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A Structural Model of the Effect of Business Intelligence on the Transformation of Management Accounting Tools through Big Data and Blockchain Technologies

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Abstract

This study presents a structural model of the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies. The research was applied, descriptive, and field-based in nature and adopted a quantitative approach using a questionnaire as the data collection instrument. Descriptive statistics and frequency tables were used to analyze the demographic data. A one-sample t-test was employed to examine the research variables relative to the midpoint of the measurement scale. Statistical analyses were conducted using SPSS version 26, while partial least squares (PLS) modeling was performed using SmartPLS 3. The results of the structural model fit assessment indicated that the model fit indices were at appropriate and desirable levels and that the proposed research model demonstrated an acceptable fit. Accordingly, future studies may apply the present research model to different case studies involving various companies or industries to investigate the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies and to measure the magnitude of these effects. The findings may enable managers and stakeholders to make appropriate investments to improve management accounting practices in companies and industries based on big data technologies, blockchain, and business intelligence systems.

Keywords: Business intelligence, big data, management accounting tools, blockchain, modeling

1. Introduction

The rapid digitalization of contemporary organizations has fundamentally changed the information environment in which management accounting operates. Traditional management accounting systems were primarily designed to process structured, internally generated financial information and to support planning, control, budgeting, cost analysis, and performance evaluation. However, the growing complexity of competitive markets, the acceleration of technological change, the expansion of digital platforms, and the increasing volume and variety of organizational data have created new demands for faster, more integrated, and more predictive forms of managerial information. In this environment, management accounting can no longer be viewed solely as a system for recording and reporting historical financial information; rather, it increasingly functions as an analytical and strategic information infrastructure that connects operational data, financial data, managerial judgments, and organizational decision-making. The development of management accounting maturity models also reflects this transition from conventional accounting practices toward more integrated, strategic, and technology-enabled systems capable of supporting higher levels of organizational decision quality and performance (Naser Torabi et al., 2021).

This transformation has been reinforced by the growing importance of management accounting in organizational performance. Management accounting provides managers with information needed for cost control, resource allocation, performance measurement, strategic planning, and the evaluation of alternative courses of action. Accordingly, the quality, speed, relevance, and analytical depth of management accounting information can directly influence managerial effectiveness and organizational outcomes. Research has emphasized the role of management accounting in improving corporate performance by facilitating better planning, more effective monitoring, and more informed decision-making (Mahmoudkhani et al., 2022). At the same time, corporate governance characteristics and strategic management accounting practices can shape the way accounting information is produced, interpreted, and used in organizational control and strategic decision processes (Sahari & Heydarpour, 2023; Sahari & Pourzamani, 2022). These developments indicate that management accounting tools are increasingly embedded within broader organizational governance, control, and information systems rather than operating as isolated accounting techniques.

The increasing reliance on digital information has also made the effectiveness of accounting controls and information processes more important. The performance of accountants is influenced not only by their technical knowledge but also by the control structures, task characteristics, and behavioral conditions under which accounting activities are performed. Evidence suggests that the establishment and development of control mechanisms can affect accountants' performance, while task repetitiveness and accountants' behavioral inclination may modify the effectiveness of such controls (Bana & Shahmoradi, 2024). This implies that the transformation of management accounting tools should not be examined only as a technological issue. Rather, it should be viewed as an organizational phenomenon in which digital technologies, information systems, professional practices, internal controls, and managerial behavior interact. Consequently, the adoption of advanced technologies such as business intelligence, big data analytics, blockchain, and artificial intelligence can influence both the technical architecture of accounting systems and the roles performed by management accountants.

Among these technologies, business intelligence has emerged as one of the most important infrastructures for converting organizational data into actionable managerial knowledge. Business intelligence refers to an integrated set of technologies, architectures, analytical techniques, databases, dashboards, and decision-support processes that enable organizations to collect, integrate, analyze, and visualize information for decision-making. In the management accounting context, business intelligence can improve access to relevant information, accelerate reporting cycles, strengthen performance monitoring, and support the integration of financial and nonfinancial indicators. A review of the literature on business intelligence systems and management accounting indicates that BI systems can significantly affect management accounting practices by improving information quality, analytical capacity, reporting flexibility, and managerial decision support (Achhaiba & Omari, 2022). Intelligent systems have likewise been shown to reshape management accounting through automation, advanced analytics, and enhanced information processing, thereby changing both the nature of accounting tasks and the competencies required of management accountants (Marques et al., 2023).

Business intelligence also has important implications for organizational performance because it creates an analytical interface between raw data and managerial action. By consolidating information from multiple sources, BI systems can reduce fragmentation and improve the consistency of managerial information. More importantly, business intelligence becomes especially valuable when organizations operate in environments characterized by large data volumes, rapid changes, and complex interdependencies. In such environments, BI is increasingly linked with big data analytics and blockchain technology. Research has demonstrated that business intelligence can contribute to firm performance through the combined roles of big data analytics and blockchain technology, suggesting that these technologies should be considered as interconnected components of a broader digital decision-support ecosystem rather than as isolated innovations (Pancić et al., 2023). This integrated perspective is particularly relevant to management accounting because accounting tools increasingly depend on real-time data processing, cross-functional information integration, data integrity, and predictive analysis.

Big data represents one of the most influential drivers of this transformation. Big data is generally associated with extremely large, diverse, rapidly generated, and complex datasets that exceed the processing capacity of conventional information systems. For management accounting, the importance of big data does not lie merely in data volume but in the possibility of integrating structured and unstructured information from financial systems, customer transactions, supply chains, production processes, digital platforms, social media, and external markets. Big data analytics enables accountants and managers to identify patterns, detect anomalies, evaluate performance drivers, and generate forward-looking insights. Recent research on the accounting function shows that big data analytics is reshaping the work of accounting professionals by modifying traditional tasks, expanding analytical responsibilities, and increasing the importance of interpretation, data literacy, and strategic business partnering (Mukherjee et al., 2025). Accordingly, management accountants are increasingly expected to move beyond retrospective reporting toward predictive and prescriptive forms of analysis.

