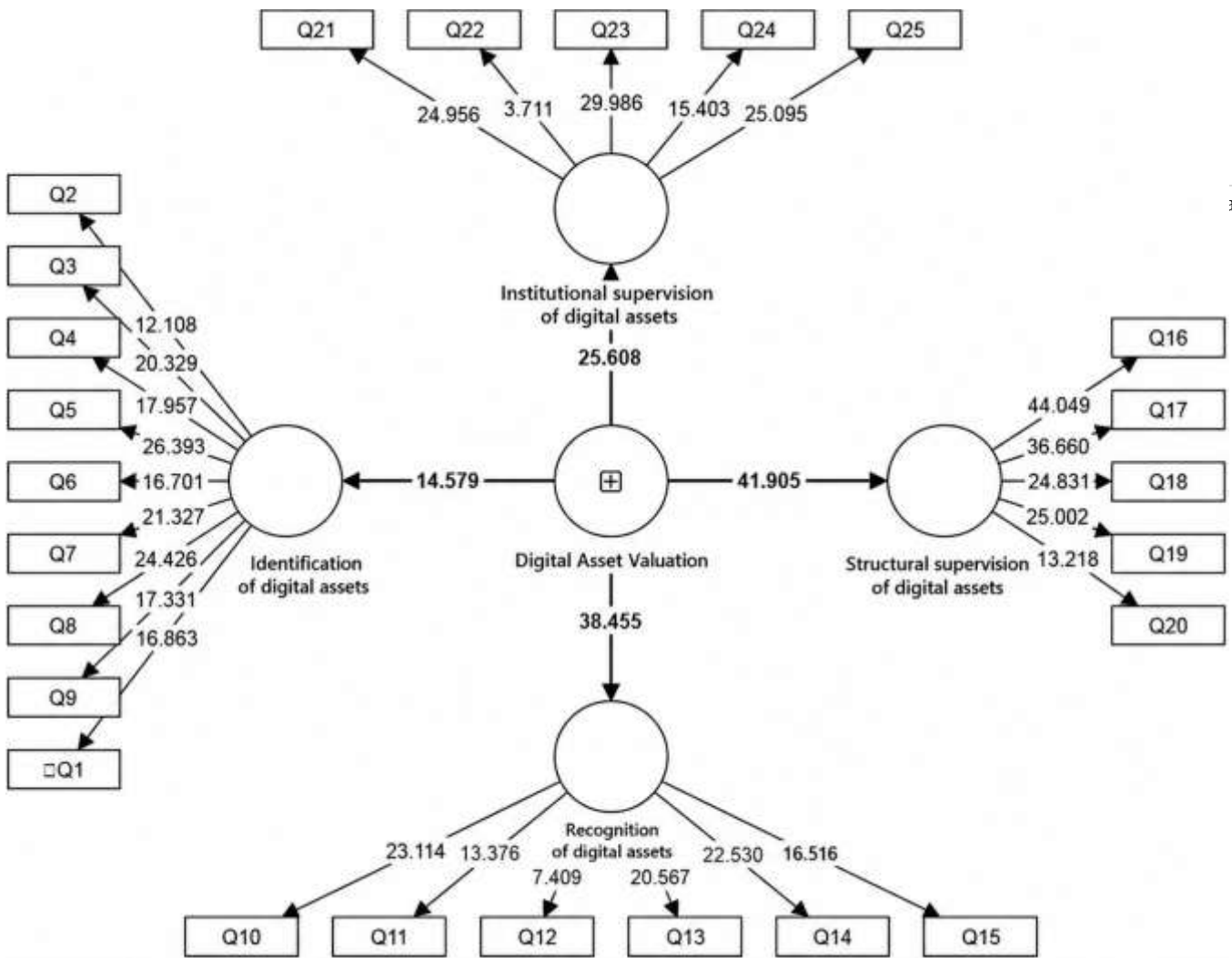


Figure 2. Digital Asset Valuation Model in Significance-Values Mode

Based on the results obtained from Figure 2, it is clear that the external significance values for the relationships between constructs and dimensions, as well as the relationships between dimensions and the variable, were greater than 1.96. Moreover, the internal and external significance levels for these relationships were lower than 5%; therefore, it can be stated that the relationships between the constructs and dimensions, as well as the relationships between the dimensions and the variable, were significant, and the intended constructs and dimensions were properly selected. The results of the significance values, estimation coefficients, and factor loadings obtained from running the model are shown in Table 1.

