



Designing and Analyzing a Novel BSC-Based Strategy Implementation Model Using a Fuzzy Decision-Tree Approach: A Case Study of Soufian Cement Company

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Abstract

This study aimed to develop an applied model for analyzing and implementing organizational strategies based on the Balanced Scorecard (BSC) using a fuzzy decision-tree approach. Organizations employ strategy maps to achieve their overarching objectives, and the Balanced Scorecard is regarded as one of the most important tools used in this domain. Despite the development of numerous BSC-based models, each has certain limitations and weaknesses that reduce its effectiveness in strategy analysis and implementation. In this study, a new model was developed using a fuzzy decision tree. In addition to incorporating the four BSC perspectives—growth and learning, internal processes, customer and market, and financial performance—the model allows other indicators to be incorporated according to organizational requirements. Moreover, by presenting various scenarios, clarifying the relationships among indicators, and classifying them according to the opinions of experts and senior managers, the proposed model provides a basis for operationalizing strategy implementation. Another advantage of the model is its capacity to analyze alternative pathways and assess the extent to which strategic objectives have been achieved. The application of the model was examined at Soufian Cement Company. The results of the questionnaire analysis indicated that the values of the growth and development, internal processes, customer/market, and financial dimensions were 0.63, 0.64, 0.61, and 0.60, respectively. After entering the data into MATLAB, the level of strategy implementation was calculated as 0.611. This result indicates that the achievement of the strategic objectives of Soufian Cement Company was above the average level.

Keywords: strategy implementation, Balanced Scorecard, fuzzy logic, decision tree, entropy, structural equation modeling

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1. Introduction

Strategy constitutes one of the principal mechanisms through which organizations define their long-term direction, allocate resources, coordinate activities, and respond to environmental opportunities and threats. In contemporary competitive environments, however, the formulation of a coherent strategy does not by itself guarantee organizational success. A substantial proportion of strategic initiatives fail not because their underlying objectives are necessarily inappropriate, but because organizations encounter difficulties in translating broad strategic intentions into coordinated operational actions. The

distinction between strategy formulation and strategy implementation is therefore fundamental to strategic management. Formulation determines what an organization intends to achieve, whereas implementation concerns how strategic choices are converted into structures, processes, responsibilities, resource commitments, performance measures, and daily managerial practices. Advanced strategic management accordingly emphasizes that the strategic management process must integrate environmental analysis, strategic choice, implementation, control, and organizational learning rather than treating strategy as a static planning document [1]. From this perspective, implementation is the stage at which strategic concepts are



tested against organizational realities, including managerial capabilities, employee behavior, information quality, operational constraints, and changing environmental conditions.

The implementation of strategy has increasingly been recognized as one of the most difficult and consequential dimensions of management. Organizations frequently devote extensive time and resources to strategic planning but pay insufficient attention to the institutional and operational mechanisms required for execution. Strategy implementation requires the alignment of organizational structures, leadership behavior, culture, communication systems, incentives, budgets, performance indicators, and employee competencies. When these components are fragmented, even logically sound strategies may remain disconnected from organizational action. Recent literature reviews describe strategy execution as a dynamic organizational capability through which planning is converted into coordinated activity, monitored outcomes, and adaptive responses [2]. Such a capability becomes especially important in volatile environments, where assumptions underlying strategic decisions can change rapidly and where organizations must simultaneously preserve long-term direction and maintain short-term flexibility. Therefore, the quality of strategy implementation depends not only on compliance with a predetermined plan but also on the organization's ability to interpret feedback, recognize emerging patterns, and revise implementation pathways when necessary.

A central issue in the implementation literature is the persistent gap between strategic intention and organizational performance. This gap emerges when strategic objectives are not sufficiently communicated, responsibilities are unclear, performance measures are inconsistent with priorities, or operational units interpret strategy differently. Strategy implementation is thus not a single managerial action but a multidimensional process involving the interaction of strategic content, organizational context, managerial action, and performance control. A comprehensive review of the field indicates that successful implementation requires coordinated attention to strategic decisions, organizational arrangements, implementation activities, and contextual conditions [3]. This view moves beyond linear models in which senior managers formulate strategy and lower organizational levels merely execute instructions. Instead, implementation is understood as an iterative process involving interpretation, negotiation, learning, adjustment, and feedback across hierarchical levels. The effectiveness of

the process depends on the degree to which strategic objectives are transformed into specific and measurable expectations that can guide decisions at the operational level.