This shift is consistent with the broader evolution of advanced technologies in accounting and finance. Systematic reviews and bibliometric analyses show rapid growth in the application of artificial intelligence, machine learning, blockchain, robotic process automation, advanced analytics, and related digital technologies across accounting and finance domains (Sanz Martín et al., 2025). The growing adoption of these technologies indicates that accounting systems are moving toward more automated, interconnected, and analytically sophisticated architectures. The management accounting profession is therefore being transformed at both the technological and occupational levels. Accounting professionals increasingly need the capacity to interpret algorithmic outputs, evaluate data quality, understand digital controls, and integrate technology-generated insights into managerial decisions.

Artificial intelligence further strengthens this transition by enhancing the analytical and predictive capabilities of accounting information systems. AI-enabled accounting systems can support classification, anomaly detection, forecasting, fraud detection, and decision support. In accounting information systems, artificial intelligence has been identified as an important mechanism for strengthening fraud detection by improving the ability of systems to identify unusual patterns and suspicious transactions (Zayed et al., 2024). In management accounting, AI has broader implications because it can automate routine analytical tasks, support scenario analysis, and improve predictive planning. Futures-oriented research also suggests that artificial intelligence will substantially affect the future structure and functions of management accounting, particularly through automation, intelligent forecasting, continuous monitoring, and enhanced strategic decision support (Aboeuimehrizi et al., 2025). These developments reinforce the need to understand management accounting transformation within a broader digital ecosystem in which business intelligence interacts with big data, blockchain, and artificial intelligence.

Blockchain technology represents another major technological development with significant implications for accounting. Blockchain is a distributed ledger architecture that records transactions in a decentralized, transparent, traceable, and relatively tamper-resistant manner. Its accounting relevance stems from its capacity to strengthen data integrity, reduce reconciliation requirements, enhance transaction traceability, and facilitate real-time verification. Reviews of blockchain applications in accounting indicate that the technology can affect financial reporting, auditing, transaction processing, control systems, and accounting information quality (Putritama et al., 2024). Similarly, research on blockchain and artificial intelligence in accounting and auditing has shown that these technologies can change the architecture of accounting information systems and the nature of assurance, verification, and reporting activities (Han et al., 2023). These changes are especially relevant to management accounting because improved data reliability and transaction visibility can strengthen cost analysis, performance measurement, budgeting, and strategic control.

Blockchain may also contribute to the improvement of accounting information systems by reinforcing integration, transparency, and data reliability. An interpretive structural analysis of blockchain and artificial intelligence in accounting information systems indicates that these technologies can improve the quality and effectiveness of accounting systems through better information processing, enhanced control, and more advanced analytical capabilities (Zeinali Kermani et al., 2025). In combination with business intelligence, blockchain can provide a more reliable data foundation upon which analytical models and managerial dashboards are built. In combination with big data, blockchain can support secure and traceable data environments in which larger volumes of information can be integrated and analyzed. Therefore, the technological transformation of management accounting is increasingly characterized by convergence rather than by the isolated adoption of individual digital tools.

This convergence is also evident in strategic cost management. Big data and blockchain technologies can influence cost management practices by improving the timeliness, scope, and traceability of cost information and by changing the skills required from accounting professionals. Evidence from technological environments suggests that both blockchain technology and big data can affect strategic cost management and accountants' competencies, particularly by increasing demand for digital, analytical, and systems-oriented skills (Agrab & Fourati, 2025). This has important implications for management accounting tools because strategic cost analysis, budgeting, performance measurement, and control systems increasingly depend on integrated digital data infrastructures. The transformation of management accounting tools should therefore be understood not simply as digitization of existing techniques, but as a deeper redesign of how information is generated, analyzed, communicated, and used in strategic decision processes.

At the same time, the increasing transparency of accounting information can influence decision-making beyond the boundaries of the individual firm. Greater financial information transparency can improve financial decision processes by reducing information asymmetry and facilitating more informed assessments among actors across supply chains (Xue, 2024). From a management accounting perspective, this highlights the importance of accurate, timely, and accessible information not only for internal control but also for interorganizational coordination. Business intelligence systems, big data technologies, and blockchain can contribute to such transparency by connecting internal accounting information with operational and external datasets and by improving data consistency and traceability.

The growing digitalization of management accounting must also be understood within the wider context of financial technology and digitally enabled financial systems. FinTech-oriented investment models demonstrate that technological innovation is increasingly embedded in financial systems and organizational resource allocation decisions (Kalaei et al., 2024). These changes influence management accounting because investment evaluation, risk assessment, budgeting, performance analysis, and strategic planning increasingly require information generated through digital platforms and advanced financial technologies. Thus, management accounting tools must evolve to remain compatible with technologically advanced financial environments.

Despite the potential advantages of digital technologies, their organizational value depends on how effectively they are incorporated into decision-making. Decision processes are not purely technical; they are socially constructed and shaped by interpretation, organizational discourse, and professional judgment. Research examining decision-making processes has shown that organizational actors construct and justify decisions through interpretive and discursive processes rather than relying solely on objective information (Cooper, 2023). Therefore, even advanced business intelligence systems cannot automatically improve management accounting unless the generated information is appropriately interpreted and integrated into managerial reasoning. This perspective reinforces the importance of examining the structural relationships among business intelligence, digital technologies, and management accounting tools rather than assuming direct technological determinism.

