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Paradigmatic Explanation of the Impact of Business Intelligence on Activity-Based Costing Systems with Emphasis on Cost Drivers under Conditions of Uncertainty: A Qualitative Approach

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A B S T R A C T

Objective: This study aimed to develop a paradigmatic qualitative model explaining how Business Intelligence (BI) influences Activity-Based Costing (ABC) systems, with particular emphasis on the management of cost drivers under conditions of uncertainty.

Methods and Materials: This qualitative study employed the systematic grounded theory approach of Strauss and Corbin. Participants consisted of 13 academic and professional experts in management accounting, ABC, BI, information systems, financial management, industrial accounting, and related managerial fields who were selected through purposive judgmental sampling, supplemented where necessary by snowball sampling. Data were collected through in-depth semi-structured interviews and continued until theoretical saturation was achieved after the thirteenth interview. All interviews were recorded with participants' consent, transcribed verbatim, and analyzed using MAXQDA. Data analysis was conducted through open, axial, and selective coding, constant comparison, memo writing, and organization of the emerging categories within the Strauss and Corbin paradigmatic framework. Credibility and trustworthiness were strengthened through member checking, expert review, triangulation of professional perspectives, continuous comparison, and documentation of the analytical process.

Findings: The analysis yielded five major paradigmatic dimensions comprising 11 axial categories. Environmental uncertainty and dynamism, competitive pressure and the need for cost management, and management and analysis of cost drivers emerged as causal conditions. Integration and quality of organizational data, BI technological infrastructure and capabilities, and human resource capability and readiness formed the contextual conditions. Managerial support and organizational governance constituted the intervening condition. The principal strategies were the design and implementation of a BI-based ABC system and the development of analytical and predictive capabilities. These strategies led to improved decision-making, control and performance optimization, as well as strategic

outcomes and organizational resilience. The findings indicate that BI transforms ABC from a largely retrospective costing mechanism into a more dynamic, integrated, predictive, and decision-support-oriented system.

Conclusion: Effective integration of BI with ABC depends on the simultaneous alignment of data quality, technological infrastructure, human capabilities, managerial governance, and predictive analytics, enabling organizations to manage cost drivers more accurately and respond more effectively to uncertainty.

Keywords: *Business Intelligence; Activity-Based Costing; Cost Drivers; Uncertainty; Grounded Theory; Management Accounting; Predictive Analytics; Organizational Resilience*

1 Introduction

The growing complexity of contemporary business environments has intensified the need for management accounting systems capable of producing timely, accurate, analytically rich, and decision-relevant cost information. Organizations now operate under conditions characterized by volatile input prices, rapidly changing technologies, shifting customer preferences, intensified competition, increasing data volumes, and uncertainty regarding future demand and resource requirements. Under such circumstances, conventional costing systems that rely heavily on aggregated historical information may be inadequate for explaining the economic mechanisms through which activities consume resources and ultimately generate costs. The challenge is particularly significant in organizations with diversified products, complex production processes, substantial indirect costs, and heterogeneous cost drivers. Activity-Based Costing (ABC) was developed to address part of this problem by assigning resource costs to activities and subsequently allocating activity costs to products, services, customers, or other cost objects based on relevant cost drivers. Nevertheless, the practical effectiveness of ABC depends heavily on the quality, timeliness, integration, and analytical usability of the information available to managers. Contemporary studies therefore increasingly emphasize the need to integrate ABC with advanced information technologies, Enterprise Resource Planning (ERP), artificial intelligence, and digital data infrastructures to strengthen the informational foundation of cost management (Kitsantas et al., 2026; Mahmoudabadi et al., 2025).

ABC is fundamentally distinguished from traditional allocation approaches by its emphasis on activities and the causal mechanisms underlying resource consumption. Rather than merely distributing overhead costs through broad volume-based allocation bases, ABC attempts to identify activities, determine the resources consumed by those activities, and select cost drivers that reasonably explain variations in activity costs. This logic can improve the visibility of indirect costs, enhance the identification of costly or non-value-adding activities, and provide a more differentiated representation of the economics of products, services, processes, and customers. Research continues to demonstrate the relevance of ABC and its variants for contemporary cost-management problems. The application of Time-Driven Activity-Based Costing has, for example, been examined in service settings and managerial decision contexts in which time, capacity use, and process complexity need to be incorporated more explicitly into costing (Landi et al., 2025; Masoumi Torkamani & Moghadamnia, 2024). Similarly, recent work integrating ABC with Building Information Modelling demonstrates the continuing search for more accurate approaches to overhead-cost estimation in complex project environments (Naderi et al., 2025). These developments suggest that ABC remains an important management accounting architecture, but its usefulness increasingly depends on its ability to interact with broader digital and analytical systems.

A central issue in the effectiveness of ABC concerns the identification and management of cost drivers. Cost drivers are not merely technical allocation variables; they represent the underlying factors that explain why an activity consumes resources and why the cost of performing that activity changes. Poorly selected drivers can distort cost assignments, weaken managerial interpretations, and reduce the decision usefulness of the entire costing system. Conversely, accurate identification of cost behavior and the relationships between activities, resources, and operational conditions can improve both costing precision and the strategic relevance of accounting information. Meyer and Schmidt emphasize the importance of robust design principles in product costing systems and revisit the logic of ABC cost hierarchies, reinforcing the idea that costing architecture must be designed in accordance with the underlying structure of cost causation (Meyer & Schmidt, 2025). The importance of such design considerations becomes even greater when operational processes, cost structures, and environmental conditions are unstable rather than fixed.

Uncertainty therefore represents a major challenge for the design and use of costing systems. Accounting decisions are

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routinely made without complete knowledge of future outcomes, and uncertainty affects recognition, measurement, forecasting, valuation, and managerial interpretation. Penman explicitly frames uncertainty as a fundamental accounting issue, indicating that accounting information must assist decision makers in dealing with incomplete and uncertain economic conditions rather than merely reporting realized historical outcomes (Penman, 2024). In management accounting, environmental uncertainty can influence the usefulness of information systems because managers operating in unstable settings require more frequent, timely, detailed, and forward-looking information. Evidence examining environmental uncertainty together with accounting information systems further indicates that the informational context of managerial performance cannot be separated from the uncertainty within which organizational decisions are made (Damis et al., 2025). For ABC, this means that the relationships among activities, resource consumption, and cost drivers may themselves vary as demand, production conditions, prices, technologies, and operating constraints change.

The methodological problem of uncertainty is not unique to accounting. Across scientific fields, contemporary research increasingly attempts to identify, quantify, and explicitly incorporate uncertainty into analytical models rather than treating uncertain inputs as fixed and perfectly known. Studies in genetics have incorporated uncertainty in linked-marker pedigree calculations and in Bayesian analysis of uncertain genetic parameters, while medical research has emphasized the importance of recognizing and accounting for classification uncertainty when defining heterogeneous disease subtypes (Kling et al., 2025; López-Carbonell et al., 2025; Mori et al., 2025). Likewise, environmental research has examined uncertainty in nitrogen-deposition estimates because decisions based on model outputs may be sensitive to uncertainty in underlying assumptions and measurements (Woodward et al., 2025). Although these studies arise from domains different from management accounting, they illustrate a broader analytical principle that is highly relevant to cost management: decision-support models become more credible when uncertainty in classifications, parameters, relationships, and predictions is explicitly recognized. Within ABC, this principle implies that cost-driver behavior and future activity consumption should not necessarily be treated as static or deterministic, particularly in turbulent organizational environments.

One response to this challenge has been the development of fuzzy and uncertainty-sensitive costing approaches. Wang and Simarmata proposed a fuzzy Activity-Based Costing approach for investment evaluation in smart-factory management information systems, demonstrating the potential value of integrating ABC with methods capable of representing imprecision in decision environments (Wang & Simarmata, 2024). More broadly, the growing emphasis on smart factories, digital manufacturing, and Industry 4.0 has created new opportunities to obtain detailed operational data and connect those data directly with cost-management systems. Tsai et al. integrated Industry 4.0, ABC, and the Theory of Constraints in the context of sustainable and profitable manufacturing, illustrating how cost information can increasingly be embedded within digitally enabled production and managerial architectures (Tsai et al., 2024). Such developments shift ABC away from being a periodically updated accounting procedure and toward becoming a potentially dynamic system linked to continuous operational information.