Table 1. Significance Values, Estimation Coefficients, and Factor Loadings of Criteria and Sub-Criteria for Digital Asset Valuation

Criteria	Estimation Coefficient	Significance Values	Sub-Criteria	Factor Loading	Significance Values	Result
Identification of digital assets	0.757	14.579	Estimating cryptocurrency volatility based on market value at the time of digital asset identification	0.735	16.863	Confirmed
			Estimating the value of digital assets after transfer	0.709	12.108	Confirmed
			Estimating digital assets at the time of purchase based on fair value	0.775	20.329	Confirmed
			Estimating digital asset tax based on market value during the holding period	0.770	17.957	Confirmed
			Measuring the ratio of the cost of digital asset sales to the impairment of their holding value	0.810	26.393	Confirmed
			Measuring the ratio of digital asset value added to the company's total revenues	0.763	16.701	Confirmed



			Measuring the ratio of the market value of digital assets to replacement value with other assets	0.809	21.327	Confirmed
			Measuring the ratio of flows arising from the economic benefits of digital assets to the company's total liabilities	0.822	24.426	Confirmed
			Measuring the ratio of digital asset value added to other intangible assets	0.748	17.331	Confirmed
Recognition of digital assets	0.855	38.455	Determining the holding-period duration of digital assets at the time of investment	0.801	23.114	Confirmed
			Classifying digital assets within the group of intangible assets with a useful life	0.742	13.376	Confirmed
			Determining impairment loss of digital assets in excess of their carrying amount relative to their recoverable amount	0.604	7.409	Not confirmed
			Determining pre-operating expenditures of digital assets	0.767	20.567	Confirmed
			Classifying digital assets among software-based asset items	0.804	22.530	Confirmed
			Classifying digital assets as non-current intangible assets held for sale to generate returns	0.726	16.516	Confirmed
Structural supervision of digital assets	0.861	41.905	Internal supervision and controls based on the recording and disclosure of digital assets by internal auditing	0.880	44.049	Confirmed
			Internal supervision and controls based on assurance testing for calculating the fair value of digital assets	0.869	36.660	Confirmed
			Internal supervision and controls based on the efficiency of digital asset recognition operations	0.832	24.831	Confirmed
			Internal supervision and controls based on uploading documents into systems related to the comprehensive resolution on cryptocurrency regulation	0.856	25.002	Confirmed
			Internal supervision and controls based on the accounting information system in the timely disclosure of digital assets	0.689	13.218	Not confirmed
Institutional supervision of digital assets	0.631	25.608	Evaluating the recognition of digital assets based on compliance with Accounting Standard No. 15 on investments	0.775	24.956	Confirmed
			Evaluating the recognition of digital assets according to Paragraph 3 of Accounting Standard No. 8 as inventories	0.388	3.711	Not confirmed
			Evaluating the recognition of digital assets according to Paragraph 5 of Accounting Standard No. 17 on intangible assets	0.849	29.986	Confirmed
			Evaluating the recognition of digital assets according to Accounting Standard No. 21 regarding the calculation of exchange-rate changes in these assets	0.762	15.403	Confirmed
			Evaluating the recognition of digital assets according to Accounting Standard No. 10 regarding the calculation of changes in the value of these assets after the financial reporting period	0.825	25.095	Confirmed

Another criterion for assessing the goodness-of-fit of the measurement models is convergent validity, which examines the degree of correlation between each construct and its own items. Convergent validity demonstrates the high correlation of the indicators of one construct compared with the indicators of other constructs, and it should be evaluated in reflective models. To assess convergent validity, the Average Variance Extracted (AVE) is used. The value of this coefficient ranges from 0 to 1, and values greater than 0.40 are considered acceptable. The results of the AVE for the model are presented in Table 2.

Table 2. Results of Convergent Validity (Average Variance Extracted)

Digital Asset Valuation Measurement Model	Average Variance Extracted (AVE)
Recognition of digital assets	0.553
Identification of digital assets	0.596
Structural supervision of digital assets	0.686
Institutional supervision of digital assets	0.547



Discriminant validity is another criterion used to assess the goodness-of-fit of measurement models. In this study, the Fornell–Larcker method was employed. This method evaluates the degree of relationship between a construct and its indicators compared with the relationship between that construct and other constructs. The discriminant validity of a model is considered acceptable when a construct has stronger interactions with its own indicators than with other constructs; in other words, the value displayed on the diagonal of the matrix must be greater than the other values in the same column. Based on this matrix, the principal diagonal values are greater than the values below and to the left of them. Since all variables satisfied this condition, the analysis could proceed to the subsequent stages of structural model evaluation. The results of discriminant validity based on the Fornell–Larcker method are presented in Table 3.

Table 3. Results of Discriminant Validity (Fornell–Larcker Criterion)

	Digital Asset Valuation	Recognition of Digital Assets	Identification of Digital Assets	Structural Supervision of Digital Assets	Institutional Supervision of Digital Assets
Digital asset valuation	0.623				
Recognition of digital assets	0.456	0.744			
Identification of digital assets	0.757	0.455	0.772		
Structural supervision of digital assets	0.861	0.767	0.426	0.828	
Institutional supervision of digital assets	0.794	0.605	0.446	0.669	0.739

According to the data analysis algorithm in the Partial Least Squares (PLS) method, Cronbach’s alpha and composite reliability coefficients are used to examine reliability. Composite reliability, or the construct reliability coefficient, is a factor used to evaluate the internal consistency reliability of reflective models. The value of this coefficient ranges between 0 and 1, where values higher than 0.70 are considered acceptable, and values lower than 0.60 are considered undesirable. Based on the results presented in Table 4, the composite reliability index was obtained within an appropriate range. Cronbach’s alpha coefficient is another factor used to evaluate the internal consistency reliability of reflective models. The value of this coefficient also ranges between 0 and 1, where values higher than 0.70 are considered acceptable and values lower than 0.60 are considered undesirable. Table 4 presents the reliability results of the variables.