The recent literature increasingly recognizes that digital technologies are producing a broad transformation in management accounting. A systematic review of advancements in management accounting and digital technologies demonstrates that digitalization affects management accounting processes, professional roles, analytical practices, information quality, decision support, and organizational control (Barreto et al., 2025). Nevertheless, the literature remains fragmented because many studies focus on individual technologies or isolated accounting applications. Some studies emphasize business intelligence, others focus on blockchain, artificial intelligence, or big data, while fewer studies examine their combined structural relationships with the transformation of management accounting tools. This fragmentation creates an important research gap, particularly in contexts where organizations are simultaneously adopting multiple technologies and where the value of one technology may depend on the presence of another.

In particular, there is a need to examine whether business intelligence functions as a central driver of management accounting transformation and whether big data and blockchain technologies reinforce or mediate this relationship. Business intelligence provides the analytical architecture through which organizational information is transformed into managerial insights; big data expands the scope, volume, and diversity of information available for analysis; and blockchain can strengthen the reliability, traceability, and integrity of the underlying data. The interaction of these technologies can therefore create a more advanced management accounting environment characterized by integrated databases, real-time reporting, predictive analytics, transparent transactions, and enhanced decision support. Such a configuration is consistent with the broader technological evolution documented in recent accounting research and provides a theoretical basis for examining management accounting transformation as a multidimensional digital process (Marques et al., 2023; Mukherjee et al., 2025; Pancić et al., 2023).

Furthermore, as accounting information systems become increasingly dependent on interconnected digital technologies, understanding the structural relationships among these technologies becomes important for both theory and practice. Managers need empirical evidence regarding where digital investments generate the greatest accounting value, while accountants need clearer insight into how emerging technologies reshape their tools, tasks, and professional competencies. Researchers likewise need integrated models capable of explaining how business intelligence, big data, and blockchain collectively influence management accounting practices. Without such models, organizations may adopt technologies independently without understanding their complementary effects or their contribution to the transformation of accounting tools and decision-support systems.

Accordingly, the aim of this study is to develop and test a structural model of the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies.

2. Methods and Materials

The present study is descriptive-correlational research examining the relationships incorporated in a model of the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies. Correlational research is itself a subset of descriptive (nonexperimental) research. In general, the data collection methods employed in the present study are described below.

a) In terms of research objective: Since the present study seeks to design a model explaining the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies, it is classified as applied research in terms of its objective.

b) In terms of data: With respect to data and information collection and the method of analysis, the present research is quantitative.

c) In terms of the nature and type of study: Based on its nature and study design, the present research is a cross-sectional survey.

The statistical population consisted of all individuals working and professionally active in the field of management accounting in companies listed on the stock exchange. This group of management accountants was selected for two reasons. First, this group constitutes a pivotal category within the occupational hierarchy of management accountants. Second, because they possess at least some management accounting experience, they have relatively established behaviors and attitudes. Clearly, when the target population is large and includes a substantial number of individuals, studying the entire population is difficult. Therefore, to facilitate the research process and conserve time, energy, and financial resources, a sampling method was employed, and the results were generalized to the population. The study was conducted during 2024–2025. Convenience sampling was used, and paper-based questionnaires were distributed manually among accountants working in management accounting occupational groups. The completed questionnaires were subsequently collected. Because no official statistics were available regarding the number of management accountants employed by Iranian listed companies, the population size was considered unknown. Accordingly, given the unknown population size and the unavailability of the population variance, the sample size was calculated using Cochran's formula for an indefinite population, and ultimately, 150 individuals from the statistical population were selected as the study sample. The research data were collected using the standardized questionnaire for measuring the study variables developed by Pacic et al. (2023). Finally, descriptive statistics and frequency tables were used to analyze the demographic data. A one-sample *t*-test was used to examine the research variables relative to the midpoint of the measurement scale. Statistical analyses were performed using SPSS version 26, and structural equation modeling (SEM) with the partial least squares (PLS) approach was conducted using SmartPLS 3.

3. Findings and Results

This section first presents the descriptive statistics for the demographic variables.

Table 1. Descriptive Statistics of Demographic Variables

Variable	Category	Frequency	Percentage
Gender	Female	27	18.0
	Male	123	82.0
	Total	150	100
Marital status	Married	119	79.3
	Single	31	20.7
	Total	150	100
Age	30–40 years	32	21.3
	40–50 years	75	50.0
	Over 50 years	43	28.7
	Total	150	100
Education level	Bachelor's degree	12	8.0
	Master's degree	74	49.3
	Doctoral degree	64	42.7
	Total	150	100
Work experience	5–10 years	13	8.7
	10–15 years	46	30.7
	15–20 years	59	39.3
	Over 20 years	32	21.3
	Total	150	100

The results of the one-sample *t*-test comparing the observed means of the research variables with the theoretical midpoint of the measurement scale are presented in Table 2.

Table 2. Description of the Research Variables

Variable	Mean	*t* Statistic	df	Significance Level	Mean Difference
Business intelligence	3.97	4.687	209	.000	0.97
Big data	3.84	7.927	209	.021	0.84
Management accounting tools	3.41	3.591	209	.006	0.41
Blockchain	4.12	9.139	209	.042	1.12

The results showed that, given significance levels below .05, the mean scores for business intelligence (3.97), big data (3.84), management accounting tools (3.41), and blockchain (4.12) were all above the midpoint of the measurement scale. Therefore, all calculated means for the research variables were greater than 3, representing the moderate level of the scale.

Before conducting the inferential analyses, the normality of the data distribution was assessed to determine the appropriate analytical method and software for modeling and hypothesis testing. For this purpose, the Kolmogorov–Smirnov test was used to examine the normality of the distributions of the research variables. The results are presented in Table 3.

Table 3. Results of the Normality Assessment for the Research Variables

Variable	Significance Level	Test Statistic
Business intelligence	.003	0.859
Big data	.012	0.651
Management accounting tools	.024	0.369
Blockchain	.004	0.125

According to the information presented in the table above, because the significance levels for all variables were below .05, the assumption of normality for the questionnaire data was rejected. Therefore, the variables examined in this study did not follow a normal distribution, and the partial least squares structural equation modeling (PLS-SEM) approach using SmartPLS was employed for their analysis.