Artificial intelligence has further expanded the analytical possibilities available to management accounting. Contemporary AI tools can support pattern recognition, anomaly detection, forecasting, scenario analysis, and the processing of large and heterogeneous datasets. Recent studies specifically discussing advanced AI in ABC argue that intelligent technologies can strengthen cost management by improving the processing and interpretation of cost-related data (Chen, 2025; Nourallahzadeh & Kazemi, 2025). Similarly, empirical and conceptual research has examined how artificial intelligence and ERP technologies may affect the implementation of ABC systems, suggesting that digital integration can alter both the technical infrastructure and organizational processes required for effective costing (Mahmoudabadi et al., 2025). The relevance of AI extends beyond cost calculation itself. Scenario-planning research shows that AI can support the evaluation of alternative future conditions and strengthen resilience-oriented decision-making, particularly where decision makers must anticipate interacting uncertainties rather than simply extrapolate historical trends (Hao et al., 2024). These capabilities are highly pertinent to cost-driver management because changes in demand, material prices, production volumes, resource constraints, and operational conditions can be translated into alternative cost scenarios before their full effects are realized.

Within this wider digital transformation, Business Intelligence (BI) provides a particularly important bridge

between data infrastructure and managerial decision-making. BI can be understood as an integrated set of technologies, processes, analytical tools, and organizational practices through which data from multiple internal and external sources are transformed into meaningful information for monitoring, analysis, planning, and decision support. Rather than simply storing accounting data, BI environments can integrate financial and nonfinancial information, support interactive dashboards, enable multidimensional analysis, identify trends and exceptions, and provide managers with more rapid access to relevant indicators. The relationship between BI and organizational performance has therefore received increasing attention. Abouei Mehrizi and Bozorgi discuss BI in relation to firm performance while highlighting the complementary importance of big-data analytics and blockchain-related technological capabilities (Abouei Mehrizi & Bozorgi, 2025). Ahmadi et al. likewise examine the effect of BI on strategic performance and position organizational innovation as an important mechanism linking analytical capabilities with organizational outcomes (Ahmadi et al., 2025). These studies collectively reinforce the view that BI should not be treated merely as a reporting technology; rather, it is an organizational capability through which data may be transformed into strategic and operational knowledge.

Business analytics research similarly emphasizes the importance of analytical capabilities for strategic decision-making. A broad review of business analytics and decision science identifies analytical techniques as increasingly central to the quality of strategic business decisions, particularly when organizations must interpret large amounts of information and compare alternative courses of action (Ibeh et al., 2024). Data-driven analytics are also being applied in domains such as ESG-oriented communication, where the ability to synthesize heterogeneous data and support evidence-based managerial action is becoming increasingly important (Hasan, 2025). For management accounting, the implication is that BI and analytics can potentially enhance the explanatory and predictive functions of ABC by linking accounting cost data with operational, market, customer, production, and supply-chain information. Instead of viewing a cost driver only as a fixed allocation base, a BI-enabled system can potentially monitor its behavior over time, detect unusual variations, identify associated operational conditions, and examine how changes in one driver affect other activities and cost objects.

The integration of BI with ABC is therefore conceptually attractive because the strengths of each approach address important limitations of the other. ABC offers a causal structure for understanding how activities and cost drivers generate costs, whereas BI provides the data integration, processing, visualization, and analytical capabilities necessary to make that structure more dynamic. Integration with ERP is particularly relevant because ERP systems can supply standardized operational and financial data required by ABC while reducing fragmentation across functional units. The literature on ABC–ERP integration emphasizes the managerial benefits of combining activity-oriented costing logic with integrated enterprise information systems (Kitsantas et al., 2026). Likewise, emerging applications of digital technologies demonstrate that more sophisticated information architectures can strengthen the practical implementation of ABC when cost data need to be updated frequently and linked to operational processes.

The potential benefits of BI-enabled ABC extend beyond improvements in costing accuracy. Better information regarding activities and cost drivers can support budgeting, pricing, profitability analysis, capacity management, customer evaluation, process improvement, and strategic resource allocation. Feizizadeh and Hashemi's examination of the effectiveness of ABC systems underscores the continuing managerial importance of evaluating whether ABC produces meaningful organizational benefits rather than functioning merely as a technically sophisticated allocation method (Feizizadeh & Hashemi, 2025). When embedded in BI, the system may provide more transparent information on cost deviations, facilitate faster identification of non-value-adding activities, and enable managers to evaluate how changing conditions influence product and customer profitability. This shift is especially important where cost drivers are themselves volatile, because static driver assumptions may rapidly become obsolete under uncertain conditions.

From a strategic perspective, the combination of BI and ABC may also contribute to organizational resilience. Resilience requires organizations to detect environmental changes, interpret their implications, reconfigure resources, and maintain performance under disruption. Data-driven decision systems can strengthen these capabilities by improving situational awareness and reducing the delay between the emergence of a problem and managerial response. Studies linking BI with strategic performance and organizational innovation suggest that analytical capabilities may contribute to broader organizational outcomes when

integrated with managerial processes (Ahmadi et al., 2025). AI-enabled scenario planning similarly demonstrates how analytical technologies can support anticipatory rather than purely reactive management (Hao et al., 2024). In cost-management settings, this implies that an organization able to identify changing cost drivers and model their potential consequences can adjust pricing, production, resource allocation, sourcing, or activity structures before cost pressures become unmanageable.

Despite these developments, an important conceptual gap remains. Existing research has frequently examined ABC effectiveness, AI-supported costing, ERP integration, fuzzy costing, Industry 4.0 applications, BI capabilities, and uncertainty as separate or partially connected topics. Some studies focus on technological enhancement of ABC (Chen, 2025; Nourallahzadeh & Kazemi, 2025), whereas others emphasize improved cost-system design (Meyer & Schmidt, 2025), specific applications of ABC in construction, healthcare, restaurants, or manufacturing (Landi et al., 2025; Masoumi Torkamani & Moghadamnia, 2024; Naderi et al., 2025; Tsai et al., 2024), or the role of analytics and BI in strategic performance and decision-making (Abouei Mehrizi & Bozorgi, 2025; Ibeh et al., 2024). However, considerably less attention has been devoted to explaining, as an integrated organizational phenomenon, how BI shapes ABC specifically through the identification, monitoring, analysis, and management of cost drivers under conditions of uncertainty. This gap is theoretically important because technology alone cannot guarantee effective cost management. The consequences of BI integration depend on the quality and integration of organizational data, technological infrastructure, human expertise, managerial support, governance arrangements, and the strategies through which analytical capabilities are embedded in the costing process.

A qualitative investigation is particularly suitable for addressing this gap because the implementation of BI-enabled ABC involves organizational interpretations and interactions that cannot be adequately captured through predefined variables alone. Managers, management accountants, BI specialists, information technology professionals, and academic experts may perceive different causal pressures, implementation conditions, organizational barriers, strategic responses, and consequences. A grounded understanding of these perspectives can reveal how the phenomenon operates in practice and how its technological, accounting, organizational, and environmental dimensions interact. Such an approach also permits uncertainty to be examined not merely as a statistical parameter but as an experienced organizational condition that affects the need for cost information, the stability of cost drivers, the design of analytical processes, and the nature of managerial responses.

Accordingly, the aim of this study was to develop a paradigmatic qualitative model explaining the impact of Business Intelligence on Activity-Based Costing systems, with particular emphasis on the management of cost drivers under conditions of uncertainty.