Table 4. Reliability Coefficients

Digital Asset Valuation Measurement Model	Composite Reliability	Cronbach’s Alpha
Recognition of digital assets	0.847	0.837
Identification of digital assets	0.918	0.915
Structural supervision of digital assets	0.889	0.883
Institutional supervision of digital assets	0.836	0.786

Finally, one of the most important model fit indices used to assess the predictive capability of the model is the coefficient of determination, which was examined in two forms: the coefficient of determination (R^2) and the adjusted coefficient of determination. These coefficients indicate the effect of an exogenous variable on an endogenous variable. The values of 0.19, 0.33, and 0.67 are considered benchmark values for weak, moderate, and strong R^2 values, respectively. The results of these two coefficients are presented in Table 5.

Table 5. Results of Coefficients of Determination and Adjusted Coefficients of Determination

Digital Asset Valuation Measurement Model	Coefficient of Determination (R^2)	Adjusted Coefficient of Determination
Recognition of digital assets	0.730	0.728
Identification of digital assets	0.572	0.569
Structural supervision of digital assets	0.742	0.740
Institutional supervision of digital assets	0.631	0.628

Based on the results of the first- and second-order confirmatory factor analysis, the final criteria and sub-criteria of the digital asset valuation measurement model are presented in Table 6.



Table 6. Final Criteria and Sub-Criteria of the Digital Asset Valuation Measurement Model After Confirmatory Factor Analysis

Criteria	Final Sub-Criteria
Identification of digital assets	Estimating cryptocurrency volatility based on market value at the time of digital asset identification
	Estimating the value of digital assets after transfer
	Estimating digital assets at the time of purchase based on fair value
	Estimating digital asset tax based on market value during the holding period
	Measuring the ratio of the cost of digital asset sales to the impairment of their holding value
	Measuring the ratio of digital asset value added to the company's total revenues
	Measuring the ratio of the market value of digital assets to replacement value with other assets
	Measuring the ratio of flows arising from the economic benefits of digital assets to the company's total liabilities
	Measuring the ratio of digital asset value added to other intangible assets
Recognition of digital assets	Determining the holding-period duration of digital assets at the time of investment
	Classifying digital assets within the group of intangible assets with a useful life
	Determining pre-operating expenditures of digital assets
	Classifying digital assets among software-based asset items
	Classifying digital assets as non-current intangible assets held for sale to generate returns
Structural supervision of digital assets	Internal supervision and controls based on the recording and disclosure of digital assets by internal auditing
	Internal supervision and controls based on assurance testing for calculating the fair value of digital assets
	Internal supervision and controls based on the efficiency of digital asset recognition operations
	Internal supervision and controls based on uploading documents into systems related to the comprehensive resolution on cryptocurrency regulation
Institutional supervision of digital assets	Evaluating the recognition of digital assets based on compliance with Accounting Standard No. 15 on investments
	Evaluating the recognition of digital assets according to Paragraph 5 of Accounting Standard No. 17 on intangible assets
	Evaluating the recognition of digital assets according to Accounting Standard No. 21 regarding the calculation of exchange-rate changes in these assets
	Evaluating the recognition of digital assets according to Accounting Standard No. 10 regarding the calculation of changes in the value of these assets after the financial reporting period

Step Two: Ranking the Criteria and Sub-Criteria Using Multi-Criteria Decision-Making Methods

In this section, the Shannon entropy method was first used to weight the criteria, and then the WASPAS method was used to rank the criteria. The WASPAS method is one of the modern multi-criteria decision-making methods introduced in 2012 by Edmundas Kazimieras Zavadskas and colleagues in a research study. This method combines the Weighted Sum Model (WSM) and the Weighted Product Model (WPM) and has greater accuracy compared with independent methods. The method includes a criterion–sub-criterion matrix and requires the weights of the criteria to rank the sub-criteria. In the first step of this method, the decision matrix is developed. The weights of the criteria had already been calculated using the entropy method. In the first stage, the mean decision-making matrix was formed, as presented in Table 7.