In structural equation modeling, construct validity must first be examined to determine whether the items selected to measure the variables possess sufficient measurement accuracy. The results regarding the construct validity of the research variables were presented previously. To further ensure measurement adequacy, confirmatory factor analysis (CFA) was used to assess the fit of the questionnaire items. The criterion for statistical significance was that the factor loading of each item on its corresponding variable should have a *t*-value greater than 1.96 and a *p*-value below .05. On this basis, it can be concluded that the respective dimensions or items possess sufficient accuracy to measure the corresponding construct or latent variable. Table 4 presents the factor loadings of the items associated with each construct (variable).

Table 4. Results of Confirmatory Factor Analysis and Factor Loadings of the Research Items

Variable	Item No.	Factor Loading	*t* Statistic	*p* Value
Business intelligence	1	0.519	11.461	.000
	2	0.614	5.972	.008
	3	0.116	1.241	.058
	4	0.659	10.889	.002
	5	0.624	27.208	.000
	6	0.609	9.355	.000
	7	0.527	33.352	.000
	8	0.629	8.217	.004
	9	0.597	48.746	.000
	10	0.718	24.021	.000
	11	0.639	16.278	.000
	12	0.667	8.995	.000
	13	0.572	27.216	.000
	14	0.834	43.779	.000
	15	0.566	3.517	.003
	16	0.798	7.215	.000
	17	0.814	19.446	.000
	18	0.669	38.415	.000
	19	0.824	8.258	.000
	20	0.716	3.657	.000
	21	0.889	21.327	.000
	22	0.765	15.214	.000
	23	0.778	32.446	.000
	24	0.814	19.327	.000
	25	0.885	46.150	.000
	26	0.874	22.557	.000
	27	0.833	43.632	.000
	28	0.796	55.217	.000
	29	0.558	6.546	.000
	30	0.893	28.339	.000
	31	0.536	5.214	.001
Management accounting tools	1	0.536	33.216	.000
	2	0.662	8.321	.001
	3	0.616	12.746	.000
	4	0.527	5.589	.000
	5	0.549	3.216	.001
	6	0.638	7.028	.000
	7	0.541	10.227	.000
	8	0.632	17.264	.000
	9	0.726	4.366	.000
	10	0.652	3.058	.000
	11	0.639	16.004	.000
	12	0.574	9.556	.000
	13	0.613	14.337	.000
	14	0.554	8.031	.000
	15	0.631	5.285	.000
Big data	1	0.669	20.119	.002
	2	0.627	27.201	.000
	3	0.609	9.366	.000
	4	0.627	33.362	.000
	5	0.629	5.227	.007

	6	0.697	71.776	.000
	7	0.721	27.022	.000
	8	0.639	26.271	.000
	9	0.667	6.996	.000
	10	0.672	27.226	.000
Blockchain	1	0.537	73.779	.000
	2	0.592	12.512	.000
	3	0.554	20.779	.000
	4	0.566	8.517	.003
	5	0.203	0.241	.146
	6	0.824	8.258	.000
	7	0.726	3.887	.000
	8	0.559	14.069	.000
	9	0.567	26.555	.000
	10	0.558	7.216	.000
	11	0.612	10.327	.000

The results showed that all items, except Item 3 of the business intelligence construct and Item 5 of the blockchain construct, had *t*-statistics greater than 1.96 and significance levels below .05. Therefore, these two items were removed, while all remaining items were retained and confirmed.

Because Cronbach's alpha is a traditional criterion for evaluating construct reliability, composite reliability (CR) and rho coefficients are considered more recent reliability measures. Accordingly, all three criteria were employed in this section. It should be noted that calculated coefficients greater than .70 are considered acceptable (Davari & Rezazadeh, 2014). The reliability results for each variable in the model are presented in the following table.

Table 5. Reliability Indices for the Model Variables

Variable	Cronbach's Alpha	Composite Reliability (CR)	Rho Coefficient
Business intelligence	0.781	0.835	0.832
Big data	0.812	0.812	0.752
Management accounting tools	0.735	0.849	0.864
Blockchain	0.797	0.867	0.799

As shown in the table above, all variables had reliability coefficients of .70 or higher. Therefore, the model was also confirmed in terms of composite reliability.

To assess the validity of the measurement model, convergent validity and discriminant validity were examined. The results of the average variance extracted (AVE), factor loadings, cross-loadings, Fornell–Larcker criterion, and heterotrait–monotrait ratio (HTMT) were analyzed. It should be noted that when a construct (latent variable) is measured through observable indicators, the correlations among its items can be evaluated using convergent validity. If the correlations among the factor loadings are high, the variables demonstrate convergent validity.

Average variance extracted (AVE) was used to assess convergent validity (Azar et al., 2012). The critical threshold for this criterion is .50; that is, an AVE value greater than .50 indicates acceptable convergent validity. The values of this criterion for the measurement model of the present study are presented in Table 6.

Table 6. Convergent Validity of the Model Variables

Variable	AVE
Business intelligence	0.555
Big data	0.637
Management accounting tools	0.524
Blockchain	0.569

As shown in the table, the AVE values for all variables were greater than .50, confirming the convergent validity of the model.

Discriminant validity was assessed using two approaches: the Fornell–Larcker criterion and the HTMT ratio. Each of these indices is examined below.

When an instrument measures a construct that is distinct from those measured by other instruments, it is said to possess discriminant validity. Discriminant validity essentially demonstrates the uniqueness of a measurement instrument. Evidence of discriminant validity requires demonstrating that indicators that should not be strongly related to one another are, in fact, sufficiently distinct (Davari & Rezazadeh, 2014). In SmartPLS, this validity is evaluated using the Fornell–Larcker matrix, whose cells contain correlations among the variables and the square roots of the AVE values for the respective variables. This

matrix is presented in the following table. A model demonstrates acceptable discriminant validity when the values on the main diagonal of the matrix exceed the corresponding off-diagonal values.