2 Methods and Materials

This study employed a qualitative, exploratory research design based on the systematic grounded theory approach of Strauss and Corbin to develop a paradigmatic explanation of how Business Intelligence (BI) influences Activity-Based Costing (ABC) systems, with particular emphasis on the management of cost drivers under conditions of uncertainty. The qualitative approach was selected because the phenomenon under investigation involves complex interactions among technological capabilities, management accounting practices, organizational conditions, cost information, managerial decision-making, and environmental uncertainty, and these interactions cannot be adequately understood solely through predefined variables or conventional quantitative measurement. Rather than testing an existing theoretical model, the study sought to generate an empirically grounded explanatory framework based on the experiences, interpretations, and professional judgments of individuals who possessed direct knowledge of BI, management accounting, ABC implementation, information systems, and cost management. The study was therefore situated within an interpretive and exploratory methodological orientation in which the meanings attributed by knowledgeable participants to organizational processes constituted the primary basis for theory development. The systematic version of grounded theory was particularly appropriate because it provides a structured analytical framework for identifying causal conditions, the central phenomenon, contextual conditions, intervening conditions, action and interaction strategies, and consequences, thereby corresponding directly to the objective of developing a paradigmatic model explaining the influence of BI on ABC systems and cost-driver management under uncertainty. From the standpoint of research purpose, the study was applied-developmental because its objective extended beyond conceptual understanding and sought to generate a

contextually grounded model capable of informing the design, implementation, and intelligent use of ABC systems in organizational settings characterized by informational, operational, technological, and environmental uncertainty.

The study population consisted of academic and professional experts with substantial knowledge and experience in management accounting, Activity-Based Costing, Business Intelligence, management information systems, information technology, industrial management, and cost management in large manufacturing organizations. Particular attention was given to experts familiar with the operational and managerial environments of large Iranian manufacturing companies, including firms listed on the Tehran Stock Exchange, because these organizations typically operate with complex cost structures, multiple cost drivers, large volumes of operational and financial data, and substantial uncertainty in production and decision-making environments. Participants were selected through purposive judgmental sampling, supplemented where necessary by snowball sampling to identify additional information-rich participants with specialized expertise relevant to the emerging concepts. Eligibility criteria required participants to possess at least a master's degree in a relevant academic discipline, have a minimum of five years of professional, managerial, academic, consulting, or industrial experience related to the research domain, and demonstrate substantive familiarity with at least one of the principal areas of BI, ABC, management accounting, cost-driver analysis, information systems, or decision-making under uncertainty. Preference was given to individuals whose expertise crossed more than one of these domains because the research problem required integration of accounting, technological, and managerial perspectives.

Sampling continued according to the principle of theoretical saturation rather than according to a predetermined statistical sample size. Theoretical saturation was defined as the point at which additional interviews no longer generated substantively new concepts, categories, dimensions, properties, or relationships relevant to the developing paradigmatic model and new data primarily confirmed or elaborated previously identified findings. Saturation was achieved after 13 semi-structured interviews. During the initial interviews, numerous new codes, concepts, and relationships emerged; during subsequent interviews, the rate of emergence of new concepts gradually declined; and in the final interviews, responses predominantly reinforced existing categories without producing a new fundamental category or conceptual relationship. Accordingly, data collection was discontinued after the thirteenth interview once sufficient conceptual density and theoretical saturation had been established. The study maintained variation among participants by incorporating academic experts, management accounting specialists, information systems professionals, managers, and practitioners with relevant industrial experience. This diversity was intentional because it permitted the phenomenon to be examined from different professional perspectives and reduced the likelihood that the emergent model would merely reproduce the assumptions of a single disciplinary or organizational group.

Data were collected primarily through in-depth semi-structured expert interviews. A semi-structured interview protocol was considered appropriate because it provided sufficient consistency across interviews while allowing the researcher to pursue emerging themes, request clarification, explore examples, and investigate relationships that became theoretically important during data collection. The initial interview guide was developed on the basis of the research objective and a focused review of the literature concerning Business Intelligence, Activity-Based Costing, cost drivers, management accounting information systems, organizational decision-making, and uncertainty. The literature review was used only to sensitize the researcher to potentially relevant dimensions of the phenomenon and to support development of broad interview prompts; it was not used to impose predetermined categories on the empirical data. Consistent with grounded theory principles, the interview guide remained flexible throughout the research process and was progressively refined in response to concepts and relationships emerging from earlier interviews. This iterative process enabled data collection and analysis to proceed concurrently and allowed subsequent interviews to explore categories requiring greater conceptual development.

The interviews were organized around several broad areas corresponding to the central research problem. Participants were invited to explain why organizations move toward integrating BI capabilities with ABC systems under uncertain conditions, which technological, accounting, organizational, informational, and managerial characteristics are necessary for such integration, how BI may alter the identification, monitoring, interpretation, and management of cost drivers, and which internal and external circumstances may facilitate or impede successful implementation. Participants were also asked to describe appropriate managerial and operational strategies for the

effective use of BI capabilities within ABC systems and to identify the principal consequences of such integration for cost accuracy, responsiveness, resource allocation, managerial control, planning, forecasting, decision quality, and organizational adaptability. Probing questions were used whenever participants introduced important concepts, causal explanations, implementation experiences, organizational barriers, contextual contingencies, or unexpected relationships. Particular attention was paid to eliciting participants' interpretations of uncertainty, including volatility in costs, changes in demand, instability of production conditions, informational ambiguity, variability in resource consumption, technological change, and other circumstances capable of affecting cost-driver behavior and managerial decisions.

Before each interview, participants were informed about the purpose of the study, the voluntary nature of their participation, the intended use of the data, and the procedures adopted to protect confidentiality. Informed consent was obtained prior to data collection. Whenever possible, the general interview topics were provided to participants electronically in advance so that they could reflect on the subject matter without being given predetermined responses or theoretical categories. At the beginning of each interview, the researcher again explained the research objectives and encouraged the participant to respond freely on the basis of professional experience and expert judgment. With the participants' permission, interviews were audio-recorded to preserve the accuracy and completeness of the data. The recordings were subsequently transcribed verbatim and checked against the original audio files before coding. Field notes and analytical memos were also maintained during and immediately after the interviews to document contextual observations, emerging interpretations, conceptual questions, relationships among categories, and issues requiring exploration in later interviews. The resulting textual dataset constituted the primary empirical material for the grounded theory analysis.

Several procedures were incorporated into data collection to strengthen the credibility and trustworthiness of the qualitative evidence. Participants were deliberately selected from different but complementary areas of expertise to facilitate triangulation of perspectives across accounting, BI, information technology, information systems, and industrial management. Emerging categories and interpretations were periodically compared with the statements of participants to determine whether they adequately represented the meanings conveyed during interviews. Selected participants were also consulted regarding preliminary interpretations and category descriptions through member checking, particularly where concepts were potentially ambiguous or where several interpretations were possible. In addition, portions of the transcripts, initial codes, and emerging categories were reviewed by individuals familiar with qualitative methodology and the substantive field of the study. These procedures were not treated as quantitative tests of validity or reliability but as qualitative mechanisms for improving credibility, dependability, confirmability, and interpretive consistency. A detailed audit trail was maintained encompassing interview records, transcripts, coding decisions, analytical memos, category development, revisions to the interview protocol, and the progressive construction of the paradigmatic model.

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The interview data were analyzed using the systematic grounded theory procedures associated with Strauss and Corbin. Data collection and analysis occurred iteratively rather than as completely separate phases, allowing concepts emerging from earlier interviews to influence the direction of subsequent data collection. The analytical process involved continuous comparison among incidents, codes, concepts, categories, participants, and successive interviews. MAXQDA qualitative data analysis software was used to organize the transcripts, manage the coding process, retrieve coded segments, compare categories, maintain analytical memos, and document the development of the conceptual model. The software was used as a data-management and analytical support environment rather than as an automated substitute for researcher interpretation. Throughout the analysis, the researcher repeatedly returned to the original interview material to ensure that emerging concepts and relationships remained grounded in empirical evidence rather than becoming detached theoretical abstractions.