Table 7. Formation of the Mean Decision-Making Matrix

Final Sub-Criteria of Digital Asset Valuation	Identification of Digital Assets	Recognition of Digital Assets	Structural Supervision of Digital Assets	Institutional Supervision of Digital Assets
Criterion weights using entropy method	0.193	0.264	0.266	0.277
Criterion type	Positive	Positive	Positive	Positive
1	8.686637964	7.938004534	8.850218609	6.897453788
2	1.792104438	2.453750842	2.483450898	4.623702267
3	3.929108208	7.734589628	8.292827274	2.875232839
4	1.722918697	6.001203338	8.026266433	5.128844695
5	6.923320687	6.263078219	4.354987738	7.093528844
6	6.953298668	3.230183636	5.067410214	5.153291119
7	8.014305144	5.611756040	6.710907421	2.590028469
8	6.885206326	6.444559741	6.297357644	5.126387218
9	8.528715063	4.045825263	8.173217281	6.549032132
10	8.392016682	2.146954611	6.828650615	6.342347524
11	7.747267682	8.435533806	1.525193103	1.011716787



12	8.670781616	6.446390073	2.019656007	4.628132040
13	7.891443163	1.653924350	7.612132720	3.894569115
14	3.509686315	6.073109499	8.418938257	6.456454328
15	3.870594320	4.696927490	7.883148644	5.180348398
16	4.742843421	8.893422428	6.738495941	6.484548467
17	2.437231985	4.166440056	3.346517776	6.677093434
18	6.827986057	2.477234301	5.736828013	5.776366076
19	8.434427604	7.012640215	8.346261162	7.517764862
20	2.704990533	5.055693427	5.482509503	2.567915072
21	4.592100033	3.082775381	3.698585307	6.231281976
22	7.832427021	3.402788528	2.616700903	3.455605564

In the next step, the decision-making matrix was normalized or scaled. Due to the inconsistency in the nature and type of the indicators, after forming the decision-making matrix, it was necessary to standardize the indicators in order to enable evaluation and comparison from the perspective of all indicators. The results are presented in Table 8.

Table 8. Normalization or Scaling of the Matrix

Final Sub-Criteria of Digital Asset Valuation	Identification of Digital Assets	Recognition of Digital Assets	Structural Supervision of Digital Assets	Institutional Supervision of Digital Assets
1	0.288137	0.304110	0.300467	0.273391
2	0.059444	0.094005	0.084314	0.183267
3	0.130329	0.296317	0.281543	0.113964
4	0.057149	0.229910	0.272494	0.203289
5	0.229647	0.239943	0.147853	0.281163
6	0.230642	0.123750	0.172040	0.204258
7	0.265835	0.214990	0.227837	0.102660
8	0.228383	0.246895	0.213797	0.203192
9	0.282898	0.154998	0.277483	0.259581
10	0.278364	0.082251	0.231834	0.251388
11	0.256978	0.323171	0.051781	0.040101
12	0.287611	0.246965	0.068568	0.183443
13	0.261760	0.063363	0.258434	0.154367
14	0.116417	0.232665	0.285825	0.255911
15	0.128388	0.179942	0.267635	0.205331
16	0.157321	0.340713	0.228773	0.257025
17	0.080843	0.159619	0.113615	0.264657
18	0.226485	0.094904	0.194767	0.228955
19	0.279771	0.268659	0.283357	0.297978
20	0.089725	0.193687	0.186132	0.101783
21	0.152320	0.118103	0.125568	0.246986
22	0.259802	0.130363	0.088838	0.136968

In the third and fourth steps of this method, the relative importance of the sub-criteria should be calculated based on the Weighted Sum Model (WSM) and the Weighted Product Model (WPM). Before implementing these steps, the relative importance of each sub-criterion with respect to each criterion had to be calculated. The results of this section are presented in Table 9.

Table 9. Determination of the Relative Importance Matrix of Each Sub-Criterion Compared with the Model Criteria

Final Sub-Criteria of Digital Asset Valuation	Identification of Digital Assets	Recognition of Digital Assets	Structural Supervision of Digital Assets	Institutional Supervision of Digital Assets
1	0.000208	0.000231	0.000226	0.000187
2	0.000009	0.000022	0.000018	0.000084
3	0.000042	0.000220	0.000198	0.000032
4	0.000008	0.000132	0.000186	0.000103
5	0.000132	0.000144	0.000055	0.000198
6	0.000133	0.000038	0.000074	0.000104
7	0.000177	0.000116	0.000130	0.000026



8	0.000130	0.000152	0.000114	0.000103
9	0.000200	0.000060	0.000192	0.000168
10	0.000194	0.000017	0.000134	0.000158
11	0.000165	0.000261	0.000007	0.000004
12	0.000207	0.000152	0.000012	0.000084
13	0.000171	0.000010	0.000167	0.000060
14	0.000034	0.000135	0.000204	0.000164
15	0.000041	0.000081	0.000179	0.000105
16	0.000062	0.000290	0.000131	0.000165
17	0.000016	0.000064	0.000032	0.000175
18	0.000128	0.000023	0.000095	0.000131
19	0.000196	0.000180	0.000201	0.000222
20	0.000020	0.000094	0.000087	0.000026
21	0.000058	0.000035	0.000039	0.000153
22	0.000169	0.000042	0.000020	0.000047

Based on Table 9, the results of the Weighted Sum Model (WSM) and Weighted Product Model (WPM) are presented in Table 10.