Table 7. Discriminant Validity of the Research Model Based on the Fornell–Larcker Criterion

Variable	Business Intelligence	Big Data	Management Accounting Tools	Blockchain
Business intelligence	0.754			
Big data	0.493	0.814		
Management accounting tools	0.548	0.546	0.936	
Blockchain	0.493	0.436	0.416	0.887

As shown in the table, acceptable discriminant validity of the research measurement model was confirmed because, in all cases, the values on the main diagonal of the matrix exceeded the corresponding values below them.

Henseler et al. (2015) introduced a new index known as the heterotrait–monotrait ratio (HTMT) for assessing discriminant validity. The HTMT criterion has been proposed as an alternative to the Fornell–Larcker criterion. The recommended threshold for HTMT is generally between .85 and .90. When the values of this criterion are below .90, discriminant validity is considered acceptable.

Table 8. Discriminant Validity of the Research Model Based on the HTMT Criterion

Variable	Business Intelligence	Big Data	Management Accounting Tools	Blockchain
Business intelligence	0.834			
Big data	0.352	0.755		
Management accounting tools	0.214	0.496	0.726	
Blockchain	0.364	0.257	0.364	0.899

As shown in the table, all reported HTMT values were below .90; therefore, the discriminant validity of the model was confirmed.

Within the inner model, the research hypotheses were examined, and the paths of the structural model were evaluated. Each path corresponds to one of the hypotheses in the model. Each hypothesis was tested by examining the sign, magnitude, and statistical significance of the path coefficient (beta) between each latent variable and the dependent variable. The larger the path coefficient, the stronger the predictive effect of the latent variable on the dependent variable. Based on the results obtained for the relationships between the independent and dependent variables, the statistical significance of the effects among the study variables can be evaluated using the corresponding coefficients. To determine the statistical significance of the path coefficient, or beta coefficient, the significance of the *t*-value associated with each path coefficient must be examined. Therefore, the bootstrapping procedure was used.

Table 9. Direct and Indirect Effects of the Research Variables in the Model

Path	Path Coefficient	Standard Error	*t* Statistic	*p* Value
Business intelligence ← Management accounting tools	0.409	0.078	6.254	.000
Business intelligence ← Big data	0.625	0.261	18.169	.000
Business intelligence ← Blockchain	0.672	0.154	9.502	.000
Big data ← Management accounting tools	0.687	0.136	2.587	.003
Blockchain ← Management accounting tools	0.783	0.157	11.516	.012
Business intelligence ← Blockchain ← Management accounting tools	0.526	0.092	5.697	.000
Business intelligence ← Big data ← Management accounting tools	0.429	0.152	3.362	.000

Considering the *t*-statistics and *p*-values for all paths, all *t*-statistics were greater than 1.96 and all *p*-values were below .05. This indicates that all paths were statistically significant at the 95% confidence level and that the hypothesized significant effects were confirmed. The results of testing the research structural model are presented in Figure 1.

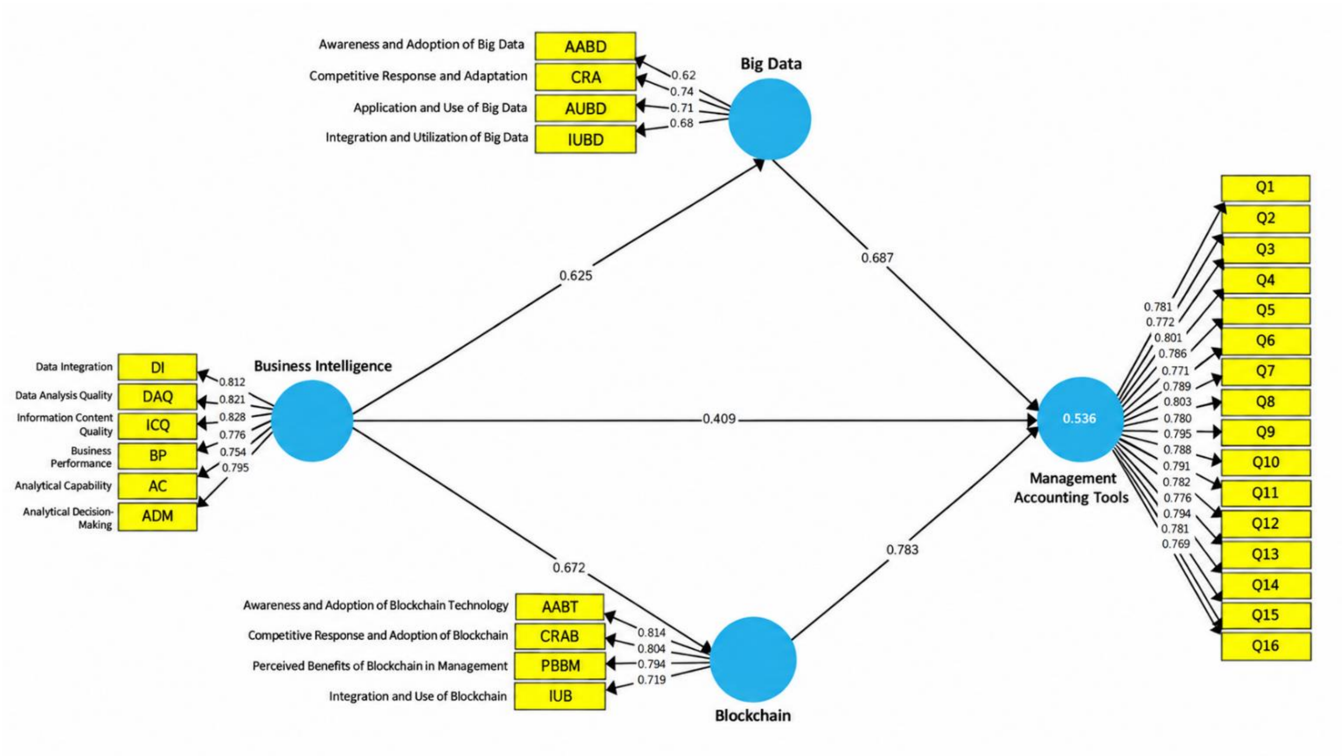

Figure 1. Structural Model of the Research

Several criteria were used to evaluate the fit of the research model, as discussed below.