Analysis began with open coding. Each transcript was examined line by line and meaningful segments of text relevant to BI, ABC systems, cost-driver management, organizational conditions, uncertainty, implementation processes, and perceived outcomes were identified and assigned conceptual labels. Similar incidents were compared and grouped, while differences among statements were retained where they represented meaningful variations in the phenomenon. Codes were continuously revised, merged, subdivided, or renamed as additional interviews provided greater conceptual clarity. Through constant comparison,

initial codes were progressively organized into concepts and higher-order categories. During this stage, attention was given not only to the frequency with which an idea appeared but also to its conceptual significance, explanatory capacity, conditions of occurrence, and relationships with other concepts. Analytical memos were written throughout open coding to record emerging interpretations, tentative category definitions, possible causal mechanisms, contradictory evidence, and questions requiring further examination.

The analysis then proceeded to axial coding, during which relationships among the categories generated through open coding were systematically examined. The categories were organized using the Strauss and Corbin paradigm model, which distinguishes causal conditions, the central phenomenon, contextual conditions, intervening conditions, action and interaction strategies, and consequences. In the present study, causal conditions referred to organizational, managerial, informational, technological, and environmental forces that stimulated the adoption or development of BI-enabled ABC systems. The central phenomenon represented the core process through which BI capabilities were incorporated into activity-based costing and the management of cost drivers under uncertainty. Contextual conditions described the specific organizational and environmental circumstances within which this process occurred, whereas intervening conditions represented facilitating or constraining factors capable of strengthening, weakening, or modifying the implementation process. Strategies referred to managerial, technological, accounting, and organizational actions through which organizations could establish and exploit BI capabilities within ABC systems. Consequences represented the outcomes associated with these strategies, including potential changes in cost-information quality, visibility of cost drivers, responsiveness to environmental changes, planning accuracy, resource allocation, managerial control, decision quality, and organizational adaptability. Relationships among these categories were repeatedly checked against the interview evidence, and categories lacking adequate empirical support were revised or reconsidered.

Selective coding constituted the final major stage of analysis. At this stage, the researcher identified the core category capable of integrating the major categories and explaining the overall phenomenon investigated in the study. The relationships among causal conditions, the central phenomenon, contextual and intervening conditions, strategies, and consequences were refined into a coherent explanatory storyline. Categories were examined for conceptual completeness, internal consistency, distinctiveness, and explanatory relevance, and the developing framework was repeatedly compared with the raw data. Where gaps, ambiguities, or weak relationships were identified, earlier transcripts were revisited and, while data collection was still ongoing, later interviews were used to elaborate underdeveloped categories. The final model was accepted only after the researcher established that the categories had sufficient conceptual density, the principal relationships could be supported by multiple pieces of interview evidence, and additional data no longer produced a substantive modification of the explanatory structure.

The trustworthiness of the analytical process was strengthened through continuous comparison, member checking, expert review, triangulation of professional perspectives, maintenance of an audit trail, and repeated verification of the connection between raw data and higher-order interpretations. Credibility was enhanced by comparing interpretations across participants and returning selected findings to qualified participants for confirmation or clarification. Dependability was supported by systematic documentation of the coding process and changes made to concepts and categories over time. Confirmability was strengthened by maintaining transcripts, coded segments, methodological notes, and analytical memos that enabled the progression from empirical evidence to theoretical interpretation to be traced. Transferability was addressed through detailed specification of the participants' professional characteristics, the organizational context, and the conceptual conditions under which the findings emerged rather than through claims of statistical generalizability. Finally, theoretical coherence was assessed by examining whether the resulting paradigmatic framework provided a logically integrated account of how BI affects ABC systems and cost-driver management under uncertainty and whether the relationships among causal conditions, contextual conditions, intervening factors, strategies, and consequences were consistently supported by the participants' accounts. Thus, the final output of the analysis was a purely qualitative, empirically grounded paradigmatic model explaining the mechanisms through which Business Intelligence can shape Activity-Based Costing systems, particularly the identification and management of cost drivers in uncertain organizational environments.

3 Findings and Results

The qualitative phase included 13 experts selected purposively on the basis of their academic and professional experience in management accounting, Activity-Based Costing (ABC), Business Intelligence (BI), information systems, financial management, industrial accounting, and related managerial fields. Of the 13 participants, nine (69.2%) were men and four (30.8%) were women. Participants were between 41 and 54 years of age, with a mean age of 47.00 years. Their professional experience ranged from 10 to 18 years, with an average of 12.77 years. The sample represented a diverse combination of academic and executive expertise, including university faculty members in accounting, financial managers, industrial accounting and cost managers, BI and data analytics specialists, information technology managers, planning managers, and senior managers involved in information systems and BI projects. This diversity provided access to complementary perspectives concerning cost management, organizational data infrastructures, BI capabilities, cost-driver analysis, and decision-making under conditions of uncertainty. Theoretical saturation was reached after the thirteenth interview, as the final interviews primarily reinforced previously identified concepts and relationships and did not generate a substantively new category.

Table 1

Open Codes, Axial Categories, and Selective Codes Extracted from the Qualitative Grounded Theory Analysis

Paradigmatic Dimension	Selective Code	Axial Category	Open Codes
Causal Conditions	Uncertainty	Environmental Uncertainty and Dynamism	Increasing environmental uncertainty; changes in the business environment; demand fluctuations; changes in customer behavior; fluctuations in cost drivers; changes in input prices; environmental pressures; economic and environmental conditions; uncertainty management
Causal Conditions	Cost Management	Management and Analysis of Cost Drivers	Identification of cost drivers; determination of cost drivers; tracking cost drivers; analysis of causes of costs; understanding cost behavior; analysis of cost-increasing factors; monitoring cost drivers; changes in cost drivers
Causal Conditions	Cost Management	Competitive Pressure and the Need for Cost Management	Intensity of competition; pressure to reduce costs; pressure to improve productivity; cost control; reduction of unnecessary costs; elimination of low-value activities; optimization of activities; competitive advantage
Contextual Conditions	Human and Organizational Factors	Integration and Quality of Organizational Data	Integrated database; increasing data volume; diversity of information sources; integration of organizational data; processing large volumes of data; data quality; data standardization; information reliability; data quality control; information updating; integration of ABC and BI
Contextual Conditions	Human and Organizational Factors	Human Resource Capability and Readiness	Skilled human resources; employee training; employee participation; employee knowledge and skills; specialized BI and ABC training; data analysis capability; human resource empowerment; reduction of resistance to change; interdepartmental collaboration
Contextual Conditions	Infrastructure and Technology	BI Technological Infrastructure and Capabilities	Development of digital technologies; access to BI tools; information technology infrastructure; integrated information systems; organizational technical capability; integration with ERP; connection of information systems; management dashboards; real-time analytics; warning systems
Intervening Conditions	Management Support	Managerial Support and Organizational Governance	Top-management support; designation of a project owner; provision of required resources; data-driven culture; data-based decision-making; flexible organizational structure; reduction of bureaucracy; system performance evaluation; definition of performance indicators
Strategies	Managerial Analysis and Effective Actions	Design and Implementation of a BI-Based ABC System	Accurate identification of activities; proper ABC model design; costing accuracy; improved accuracy of cost allocation; determination of cost drivers; phased system implementation; pilot implementation; gradual system development; system flexibility; updateability
Strategies	Managerial Analysis and Effective Actions	Analytical and Predictive Capabilities	Rapid information analysis; cost trend analysis; analysis of financial and operational data; predictive analytics; cost forecasting; scenario development; evaluation of the effects of changes; forecasting and scenario analysis; analysis of the relationship between demand and activity costs
Consequences	Improved Decision-Making and Resilience	Decision-Making, Control, and Performance Optimization	Need for rapid decision-making; importance of timely information; reduction of decision-making risk; improved decision quality; cost transparency; control of cost variances; rapid response to changes; improved pricing; product profitability assessment; customer profitability assessment; optimal resource allocation
Consequences	Improved Decision-Making and Resilience	Strategic Outcomes and Organizational Resilience	Increased productivity; improved organizational performance; enhanced competitive advantage; transformation of information into a strategic resource; increased organizational flexibility; greater resilience; enhanced competitive capability; risk management; improved organizational performance; optimal use of resources

The open, axial, and selective coding process resulted in a paradigmatic structure comprising five major dimensions: causal conditions, contextual conditions, intervening conditions, strategies, and consequences. Within these dimensions, 11 axial categories were identified. The findings indicate that the influence of BI on ABC systems is not restricted to the technological automation of costing activities. Rather, it represents a broader organizational mechanism through which environmental uncertainty, cost-driver information, integrated data, human capabilities, managerial support, and analytical technologies interact to transform the manner in which costs are identified, interpreted, predicted, and managed. The emerging structure therefore depicts BI-enabled ABC as a dynamic decision-support capability whose effectiveness depends on the alignment of environmental pressures, organizational readiness, managerial governance, and analytical practices.