Table 10. Calculation of the Weighted Sum and Weighted Coefficient

Final Sub-Criteria of Digital Asset Valuation	WSM	WPM
Estimating cryptocurrency volatility based on market value at the time of digital asset identification	0.000016	0.000054
Estimating the value of digital assets after transfer	0.000001	0.000005
Estimating digital assets at the time of purchase based on fair value	0.000009	0.000024
Estimating digital asset tax based on market value during the holding period	0.000006	0.000016
Measuring the ratio of the cost of digital asset sales to the impairment of their holding value	0.000007	0.000029
Measuring the ratio of digital asset value added to the company's total revenues	0.000004	0.000020
Measuring the ratio of the market value of digital assets to replacement value with other assets	0.000008	0.000026
Measuring the ratio of flows arising from the economic benefits of digital assets to the company's total liabilities	0.000007	0.000032
Measuring the ratio of digital asset value added to other intangible assets	0.000010	0.000035
Determining the holding-period duration of digital assets at the time of investment	0.000008	0.000022
Classifying digital assets within the group of intangible assets with a useful life	0.000009	0.000010
Determining pre-operating expenditures of digital assets	0.000008	0.000019
Classifying digital assets among software-based asset items	0.000007	0.000017
Classifying digital assets as non-current intangible assets held for sale to generate returns	0.000008	0.000027
Internal supervision and controls based on the recording and disclosure of digital assets by internal auditing	0.000006	0.000022
Internal supervision and controls based on assurance testing for calculating the fair value of digital assets	0.000011	0.000035
Internal supervision and controls based on the efficiency of digital asset recognition operations	0.000003	0.000011
Internal supervision and controls based on uploading documents into systems related to the comprehensive resolution on cryptocurrency regulation	0.000005	0.000019
Evaluating the recognition of digital assets based on compliance with Accounting Standard No. 15 on investments	0.000014	0.000050
Evaluating the recognition of digital assets according to Paragraph 5 of Accounting Standard No. 17 on intangible assets	0.000003	0.000012
Evaluating the recognition of digital assets according to Accounting Standard No. 21 regarding the calculation of exchange-rate changes in these assets	0.000003	0.000014
Evaluating the recognition of digital assets according to Accounting Standard No. 10 regarding the calculation of changes in the value of these assets after the financial reporting period	0.000004	0.000013

Finally, based on the results obtained from the joint criterion (Q_i) and lambda coefficient (λ), the rankings of the sub-criteria were determined. The results are presented in Table 11.

Table 11. Ranking of Sub-Criteria Based on the WASPAS Method

Final Sub-Criteria of Digital Asset Valuation	λ	Q_i	Rank
Estimating cryptocurrency volatility based on market value at the time of digital asset identification	0.770766	0.292744	1
Estimating the value of digital assets after transfer	0.860327	0.098041	22
Estimating digital assets at the time of purchase based on fair value	0.724852	0.206400	9
Estimating digital asset tax based on market value during the holding period	0.714114	0.180019	15
Measuring the ratio of the cost of digital asset sales to the impairment of their holding value	0.799057	0.219599	6
Measuring the ratio of digital asset value added to the company's total revenues	0.819652	0.180753	14
Measuring the ratio of the market value of digital assets to replacement value with other assets	0.773113	0.208509	8



Measuring the ratio of flows arising from the economic benefits of digital assets to the company's total liabilities	0.811176	0.224488	5
Measuring the ratio of digital asset value added to other intangible assets	0.773676	0.241348	4
Determining the holding-period duration of digital assets at the time of investment	0.740393	0.203343	10
Classifying digital assets within the group of intangible assets with a useful life	0.517891	0.152748	19
Determining pre-operating expenditures of digital assets	0.708820	0.191460	12
Classifying digital assets among software-based asset items	0.708330	0.179846	16
Classifying digital assets as non-current intangible assets held for sale to generate returns	0.768806	0.216108	7
Internal supervision and controls based on the recording and disclosure of digital assets by internal auditing	0.798814	0.192298	11
Internal supervision and controls based on assurance testing for calculating the fair value of digital assets	0.754013	0.241820	3
Internal supervision and controls based on the efficiency of digital asset recognition operations	0.801177	0.143404	21
Internal supervision and controls based on uploading documents into systems related to the comprehensive resolution on cryptocurrency regulation	0.799236	0.181472	13
Evaluating the recognition of digital assets based on compliance with Accounting Standard No. 15 on investments	0.781429	0.281238	2
Evaluating the recognition of digital assets according to Paragraph 5 of Accounting Standard No. 17 on intangible assets	0.818128	0.143635	20
Evaluating the recognition of digital assets according to Accounting Standard No. 21 regarding the calculation of exchange-rate changes in these assets	0.837721	0.153465	18
Evaluating the recognition of digital assets according to Accounting Standard No. 10 regarding the calculation of changes in the value of these assets after the financial reporting period	0.762044	0.153542	17

Figure 3 presents the radar chart of the final sub-criteria for digital asset valuation.