The second criterion for assessing the structural model is the coefficient of determination (R^2) for the endogenous latent variables of the model. The higher the R^2 value for the endogenous constructs in a model, the better the explanatory power of the model. An R^2 value greater than .33 indicates a substantial relationship among the model constructs. Table 10 presents the R^2 value for the dependent variable in the present study.

Table 10. R² Value

Dependent Variable	R²
Management accounting tools	0.536

As shown, the R^2 value for the dependent variable in the research model indicates strong explanatory power.

The third criterion for assessing the structural model is Q^2. This criterion, introduced by Stone and Geisser, indicates the predictive relevance of the model for the dependent variable. The values of this index imply that, when the relationships among constructs are correctly specified within a model, the constructs should have sufficient predictive relevance for the endogenous indicators. Values of .02, .15, and .35 are interpreted as indicating low, medium, and high predictive relevance, respectively.

Table 11. Q² Value of the Dependent Variable in the Research Model

Dependent Variable	Q²
Management accounting tools	0.306

Based on the Q^2 value obtained from the analysis, the predictive power of the model for the dependent variable is at a level approaching strong predictive relevance.

One of the most widely used overall model fit indices in the partial least squares approach is the goodness-of-fit (GoF) index. The GoF criterion was proposed by Tenenhaus et al. (2004) and is calculated using the following formula:

$$\text{GoF} = \sqrt{[\text{average (Communality)} \times \text{average } (R^2)]}$$

Wetzels et al. (2009) proposed values of .10, .25, and .36 as benchmarks representing weak, moderate, and strong GoF, respectively. This index can be calculated using the geometric mean of the average communality and the average R^2 value.

According to Tenenhaus et al. (2005), the GoF index in PLS modeling provides a practical approach to evaluating the overall fit of a model and functions as an overall goodness-of-fit criterion analogous to fit indices used in covariance-based methods. It can therefore be used to assess the overall validity or quality of a PLS model. The GoF value was calculated as follows:

$$GoF = \sqrt{(0.767 \times 0.349)} = 0.517$$

The value of 0.349 represents the reported R^2 value used in the GoF calculation. Accordingly, the GoF value for the research model was 0.517, indicating a very good overall fit of the model.

4. Discussion and Conclusion

The present study developed and tested a structural model explaining the effect of business intelligence on the transformation of management accounting tools through big data and blockchain technologies. Overall, the findings provide empirical support for the proposed model and indicate that business intelligence is positively associated with both big data and blockchain technology, while these two technological capabilities are, in turn, positively associated with management accounting tools. In addition, business intelligence demonstrated a significant direct relationship with management accounting tools, suggesting that its contribution to management accounting transformation is not limited to indirect technological pathways. The measurement model also exhibited acceptable reliability and validity after the removal of two nonsignificant items, and the structural model demonstrated satisfactory explanatory and predictive capability. Taken together, the results suggest that the transformation of management accounting in digitally intensive organizational environments is best understood as the outcome of an interconnected technological architecture in which business intelligence provides analytical capability, big data expands the informational foundation of managerial analysis, and blockchain improves the reliability and traceability of the information upon which accounting decisions are based.

The first important finding was the significant positive path from business intelligence to management accounting tools ($\beta = .409$, $t = 6.254$, $p < .001$). This result indicates that greater use and development of business intelligence capabilities are associated with greater transformation and enhancement of management accounting tools. Business intelligence systems facilitate the collection, integration, processing, visualization, and interpretation of organizational information, enabling management accountants to use more timely and multidimensional information in budgeting, cost management, performance measurement, forecasting, and managerial decision-making. This finding is consistent with the literature indicating that business intelligence systems can substantially influence management accounting by increasing information availability, accelerating reporting, integrating financial and nonfinancial data, and improving decision-support capacity (Achhaiba & Omari, 2022). It also aligns with the evidence that intelligent information systems are increasingly transforming management accounting functions by replacing purely retrospective reporting with interactive analytics, automated information processing, and more forward-looking decision support (Marques et al., 2023). Accordingly, business intelligence should not be viewed merely as a reporting application but as a technological infrastructure through which conventional management accounting tools can be upgraded into more dynamic and strategically oriented systems.

This direct relationship is also compatible with the growing strategic role of management accounting. Management accounting contributes to organizational performance through planning, control, resource allocation, and managerial evaluation, and its effectiveness depends greatly on the quality and usability of the information available to managers (Mahmoudkhani et al., 2022). Similarly, strategic management accounting has been associated with broader corporate governance characteristics and the integration of accounting information into organizational monitoring and strategic decision processes (Sahari & Heydarpour, 2023; Sahari & Pourzamani, 2022). The present findings extend this perspective by showing that business intelligence may provide the technological infrastructure needed to strengthen such strategic applications. When business intelligence improves access to relevant information and allows managers to combine accounting data with operational and market indicators, management accounting can shift from a predominantly control-oriented function toward a more proactive role in strategic analysis.