The first paradigmatic dimension concerned **causal conditions**. Three axial categories emerged within this dimension: environmental uncertainty and dynamism, management and analysis of cost drivers, and competitive pressure and the need for cost management. Participants emphasized that continuous changes in economic conditions, demand patterns, customer behavior, input prices, and the broader competitive environment increase the difficulty of relying on static or historically oriented costing information. Under such circumstances, organizations require more timely and analytically rich information regarding the origin, behavior, and variation of costs. Environmental uncertainty therefore acts as an important stimulus for integrating BI capabilities with ABC because conventional costing information may be insufficient when cost structures and cost drivers change rapidly.

The analysis further showed that the management and analysis of cost drivers formed a central causal mechanism. Participants consistently distinguished between merely determining the amount of a cost and understanding the factors that generate or alter that cost. From this perspective, the value of a BI-enabled ABC system lies in its ability to identify, track, and continuously analyze cost drivers and to reveal how changes in operational activities influence resource consumption and final costs. Monitoring changes in cost drivers enables managers to move from retrospective cost reporting toward explanation of cost behavior and identification of the underlying causes of cost variation. Accordingly, the emphasis on cost drivers represents an important link between BI analytical capabilities and the fundamental logic of ABC.

Competitive pressure constituted another major causal condition. Experts described increasing competition, pressure to improve productivity, and the need to reduce unnecessary expenditure as forces encouraging organizations to seek more precise approaches to cost management. The findings suggest that the integration of BI and ABC can support the identification of low-value or non-value-added activities, facilitate more precise cost control, and provide managers with information required to optimize activity structures. Consequently, environmental uncertainty, competitive pressure, and the need for more sophisticated analysis of cost drivers collectively create the impetus for adopting a more intelligent and dynamic form of Activity-Based Costing.

The second paradigmatic dimension comprised **contextual conditions**, including integration and quality of organizational data, human resource capability and readiness, and BI technological infrastructure and capabilities. Data quality and integration emerged as fundamental prerequisites for the effective functioning of a BI-enabled ABC system. Participants emphasized that costing processes depend on information originating from multiple organizational units, including finance, production, sales, procurement, logistics, and supply-chain operations. When these data are fragmented, outdated, inconsistent, or unreliable, analytical outputs may be misleading regardless of the sophistication of the BI tools being used. The existence of integrated databases, standardized data structures, systematic data-quality controls, and timely information therefore creates the informational foundation required for accurate activity analysis and cost allocation.

Technological infrastructure was another critical contextual condition. The interviews highlighted the importance of integrated information systems, ERP connectivity, BI platforms, management dashboards, analytical engines, real-time reporting, and warning mechanisms. These technological capabilities enable organizations to combine large volumes of financial and operational data and transform them into usable cost information. In particular, integration between BI and existing enterprise systems was viewed as essential for creating continuous information flows between operational activities and costing processes. This connectivity makes it possible to update cost-driver information more rapidly and

to detect changes that might otherwise remain hidden in conventional periodic reports.

Human resource readiness complemented the technological and data-related context. The participants stressed that sophisticated BI technologies cannot independently produce effective cost management unless employees and managers possess sufficient knowledge of ABC, data interpretation, and analytical decision-making. Specialized training, data-analysis capabilities, employee participation, interdepartmental cooperation, and reduction of resistance to organizational change were repeatedly identified as conditions affecting successful system implementation. The findings therefore demonstrate that data, technology, and human resources function as mutually reinforcing contextual elements. Deficiency in any one of these areas may substantially reduce the effectiveness of the overall system.

The third dimension consisted of **intervening conditions**, represented primarily by managerial support and organizational governance. Participants regarded top-management support as a factor capable of strengthening or weakening the relationship between existing organizational capabilities and actual implementation. Senior management can facilitate implementation by allocating financial and human resources, appointing responsible project owners, promoting coordination among organizational units, establishing performance indicators, and encouraging data-driven decision-making. Conversely, inadequate managerial commitment, bureaucratic organizational structures, weak accountability, and resistance to evidence-based decision-making can prevent organizations from exploiting existing technological and informational capabilities.

The findings further revealed that managerial support must extend beyond formal approval of a BI or ABC project. Effective implementation requires the creation of an organizational governance structure in which responsibilities are clearly defined, system performance is monitored, and managerial decisions are increasingly grounded in reliable data. A flexible organizational structure and a strong data-oriented culture can accelerate adoption and encourage collaboration between financial, operational, and IT functions. Thus, managerial support and organizational governance act as an intervening condition that determines whether existing technological and human capacities are transformed into an operational capability.

The fourth paradigmatic dimension related to **strategies** and contained two principal axial categories: design and implementation of a BI-based ABC system and development of analytical and predictive capabilities. The first strategy involved accurate identification of organizational activities and appropriate cost drivers, followed by the development of an ABC architecture that could be integrated with BI technologies. Participants emphasized the importance of accurate costing, appropriate allocation of indirect costs, phased implementation, pilot testing, gradual expansion, and continuous system updating. Phased implementation was particularly important because it allowed organizations to identify implementation problems, evaluate data requirements, and modify system configurations before full organizational deployment.

The second strategic category involved using BI not only for descriptive reporting but also for analytical and predictive purposes. Participants emphasized cost-trend analysis, integration of financial and operational information, predictive analytics, cost forecasting, scenario analysis, and evaluation of the effects of environmental changes. These capabilities become particularly important under uncertainty because managers need to understand not only what has already occurred but also how future changes may affect activities, cost drivers, and product or service costs. For example, changes in production volume, demand, input prices, exchange rates, or resource consumption may alter both the intensity and relevance of particular cost drivers. BI-based predictive analysis can therefore enable the ABC system to move beyond a static representation of historical costs toward a dynamic decision-support system capable of evaluating alternative future conditions.

The fifth paradigmatic dimension concerned **consequences**. At the operational and managerial level, the integration of BI with ABC was associated with improved decision quality, greater cost transparency, more effective control of cost variances, more accurate pricing, enhanced evaluation of product and customer profitability, and more efficient resource allocation. Participants indicated that timely access to integrated cost information allows managers to identify unfavorable cost changes more rapidly and to respond before they develop into more substantial operational or financial problems. The system can also support the identification of costly or low-value activities and thereby facilitate targeted cost-reduction initiatives.