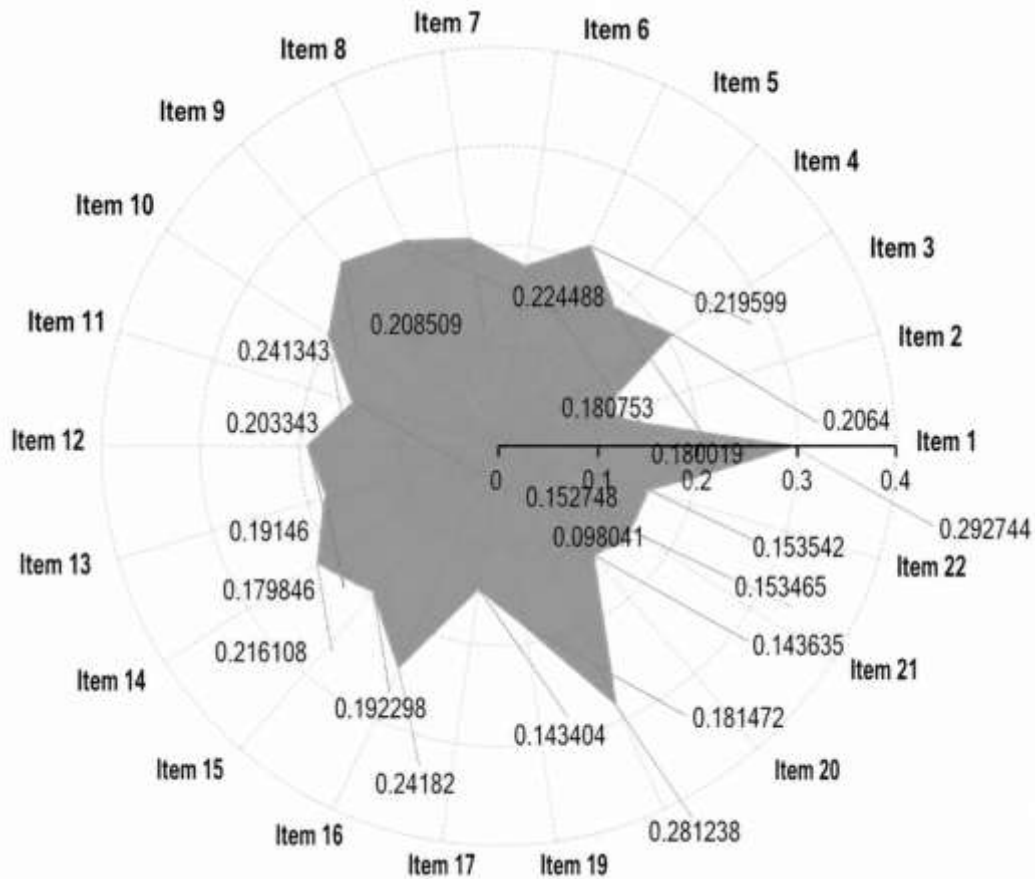


Figure 3. Radar Chart of the Ranking of the Final Sub-Criteria for Digital Asset Valuation

4. Discussion and Conclusion

The present study aimed to identify and rank the criteria and sub-criteria for digital asset valuation using confirmatory factor analysis and multi-criteria decision-making methods. The findings demonstrated that four principal criteria, namely identification of digital assets, recognition of digital assets, structural supervision of digital assets, and institutional supervision of digital assets, constitute the major dimensions of digital asset valuation. The results of the confirmatory factor analysis



indicated that most of the identified sub-criteria possessed acceptable factor loadings and satisfactory explanatory power, confirming the validity of the proposed measurement model. However, three sub-criteria, including determining impairment losses of digital assets exceeding recoverable amounts, internal controls based on accounting information systems for timely disclosure, and recognition of digital assets according to Accounting Standard No. 8 as inventories, were excluded from the final model because of weak factor loadings. Furthermore, the findings of the Shannon entropy and WASPAS methods revealed that institutional supervision of digital assets was the most important criterion among the identified dimensions, while the most significant sub-criteria included estimating cryptocurrency volatility based on market value at the time of digital asset identification, evaluating digital asset recognition according to Accounting Standard No. 15 regarding investments, and internal supervision and controls based on assurance testing for calculating the fair value of digital assets.

The confirmation of the four-dimensional structure of digital asset valuation indicates that the valuation of decentralized assets is a multidimensional process that extends beyond traditional accounting and financial approaches. The identified dimensions suggest that digital asset valuation simultaneously depends on market behavior, accounting recognition practices, internal control systems, and institutional regulatory structures. These findings are aligned with previous studies emphasizing that cryptocurrencies and blockchain-based assets possess hybrid financial, technological, and institutional characteristics that require integrated valuation frameworks (Gharibi et al., 2025; Karimi et al., 2026; Zhang et al., 2024). The significant explanatory power of the structural supervision and institutional supervision dimensions also confirms that regulatory oversight and governance mechanisms play central roles in the assessment of digital assets. This finding supports the arguments of scholars who emphasize that digital asset markets cannot achieve sustainable efficiency without transparent supervisory systems and regulatory consistency (Conlon et al., 2024; Griffith & Clancey Shang, 2023; Uzougbo et al., 2024).