The findings further showed a strong positive relationship between business intelligence and big data ($\beta = .625$, $t = 18.169$, $p < .001$). This result is theoretically plausible because the value of big data depends not only on the existence of large and diverse datasets but also on the organizational capacity to integrate, analyze, and convert those datasets into useful knowledge. Business intelligence provides precisely such an analytical and decision-support layer. The result is strongly consistent with research emphasizing the complementary relationship between business intelligence and big data analytics and their combined contribution to firm performance (Pancić et al., 2023). It is also supported by recent evidence showing that big data analytics is changing accounting functions by expanding the informational scope of accountants' work and increasing reliance on data interpretation, analytics, forecasting, and strategic advisory roles (Mukherjee et al., 2025). In this sense, business intelligence can be regarded as an enabling platform through which big data becomes managerially actionable rather than remaining a large but underutilized pool of information.

The significant direct effect of big data on management accounting tools (β = .687, t = 2.587, p = .003) further demonstrates the central role of advanced data analytics in the transformation of management accounting. The relatively large path coefficient suggests that the ability to capture and analyze high-volume, high-variety, and rapidly generated information can substantially alter the way management accounting tools are designed and used. Big data can enhance cost behavior analysis, customer profitability analysis, forecasting, budgeting, performance measurement, risk assessment, and strategic decision-making by allowing managers to incorporate both financial and nonfinancial information from internal and external sources. The finding is consistent with the argument that big data analytics is reshaping the nature of accounting work and redefining the competencies expected from accounting professionals (Mukherjee et al., 2025). It is also in line with evidence that advanced digital technologies are rapidly diffusing across accounting and finance and are changing the analytical architecture of these fields (Sanz Martín et al., 2025).

Importantly, the study also identified a significant indirect effect of business intelligence on management accounting tools through big data (β = .429, t = 3.362, p < .001). This finding indicates that part of the contribution of business intelligence to management accounting transformation operates through the development and utilization of big data capabilities. In practical terms, business intelligence alone may improve accounting processes, but its effects can become more extensive when organizations also possess the data volume, variety, analytical infrastructure, and data-management capability necessary to support more sophisticated accounting analysis. This result is compatible with the integrated technological framework proposed by Pancić et al., in which business intelligence, big data analytics, and blockchain are interrelated components contributing to organizational performance (Pancić et al., 2023). It also supports the broader conclusion of systematic reviews showing that digital transformation in management accounting increasingly emerges from combinations of technologies rather than from isolated systems (Barreto et al., 2025).

The results additionally revealed a strong positive relationship between business intelligence and blockchain technology (β = .672, t = 9.502, p < .001). This finding suggests that organizations with more developed business intelligence capabilities may also be better positioned to adopt and integrate blockchain-based systems. Although business intelligence and blockchain serve different technological functions, they are complementary. Business intelligence focuses primarily on information integration and analysis, whereas blockchain emphasizes decentralized recording, integrity, traceability, and resistance to unauthorized alteration. When combined, blockchain may improve the trustworthiness of the information base, while business intelligence transforms that information into managerial insights. This interpretation is consistent with research identifying blockchain as an increasingly important component of accounting information systems (Putritama et al., 2024) and with studies emphasizing the joint potential of blockchain and artificial intelligence to improve the quality, transparency, and functionality of accounting information systems (Zeinali Kermani et al., 2025). Reviews of blockchain in accounting and auditing similarly indicate that blockchain may alter transaction verification, recordkeeping, controls, reporting, and assurance processes (Han et al., 2023).

The strongest direct relationship in the structural model was observed between blockchain and management accounting tools (β = .783, t = 11.516, p = .012). This result implies that blockchain-related capabilities may play an especially important role in transforming management accounting tools. One explanation is that management accounting depends fundamentally on the integrity, timeliness, and traceability of transactional and operational information. Blockchain can potentially strengthen these characteristics by creating shared and verifiable records, reducing reconciliation requirements, facilitating audit trails, and improving information transparency. These characteristics are particularly relevant to cost management, internal control, supply-chain accounting, performance measurement, and interorganizational accounting. The finding is consistent with evidence that blockchain has substantial implications for accounting practices and information systems (Han et al., 2023;

Putritama et al., 2024). It also accords with research suggesting that blockchain and big data can influence strategic cost management and can alter the skill requirements of accountants in technologically advanced environments (Agrab & Fourati, 2025).

The significant indirect effect of business intelligence on management accounting tools through blockchain ($\beta = .526$, $t = 5.697$, $p < .001$) provides further evidence of technological complementarity. This indirect path was stronger than the indirect effect through big data, suggesting that the transformation of management accounting tools may depend not only on increased analytical capacity but also on the reliability and traceability of the data being analyzed. Business intelligence systems produce valuable insights only when their underlying information is sufficiently accurate, complete, timely, and trustworthy. Blockchain can contribute to this informational foundation by improving data provenance and transactional transparency. This interpretation is consistent with research emphasizing the potential of blockchain to strengthen accounting information systems and improve the reliability of digital accounting environments (Zeinali Kermani et al., 2025). It is also aligned with the wider literature suggesting that advanced technologies increasingly interact within accounting systems rather than operating as independent innovations (Barreto et al., 2025; Sanz Martín et al., 2025).

The findings also have implications for accounting transparency and control. Digital accounting transformation does not eliminate the need for control; rather, it changes the form through which controls are implemented and monitored. Prior research has shown that the development of accounting controls can influence accountants' performance and that this effect can depend on task-related and behavioral characteristics (Bana & Shahmoradi, 2024). The present results suggest that business intelligence, big data, and blockchain may expand the technological basis of such controls through automated monitoring, integrated analytics, and more traceable information flows. Improved information transparency can also facilitate better financial decision-making by reducing information asymmetry and increasing the accessibility of relevant information (Xue, 2024). Therefore, the transformation of management accounting tools through digital technologies may simultaneously strengthen decision support and organizational control.