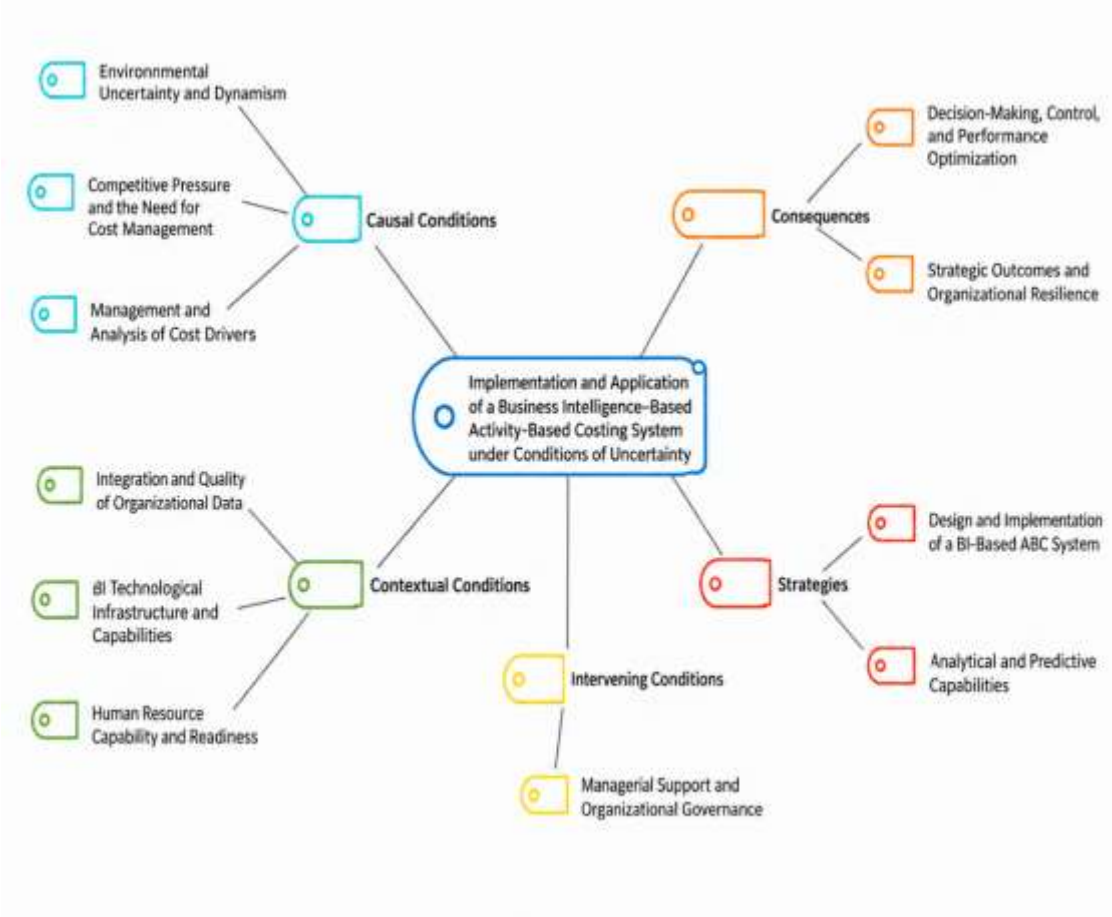
At the strategic level, the identified consequences included increased productivity, organizational flexibility, resilience, improved performance, enhanced competitive capability, more effective risk management, and transformation of accounting information into a strategic organizational resource. Predictive and scenario-based

analysis can enable organizations to anticipate possible changes and prepare alternative managerial responses instead of reacting only after environmental changes occur. Accordingly, the findings suggest that the integration of BI and ABC may transform Activity-Based Costing from a primarily accounting-oriented costing technique into a broader strategic capability for managing cost drivers and organizational uncertainty.

Taken together, the qualitative findings produced an integrated paradigmatic explanation of the phenomenon. Environmental uncertainty, competitive pressure, and the need for more sophisticated cost-driver management function as causal conditions that stimulate the adoption of BI-enabled ABC. The effectiveness of this process depends on contextual conditions consisting of integrated and high-quality organizational data, appropriate technological infrastructure, and capable human resources. Managerial support and organizational governance operate as intervening conditions that can facilitate or constrain implementation. Within this environment, organizations adopt strategies related to the design and phased implementation of BI-based ABC and the application of analytical, predictive, and scenario-based capabilities. These strategies ultimately lead to operational consequences related to decision-making, cost control, and performance optimization and to strategic consequences involving organizational flexibility, resilience, and competitive advantage. The final grounded theory model therefore explains the impact of Business Intelligence on Activity-Based Costing as a multidimensional organizational process centered on more effective identification, monitoring, prediction, and management of cost drivers under conditions of uncertainty.

Figure 1

Final Paradigmatic Model of the Impact of Business Intelligence on Activity-Based Costing Systems with Emphasis on Cost Drivers under Conditions of Uncertainty



4 Discussion

The present study developed a qualitative paradigmatic model explaining the influence of Business Intelligence (BI) on Activity-Based Costing (ABC) systems with particular emphasis on cost drivers under conditions of uncertainty. The findings showed that the phenomenon is shaped through the interaction of five major dimensions: causal conditions, contextual conditions, intervening conditions, strategies, and consequences. More specifically, environmental uncertainty and dynamism, competitive pressure and the need for cost management, and the management and analysis of cost drivers emerged as the principal causal conditions. Integration and quality of organizational data, technological infrastructure and BI capabilities, and human resource capability and readiness were identified as contextual conditions. Managerial support and organizational governance constituted the principal intervening condition. The strategic dimension comprised the design and implementation of a BI-based ABC system and the use of analytical and predictive capabilities, while the principal consequences included improved decision-making, control and performance optimization, as well as strategic outcomes and organizational resilience. Taken together, these results indicate that the effect of BI on ABC cannot be reduced to a simple technological enhancement of an accounting system; rather, it should be understood as an organizational transformation in which cost information, data infrastructure, analytical capabilities, managerial governance, and environmental uncertainty jointly shape the effectiveness of cost management.

One of the most important findings concerned the role of environmental uncertainty and dynamism as a causal condition. Participants emphasized that fluctuations in demand, changing customer behavior, changes in input prices, competitive pressures, and broader economic instability increase the need for accurate, timely, and analytically rich cost information. This finding is consistent with research suggesting that uncertainty changes the informational requirements of managerial decision-making and increases the importance of accounting information systems. Damis et al. showed that environmental uncertainty is meaningfully related to the use and usefulness of accounting information in managerial contexts, indicating that information systems become especially important when organizations face unstable operating environments (Damis et al., 2025). Similarly, Penman emphasized that uncertainty is not peripheral to accounting but is a central condition that affects the interpretation and usefulness of accounting information (Penman, 2024). From this perspective, the present findings extend prior research by showing that uncertainty also intensifies the organizational need to monitor changes in cost drivers and to update ABC information more dynamically.

The finding that cost-driver management constitutes a core causal mechanism is also theoretically significant. In the present study, experts did not view cost drivers merely as allocation bases; rather, they described them as dynamic determinants of cost behavior that must be identified, monitored, and interpreted continuously. This result is aligned with the logic of modern ABC research, which increasingly focuses on the accuracy and structural appropriateness of costing models. Meyer and Schmidt demonstrated the importance of robust cost-system design and the role of ABC cost hierarchies in improving the representation of cost causality (Meyer & Schmidt, 2025). Similarly, Naderi et al. showed that integrating ABC with Building Information Modelling can improve the accuracy of overhead cost estimation in complex project settings (Naderi et al., 2025). These studies support the view that the quality of ABC depends substantially on the quality of the relationships established between activities, resource consumption, and relevant drivers. The present findings add that, under uncertainty, these relationships must be treated as potentially variable rather than fixed.

The results also showed that competitive pressure and the need for stronger cost management push organizations toward BI-enabled ABC. Participants linked increasing competition with the need to eliminate unnecessary costs, identify low-value activities, improve efficiency, and strengthen pricing and profitability decisions. This is consistent with previous evidence regarding the continuing managerial relevance of ABC. Feizizadeh and Hashemi emphasized the effectiveness of ABC as a tool for improving cost visibility and organizational cost management (Feizizadeh & Hashemi, 2025). Landi et al. also showed how Time-Driven Activity-Based Costing can support managerial decision-making when organizations need to compare alternative technologies and evaluate their economic implications (Landi et al., 2025). Likewise, Masoumi Torkamani and Moghadamnia illustrated the usefulness of Time-Driven ABC in service operations where understanding capacity use and activity costs is essential (Masoumi Torkamani & Moghadamnia, 2024). These findings collectively reinforce the present study's conclusion

that competitive conditions increase the strategic value of more precise and analytically capable costing systems.

The contextual findings of the study showed that data integration and data quality are essential foundations for the effective use of BI within ABC. Participants emphasized that fragmented, outdated, inconsistent, or low-quality data can severely restrict the usefulness of both BI and ABC. This finding aligns with research on digital integration in management accounting. Kitsantas et al. highlighted the benefits of integrating ABC with ERP systems, particularly the ability of integrated information infrastructures to provide more consistent and timely data for management decision-making (Kitsantas et al., 2026). Mahmoudabadi et al. similarly examined the role of modern technologies, including artificial intelligence and ERP, in the implementation of ABC systems and emphasized the importance of technological integration for improving the costing process (Mahmoudabadi et al., 2025). These studies support the present result that the effectiveness of BI-enabled ABC is dependent on a reliable organizational data architecture rather than solely on the availability of analytical software.