One of the most important findings of this study was the identification of institutional supervision of digital assets as the highest-ranked criterion. This result suggests that compliance with accounting standards, legal frameworks, and institutional monitoring mechanisms constitutes the most influential factor in digital asset valuation. The importance of institutional supervision can be explained by the inherently decentralized and volatile nature of cryptocurrency markets, where the absence of centralized governance increases uncertainty regarding financial reporting, asset ownership, and market integrity. Prior studies have similarly demonstrated that regulatory interventions significantly affect cryptocurrency market quality, investor confidence, and price stability (Emmert, 2023; Saggiu et al., 2024; Seikku & Sifat, 2026). The increasing implementation of regulatory frameworks such as the European MiCA regulation further illustrates the growing institutionalization of digital asset markets and the necessity of standardized oversight mechanisms (Conlon et al., 2024). Moreover, findings related to institutional supervision are consistent with the arguments of Hubbard regarding the accounting treatment challenges associated with cryptocurrencies and the need for transparent recognition standards in financial reporting (Hubbard, 2023).

The strong importance assigned to evaluating digital asset recognition according to Accounting Standard No. 15 concerning investments demonstrates that market participants and experts increasingly perceive digital assets as investment-oriented financial instruments rather than merely speculative or technological assets. This result aligns with research emphasizing that cryptocurrencies are gradually becoming integrated into institutional investment portfolios and financial reporting systems (Heiling, 2025; Nadler & Guo, 2020). The increasing adoption of digital assets by investors and financial institutions has intensified the need for accounting frameworks capable of measuring fair value, impairment, and post-reporting-period changes. This finding is also consistent with the work of Tiwari et al., who highlighted that accounting ambiguities surrounding cryptocurrency holdings contributed to governance failures during major crypto exchange collapses such as Binance and FTX (Tiwari et al., 2025). Therefore, the emphasis on institutional supervision and accounting compliance reflects the growing demand for reliable and transparent valuation standards in decentralized financial ecosystems.

Another major finding of the study concerns the high ranking of estimating cryptocurrency volatility based on market value at the time of digital asset identification. This result indicates that market volatility is considered one of the most critical determinants of digital asset valuation. The cryptocurrency market is characterized by substantial price fluctuations driven by investor sentiment, macroeconomic uncertainty, speculative trading, and geopolitical events. Previous studies have consistently confirmed the central role of volatility in cryptocurrency pricing and investment decisions (Ahmed, 2024; Fang et al., 2024; Sakariyahu et al., 2024). The findings of this study support the argument that accurate valuation of digital assets requires



continuous monitoring of market fluctuations and dynamic price changes. Furthermore, the significance of cryptocurrency volatility in the valuation model is consistent with the Cryptocurrency Uncertainty Index proposed by Lucey et al., which demonstrated that uncertainty strongly influences digital asset returns and investor behavior (Lucey et al., 2022). This finding also supports Malekan's argument that volatility should not necessarily be interpreted solely as a weakness of cryptocurrencies but rather as a defining characteristic of emerging digital markets (Malekan, 2022).

The high ranking of internal supervision and assurance testing related to fair value calculations demonstrates the importance of internal control systems and auditing procedures in digital asset valuation. Due to the decentralized and technologically complex structure of blockchain-based assets, valuation processes are vulnerable to manipulation, fraud, cyberattacks, and disclosure inconsistencies. Previous research has shown that cryptocurrency markets are highly susceptible to fraud schemes, smart-contract vulnerabilities, and exchange-related misconduct (Lin et al., 2024; Scharfman, 2023, 2024). Consequently, organizations and financial institutions require effective assurance mechanisms capable of validating fair value calculations and ensuring accurate disclosure practices. The findings of the present study are also supported by Teng et al., who emphasized the importance of mitigating digital asset risks through stronger governance, risk management, and internal control systems (Teng et al., 2023). Similarly, the significance of structural supervision aligns with research indicating that market quality and investor protection in cryptocurrency markets are heavily dependent on transparency and institutional monitoring (Galati, 2024; Jobst et al., 2023).

The exclusion of certain sub-criteria from the final model also provides important theoretical and practical implications. Specifically, the weak factor loading associated with recognizing digital assets as inventories according to Accounting Standard No. 8 suggests that market participants and accounting experts may no longer perceive cryptocurrencies primarily as inventory-type assets. Instead, they appear to be increasingly viewed as investment-oriented intangible or financial assets. This finding reflects ongoing international debates regarding the appropriate accounting classification of digital assets (Heiling, 2025; Hubbard, 2023). Similarly, the weak explanatory power of impairment-based accounting measures may indicate that traditional impairment concepts are insufficient for highly volatile decentralized assets, where fair value changes occur continuously and rapidly. This interpretation aligns with studies emphasizing the limitations of conventional accounting frameworks in capturing the economic realities of blockchain-based financial systems (Gharibi et al., 2025; Karimi et al., 2026).