The role of artificial intelligence provides an additional conceptual context for interpreting these findings. Although AI was not directly modeled in the present structural model, its increasing integration with business intelligence, accounting information systems, and advanced analytics suggests that the technological relationships identified here may become even more important in the future. AI has demonstrated potential in accounting information systems for detecting fraud and identifying abnormal patterns in financial information (Zayed et al., 2024). Futures-oriented research similarly indicates that artificial intelligence is expected to reshape management accounting through automation, predictive analytics, continuous monitoring, and enhanced strategic decision support (Aboeuimehrizi et al., 2025). Thus, the structural relationships observed among business intelligence, big data, blockchain, and management accounting tools may constitute part of a broader transition toward intelligent management accounting systems.

At the organizational level, the findings also correspond with the broader movement toward technology-based financial systems and FinTech-oriented investment and decision architectures (Kalaei et al., 2024). As financial and operational systems become more digitally connected, management accountants must work within information environments in which data originate from multiple platforms and technologies. This increases the importance of technological integration and places greater emphasis on data-related competencies. However, technological capability alone is not sufficient. Managerial decisions still require interpretation, contextual judgment, and organizational meaning-making. Decision-making research has demonstrated that organizational actors construct and justify decisions through interpretive processes rather than merely responding mechanically to objective information (Cooper, 2023). The present findings therefore imply that the value of business intelligence and emerging technologies depends on their integration with managerial expertise and professional accounting judgment.

The measurement and predictive results provide additional support for the adequacy of the proposed framework. After removing Item 3 from the business intelligence construct and Item 5 from the blockchain construct because their loadings were not statistically significant, the retained measurement indicators showed acceptable statistical performance. Cronbach's alpha values ranged from .735 to .812, composite reliability coefficients ranged from .812 to .867, and the reported rho coefficients exceeded the commonly accepted .70 threshold. The AVE values ranged from .524 to .637, supporting convergent validity, while the reported Fornell–Larcker and HTMT results supported discriminant validity. At the structural level, management accounting tools had an R^2 value of .536, suggesting that a substantial proportion of their variance was explained by the model. The Q^2 value of .306 further indicated moderate-to-strong predictive relevance. The reported overall GoF value of .517 also suggested strong overall model performance. These findings are broadly compatible with the concept of management accounting maturity, according to which higher levels of accounting development are characterized by greater integration of information, systems, analytical tools, and strategic decision processes (Naser Torabi et al., 2021).

Overall, the study extends prior literature by empirically integrating business intelligence, big data, blockchain, and management accounting tools within a single structural framework. Whereas much previous research has examined these technologies separately, the present findings show that the transformation of management accounting is likely to emerge from their combined operation. Business intelligence appears to function as an important technological driver, while big data and blockchain provide complementary analytical and informational mechanisms through which the effects of business intelligence can be transmitted to management accounting. This interpretation is consistent with the broader digital accounting literature, which increasingly portrays management accounting transformation as a multidimensional process involving intelligent systems, advanced analytics, information transparency, technological control, and changing professional roles (Achhaiba & Omari, 2022; Barreto et al., 2025; Marques et al., 2023). Consequently, the modernization of management accounting should be approached as an integrated digital transformation initiative rather than as the acquisition of isolated technological applications.

The present study has several limitations that should be considered when interpreting its findings. First, the study employed a cross-sectional survey design, and therefore the observed structural relationships cannot establish definitive causal effects or demonstrate how the relationships evolve over time. Second, the participants were management accounting professionals working in listed companies, and the use of convenience sampling may limit the representativeness of the sample and the generalizability of the findings to smaller firms, public organizations, nonprofit institutions, or companies operating outside capital markets. Third, the study relied on self-reported questionnaire data, which may be affected by common method variance, perceptual bias, social desirability, and differences in respondents' understanding of technological concepts. Fourth, the model focused specifically on business intelligence, big data, blockchain, and management accounting tools and did not incorporate potentially relevant organizational variables such as digital culture, technological readiness, management support, employee competencies, information security, firm size, industry characteristics, or competitive intensity. Finally, the rapidly changing nature of digital technologies means that the technological practices assessed at one point in time may evolve quickly, and the findings should therefore be interpreted within the technological conditions prevailing during the study period.

Future studies should examine the proposed model through longitudinal designs to determine whether the adoption of business intelligence, big data, and blockchain produces sustained changes in management accounting tools over time. Researchers could also replicate the model across different industries, organizational sizes, ownership structures, and national contexts to assess its external validity and identify context-specific differences. Probability sampling and larger samples would improve representativeness, while multi-group analysis could determine whether the structural relationships differ according to organizational size, industry, respondents' professional experience, educational background, or degree of digital maturity. Future models could incorporate artificial intelligence, cloud computing, robotic process automation, Internet of Things technologies, cybersecurity, data governance, digital competencies, organizational culture, and top-management support. It would also be useful to distinguish among specific management accounting tools, such as budgeting, activity-based costing, balanced scorecards, strategic cost management, forecasting, and performance measurement, rather than treating them as a single aggregate construct. Mixed-method studies combining structural modeling with interviews or organizational case studies could provide deeper explanations of how these technologies are actually implemented and how accounting professionals adapt their roles and competencies to digitally transformed environments.

Organizations should approach the transformation of management accounting as an integrated digital strategy rather than purchasing business intelligence, big data, and blockchain technologies independently. Managers should first establish reliable data governance standards, interoperable information architectures, and clearly defined accounting information requirements before introducing advanced analytical tools. Investment in business intelligence should be accompanied by the development of data analytics capabilities so that high-volume and diverse information can be converted into useful accounting insights.

Blockchain implementation should focus on processes in which transparency, traceability, reconciliation, and information integrity create identifiable managerial value. Organizations should also invest in the digital competencies of management accountants, particularly data analysis, dashboard interpretation, process redesign, technology governance, and the integration of financial and nonfinancial information. Cross-functional collaboration among accounting, information technology, operations, and senior management should be strengthened to ensure that technological systems are aligned with managerial needs. Finally, organizations should evaluate digital accounting initiatives through measurable indicators such as decision speed, forecast accuracy, cost transparency, reporting quality, data reliability, control effectiveness, and improvements in managerial performance.

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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