Technological infrastructure and BI capabilities were also identified as important contextual conditions. Experts referred to ERP integration, analytical dashboards, real-time reporting, connected information systems, and warning mechanisms as key components enabling more dynamic cost management. This finding is consistent with studies that view BI as an organizational capability rather than merely a reporting application. Abouei Mehrizi and Bozorgi linked BI with firm performance and highlighted the role of advanced data technologies in strengthening organizational analytical capability (Abouei Mehrizi & Bozorgi, 2025). Ahmadi et al. also showed that BI can contribute to strategic performance and that organizational innovation may mediate this relationship (Ahmadi et al., 2025). More broadly, Ibeh et al. emphasized that business analytics and decision science enhance strategic decision-making by converting large amounts of organizational information into actionable knowledge (Ibeh et al., 2024). The findings of the present study are consistent with these studies but extend them into management accounting by demonstrating how BI capabilities can be embedded within ABC to improve cost-driver analysis and cost-related decisions.

The importance of human resource capability and readiness emerged as another major contextual finding. Participants stressed that even advanced BI infrastructure may fail to improve cost management unless employees and managers have sufficient knowledge of ABC, data analysis, system interpretation, and cross-functional collaboration. This indicates that BI-enabled ABC is a sociotechnical system rather than a purely technological solution. The importance of human interpretation is also implicit in the broader business analytics literature, where analytical tools derive managerial value only when decision makers can interpret and use their outputs effectively (Ibeh et al., 2024). Hasan's review of data-driven business analytics further demonstrates that analytical capability depends not merely on access to data but also on organizational processes that convert analytical outputs into strategic communication and action (Hasan, 2025). Therefore, the present study supports a broader capability-based view in which technology, data, and human expertise must operate together.

Managerial support and organizational governance emerged as the primary intervening condition. The findings suggested that senior management support can strengthen the effectiveness of BI-based ABC by facilitating resource allocation, coordinating organizational units, establishing a data-driven culture, defining responsibilities, and reducing resistance to change. Conversely, weak governance and bureaucratic structures can constrain system implementation even when technical capabilities are available. This result is compatible with research showing that the strategic benefits of BI are often realized through broader organizational mechanisms rather than through technology alone. Ahmadi et al. showed that the relationship between BI and strategic performance is connected to organizational innovation, highlighting the importance of organizational conditions in translating technology into outcomes (Ahmadi et al., 2025). Abouei Mehrizi and Bozorgi likewise positioned BI within a broader organizational performance architecture in which complementary technologies and managerial processes are important (Abouei Mehrizi & Bozorgi, 2025). The present findings therefore reinforce the view that managerial sponsorship and governance determine whether analytical investments become embedded in organizational decision processes.

The strategic dimension of the model emphasized two interconnected responses: designing and implementing a BI-based ABC system and using analytical and predictive capabilities. The first strategy involves accurate activity identification, appropriate selection of cost drivers, gradual implementation, system flexibility, and integration with organizational information systems. These findings correspond with the growing literature on digitally enhanced ABC. Chen argued that advanced artificial intelligence can

improve ABC-based cost management by strengthening analytical processing and cost interpretation (Chen, 2025). Nourallahzadeh and Kazemi similarly emphasized the contribution of advanced AI to improved cost management within ABC environments (Nourallahzadeh & Kazemi, 2025). Mahmoudabadi et al. further supported the importance of AI and ERP in improving the implementation process of ABC systems (Mahmoudabadi et al., 2025). Together, these studies support the present finding that the evolution of ABC increasingly depends on its integration with advanced information and analytical technologies.

The second strategic finding concerned the transition from retrospective reporting toward predictive analytics, scenario analysis, and forecasting. Participants emphasized that BI should enable managers not only to observe historical costs but also to assess the potential effects of changes in demand, production volume, input prices, or other operational variables. This result is strongly aligned with research on AI-supported scenario planning. Hao et al. argued that artificial intelligence can strengthen scenario planning and improve resilience by helping organizations assess alternative future conditions (Hao et al., 2024). Wang and Simarmata's fuzzy ABC approach also supports this direction by showing how uncertainty-sensitive techniques can be integrated with ABC in smart-factory investment evaluation (Wang & Simarmata, 2024). These findings collectively support the present conclusion that the strategic value of BI-enabled ABC lies partly in its capacity to transform costing from a backward-looking measurement system into a forward-looking analytical system.

The consequences identified in the present study further demonstrate this transformation. At the managerial level, participants associated BI-based ABC with improved cost transparency, more accurate cost allocation, better pricing, stronger profitability analysis, more effective control of cost deviations, and improved resource allocation. These findings are consistent with prior applications of ABC in complex decision settings. Landi et al. demonstrated that Time-Driven ABC can support comparative managerial decisions involving new technologies (Landi et al., 2025), while Tsai et al. showed that integrating ABC with Industry 4.0 and the Theory of Constraints can support more sustainable and profitable manufacturing decisions (Tsai et al., 2024). Naderi et al. similarly demonstrated that the integration of ABC with digital modelling improves cost-estimation accuracy (Naderi et al., 2025). These studies support the present result that linking ABC with richer digital information environments can improve both cost accuracy and managerial usefulness.

At the strategic level, the study identified improved resilience, organizational flexibility, competitive capability, and risk management as important consequences. This finding extends the role of ABC beyond conventional cost allocation and places it within a broader strategic decision-support framework. The ability to anticipate changes in cost drivers, simulate alternative scenarios, and update managerial responses can help organizations respond more effectively to uncertainty. Hao et al.'s work on AI-enabled scenario planning supports this conclusion by showing how predictive analytical systems can contribute to resilience-oriented planning (Hao et al., 2024). The emphasis on uncertainty is further supported by studies in other analytical fields that demonstrate the importance of explicitly accounting for uncertainty in model inputs, classifications, and parameters (Kling et al., 2025; López-Carbonell et al., 2025; Mori et al., 2025; Woodward et al., 2025). Although these studies are outside management accounting, they reinforce the broader methodological principle that decision systems become more robust when uncertainty is acknowledged rather than ignored.

5 Conclusion

Overall, the present findings suggest that BI changes the role of ABC in three important ways. First, it expands the informational foundation of ABC by integrating financial, operational, and potentially external data. Second, it increases the temporal responsiveness of the system by enabling more frequent monitoring and analysis of cost drivers. Third, it strengthens the predictive and strategic role of cost information by enabling scenario analysis, forecasting, and rapid managerial response. In this sense, BI-enabled ABC can be interpreted not merely as an improved costing technique but as an integrated organizational capability for managing cost causality under uncertainty. This interpretation is consistent with the broader trajectory of recent research, which increasingly combines accounting systems with ERP, AI, Industry 4.0, analytics, and uncertainty-sensitive modelling (Chen, 2025; Kitsantas et al., 2026; Tsai et al., 2024; Wang & Simarmata, 2024). The qualitative model developed in this study therefore contributes by integrating these previously fragmented themes into a single paradigmatic explanation centered on the management of cost drivers.

The study has several limitations. First, the findings were derived from a qualitative sample of 13 experts selected purposively on the basis of their knowledge and experience, and the results therefore represent analytically grounded interpretations rather than statistically generalizable estimates. Second, the study focused primarily on experts familiar with large manufacturing companies and related professional environments, meaning that some categories may operate differently in service firms, public organizations, small enterprises, or highly digital industries. Third, because the study relied on semi-structured interviews, the findings reflect participants' perceptions and professional judgments and may be influenced by their organizational experiences and areas of specialization. Finally, although theoretical saturation was achieved, the paradigmatic model reflects the organizational and technological conditions prevailing during the period of data collection and may require reinterpretation as BI technologies, artificial intelligence applications, and management accounting practices evolve.