The findings related to investor-oriented valuation indicators also support the relevance of behavioral finance perspectives in cryptocurrency markets. Variables such as market value estimation, fair value assessment, and volatility monitoring are strongly influenced by investor expectations, cognitive biases, and speculative behavior. Previous research has demonstrated that cryptocurrency investors frequently exhibit herd behavior, overconfidence, and sentiment-driven decision-making (Almeida & Goncalves, 2023; Carbo Valverde et al., 2025). Bajwa also showed that risk tolerance significantly influences reinvestment intentions in cryptocurrency markets (Bajwa, 2025). The importance of market-based valuation criteria in the present study therefore reflects the behavioral nature of digital asset pricing. In addition, the findings are consistent with studies examining the role of investor sentiment and informational noise in asset pricing and volatility formation (Sakariyahu et al., 2023). These results confirm that digital asset valuation cannot be adequately understood through purely classical financial approaches and requires integration with behavioral and psychological perspectives.

The findings additionally emphasize the growing interrelationship between digital asset valuation and technological infrastructure. The significance of sub-criteria associated with software-based assets, blockchain systems, and fair value testing indicates that digital asset valuation increasingly depends on technological verification and decentralized network structures. Previous studies have shown that blockchain ecosystems, tokenomics structures, and network activity significantly influence digital asset prices and valuation mechanisms (Lee et al., 2024; Moncada et al., 2024). Furthermore, the emergence of decentralized finance and smart-contract systems has increased the complexity of valuation processes due to issues such as liquidity fragmentation, rug pulls, and contract vulnerabilities (Lin et al., 2024). Therefore, the integration of technological considerations into valuation frameworks appears essential for accurately assessing digital asset quality and market sustainability.



Another important implication of the findings concerns the relationship between regulation and market stability. The results indicate that institutional supervision and compliance with accounting and financial standards are central to improving digital asset valuation reliability. This finding supports prior evidence suggesting that transparent regulatory systems contribute to market maturity, investor protection, and financial stability (Conlon et al., 2024; Griffith & Clancey Shang, 2023). Conversely, regulatory uncertainty and fragmented legal approaches can intensify market volatility and reduce confidence among institutional investors (Saggu et al., 2024; Seikku & Sifat, 2026). The findings are also aligned with research showing that cryptocurrency regulation directly influences market quality and capital allocation decisions (Biju & Thomas, 2023; Uzougbo et al., 2024). Consequently, the prioritization of institutional supervision in this study reflects the increasing necessity of coordinated regulatory governance in digital asset ecosystems.

This study contributes to the literature by integrating confirmatory factor analysis and multi-criteria decision-making techniques to identify and prioritize digital asset valuation criteria. Unlike many previous studies that focused on isolated dimensions of cryptocurrency markets, the present study developed a multidimensional valuation framework encompassing accounting, institutional, structural, and market-related factors. The integration of Shannon entropy and WASPAS methods enabled the prioritization of valuation criteria according to expert evaluations, thereby providing a systematic approach for understanding the relative importance of digital asset valuation dimensions. In methodological terms, the findings also demonstrate the usefulness of factor analysis and decision-making models in examining emerging financial phenomena characterized by uncertainty, technological innovation, and regulatory complexity (Craney & Surles, 2002).

One limitation of the present study is that the data were collected from a limited sample of capital market experts and cryptocurrency investors, which may restrict the generalizability of the findings to broader international contexts. In addition, the rapid evolution of blockchain technologies and cryptocurrency markets may cause some valuation criteria to change over time. Another limitation concerns the reliance on self-reported questionnaire data, which may be influenced by respondent bias and subjective perceptions. Furthermore, the study focused primarily on accounting and financial dimensions of digital asset valuation and did not extensively examine technological coding structures or macroeconomic policy variables.

Future studies are recommended to investigate digital asset valuation models across different countries and regulatory environments in order to compare institutional and accounting approaches. Researchers may also examine the role of artificial intelligence, machine learning algorithms, and blockchain analytics in improving digital asset valuation accuracy. Additional studies could investigate industry-specific digital assets, including NFTs, decentralized autonomous organizations (DAOs), and tokenized real-world assets. Longitudinal studies examining changes in valuation criteria over time may also provide valuable insights into the evolution of cryptocurrency markets and decentralized financial ecosystems.

From a practical perspective, policymakers and regulatory authorities should prioritize the development of transparent accounting standards and supervisory frameworks for digital assets in order to improve market confidence and reduce uncertainty. Financial institutions and accounting organizations should strengthen internal control systems, fair value testing procedures, and disclosure mechanisms related to cryptocurrency holdings. Investors and market participants should also pay greater attention to volatility indicators, institutional supervision, and accounting transparency when evaluating digital assets. Finally, educational institutions and professional associations should develop specialized training programs to improve financial literacy and professional expertise regarding blockchain technologies and digital asset valuation.

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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