Future research should examine the proposed paradigmatic model in different organizational and industrial contexts to assess the extent to which its categories and relationships remain stable or require modification. Comparative qualitative studies could investigate differences between manufacturing and service organizations, large and small firms, or organizations at different levels of digital maturity. Longitudinal research would also be valuable for examining how BI-based ABC systems evolve from initial implementation to organizational institutionalization and how cost-driver structures change over time. Future studies may additionally combine the present grounded model with quantitative approaches to test specific relationships among data quality, BI capabilities, managerial support, predictive analytics, cost-management effectiveness, and organizational resilience. Further investigation of artificial intelligence, machine learning, real-time analytics, and automated cost-driver detection could also clarify how emerging technologies may reshape the architecture of ABC systems under increasingly uncertain conditions.

From a practical perspective, organizations seeking to implement BI-based ABC should avoid treating the project as a stand-alone accounting or software initiative. Managers should first establish reliable and integrated data structures, define activities and cost drivers carefully, and ensure that operational, financial, and information technology units work collaboratively. Investment in BI technology should be accompanied by training in data interpretation, ABC logic, and analytical decision-making so that employees can translate system outputs into managerial action. Senior management should establish clear project ownership, provide sufficient resources, create a data-driven culture, and monitor implementation through appropriate performance indicators. A phased implementation approach beginning with pilot processes is preferable to immediate organization-wide deployment because it allows data problems, inappropriate cost drivers, and technical integration issues to be identified early. Organizations should also develop predictive and scenario-based capabilities so that the system is used not only to explain historical costs but also to anticipate changes in cost drivers and support timely decisions under uncertainty.

Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

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References

Abouei Mehrizi, S., & Bozorgi, M. (2025). Business Intelligence (BI) in Firm Performance: The Role of Big Data Analytics and Blockchain Technology. Nur.

Ahmadi, H., Rajabpour, E., Khalili, H., & Hanaei, A. (2025). The Effect of Business Intelligence on Strategic Performance with the Mediating Role of Organizational Innovation: A Study of Startups Located in the Persian Gulf Science and Technology Park. Qaenat.

Chen, B. (2025). Leveraging Advanced AI in Activity-Based Costing (ABC) for Enhanced Cost Management. *Journal of Computer, Signal, and System Research*, *2*(1), 53-62. https://doi.org/10.71222/6b2mrj72

Damis, S., Harun, H., & Arodhiskara, Y. (2025). The Impact of Environmental Uncertainty and Accounting Information Systems on Managerial Performance of Micro, Small, and Medium Enterprises in Parepare City.

Feizizadeh, A., & Hashemi, S. M. (2025). Evaluating the Effectiveness of Activity-Based Costing (ABC) Systems in Organizations. Tehran.

Hao, H., Wang, Y., & Chen, J. (2024). Empowering Scenario Planning with Artificial Intelligence: A Perspective on Building Smart and Resilient Cities. *Engineering*, *18*(5), 67-89. https://doi.org/10.1016/j.eng.2024.06.012

Hasan, R. (2025). The Role of Business Analytics in ESG-Oriented Brand Communication: A Systematic Review of Data-Driven Strategies. *ASRC Procedia: Global Perspectives in Science and Scholarship*, *1*(01), 1096-1127. https://doi.org/10.63125/4mchj778

Ibeh, C. V., Asuzu, O. F., Olorunsogo, T., Elufioye, O. A., Nduubuisi, N. L., & Daraojimba, A. I. (2024). Business Analytics and Decision Science: A Review of Techniques in Strategic Business Decision Making. *World Journal of Advanced Research and Reviews*, *21*(2), 1761-1769. https://doi.org/10.30574/wjarr.2024.21.2.0247

Kitsantas, T., Vazakidis, A., & Stefanou, C. (2026). Integrating Activity Based Costing (ABC) with Enterprise Resource Planning (ERP) for Effective Management: A Literature Review. *Technium: Romanian Journal of Applied Sciences and Technology*, *2*, 160-178. https://doi.org/10.47577/technium.v2i7.1882

Kling, D., Mostad, P., & Tillmar, A. (2025). FamLink2: A Comprehensive Tool for Likelihood Computations in Pedigrees Analyses Involving Linked DNA Markers Accounting for Genotype Uncertainties. *Forensic Science International: Genetics*, *74*(7), 103-150. https://doi.org/10.1016/j.fsigen.2024.103150

Landi, S., Maistri, G., Orsini, L. P., Leardini, C., Malandra, S., & Antonelli, A. (2025). Supporting Managerial Decisions: A Comparison of New Robotic Platforms through Time-Driven Activity-Based Costing within a Value-Based Healthcare Framework. *BMC Health Services Research*, *25*(1), 470-510. https://doi.org/10.1186/s12913-025-12598-9

López-Carbonell, D., Legarra, A., Altarriba, J., Hervás-Rivero, C., Sánchez-Díaz, M., & Varona, L. (2025). Multiple Trait Bayesian Analysis of Partitioned Genetic Trends Accounting for Uncertainty in Genetic Parameters: An Example with the Pirenaica and Rubia Gallega Beef Cattle Breeds. *Journal of Animal Breeding and Genetics*, *142*(4), 454-462. https://doi.org/10.1111/jbg.12918

Mahmoudabadi, A., Salehi, M., & Avazzadeh Fath, F. (2025). Examining the Effect of Applying Modern Technologies (Artificial Intelligence and ERP) on the Process of Implementing Activity-Based Costing Systems. *Management Accounting and Auditing Knowledge*, *15*(60), 279-294.

Masoumi Torkamani, A., & Moghadamnia, E. (2024). Using Time-Driven Activity-Based Costing in the Restaurant Business.

Meyer, M., & Schmidt, M. (2025). Robust Design Heuristics for Product Costing Systems: A Replication and Extension Using an ABC Cost Hierarchy. *Journal of Business Economics*, *95*(2), 197-235. https://doi.org/10.1007/s11573-024-01210-x

Mori, T., Zaharia, O. P., Straßburger, K., Dennis, J. M., Mai, K., & Kabisch, S. (2025). Recognising, Quantifying and Accounting for Classification Uncertainty in Type 2 Diabetes Subtypes. *Diabetologia*, *68*(10), 2139-2150. https://doi.org/10.1007/s00125-025-06486-4

Naderi, M., Nazari, A., Shafaat, A., & Abrishami, S. (2025). Enhancing Accuracy in Construction Overhead Cost Estimation: A Novel Integration of Activity-Based Costing and Building Information Modelling. *Smart and Sustainable Built Environment*, *14*(3), 758-775. https://doi.org/10.1108/SASBE-07-2023-0180

Nourallahzadeh, N., & Kazemi, H. (2025). Using Advanced Artificial Intelligence in Activity-Based Costing (ABC) for Advanced Cost Management. *Accounting and Management Perspective*, *8*(102), 16-26.

Penman, S. (2024). Accounting for Uncertainty. *Accounting, Economics, and Law: A Convivium*, *14*(3), 309-327. https://doi.org/10.1515/ael-2022-0059

Tsai, W. H., Chen, H. C., Chang, S. C., & Chan, K. C. (2024). Revolutionizing Textile Manufacturing: Sustainable and Profitable Production by Integrating Industry 4.0, Activity-Based Costing, and the Theory of Constraints. *Processes*, *12*(11), 23-111. https://doi.org/10.3390/pr12112311

Wang, K. J., & Simarmata, M. T. (2024). Fuzzy Activity-Based Costing: An Investment Evaluation Approach for Management Information System of a Smart Factory. *The Engineering Economist*, *69*(1), 66-86. https://doi.org/10.1080/0013791X.2024.2314673

Woodward, H., Fonseca, E. R., Oxley, T., Rowe, E. C., Vieno, M., Nemitz, E., & ApSimon, H. (2025). Accounting for the Uncertainty in Nitrogen Deposition Estimates in Support of Policy. *Environmental research*, *27*(6), 121-139. https://doi.org/10.1016/j.envres.2025.121519