The significance of implementation is also reflected in the argument that the practical value of a strategy is ultimately determined by whether it can be executed. A strategically sophisticated plan that cannot be translated into feasible actions has limited organizational utility. In this respect, implementability should be treated as a criterion of strategic quality rather than as a secondary concern addressed after formulation. Galpin maintains that the best strategy is not necessarily the most ambitious or analytically complex one, but the strategy that an organization can realistically implement through appropriate tools, responsibilities, processes, and organizational engagement [4]. This proposition highlights the importance of designing implementation mechanisms during the strategy-development stage. It also suggests that organizations need analytical frameworks capable of linking high-level objectives to operational indicators, identifying causal relationships among performance dimensions, and evaluating whether strategic progress is occurring as expected.

The challenges of implementation are evident in both private- and public-sector organizations. Although the institutional contexts of these sectors differ, both face problems related to fragmented accountability, insufficient coordination, weak performance measurement, resource constraints, resistance to change, and limited managerial commitment. In the public sector, strategy execution is closely associated with service delivery, institutional responsiveness, efficient resource utilization, and public accountability. Research on public-sector implementation demonstrates that strategic plans are unlikely to improve service delivery unless they are accompanied by effective leadership, stakeholder alignment, monitoring arrangements, sufficient competencies, and clear operational responsibilities [5]. These findings are relevant to industrial organizations as well, because successful execution similarly depends on the integration of objectives across functional areas and the continuous assessment of operational outcomes. In manufacturing firms, strategic implementation additionally requires alignment among production efficiency, cost management, product quality, market development, workforce capabilities, technological processes, and financial performance.

Organizational culture is another critical element in strategy implementation. Strategy is executed through

individuals and groups whose assumptions, values, routines, and patterns of interaction shape how strategic directives are understood and enacted. A culture that supports collaboration, accountability, learning, and responsiveness can facilitate implementation, whereas a culture characterized by rigid boundaries, low trust, weak communication, and resistance to change can obstruct it. Evidence from local-government organizations indicates that organizational culture influences the relationship between strategy implementation and performance by shaping employee commitment, coordination, and the acceptance of strategic priorities [6]. Cultural alignment is particularly important where implementation involves changes in established routines or performance expectations. Accordingly, implementation models should not focus solely on financial outcomes but should also account for learning, employee development, internal processes, and customer-related consequences.

One of the most influential approaches developed to address the multidimensional nature of organizational performance is the Balanced Scorecard. The Balanced Scorecard was introduced as an alternative to traditional performance systems that relied predominantly on retrospective financial indicators. Financial measures remain essential because they reflect profitability, return, sales, cost control, and the economic consequences of managerial decisions. However, they do not by themselves explain the organizational drivers that produce these outcomes. The Balanced Scorecard expands performance measurement by integrating financial indicators with customer, internal-process, and learning-and-growth perspectives. This combination enables organizations to assess both current outcomes and the capabilities that influence future performance. The Balanced Scorecard has consequently evolved from a performance-measurement framework into a broader strategic management system that supports the communication, alignment, implementation, and monitoring of strategy [7].

The historical development of the Balanced Scorecard demonstrates its increasing relevance to strategy implementation. Initially, the framework was primarily used to balance financial and nonfinancial indicators. Over time, its use expanded to include strategy maps, causal linkages, organizational alignment, strategic initiatives, target setting, and performance review. Contemporary evaluations of the framework emphasize that its enduring influence results from its capacity to translate abstract strategies into structured sets of objectives and measures [8]. The Balanced

Scorecard allows managers to articulate how investments in employee competencies and organizational learning are expected to improve internal processes, how process improvements should enhance customer value, and how customer outcomes should contribute to financial performance. By making these presumed relationships explicit, the framework provides a foundation for strategic communication and performance evaluation.

The practical application of the Balanced Scorecard requires more than the selection of indicators. The four perspectives must be adapted to the organization's strategic context, and the selected indicators must represent meaningful aspects of strategic success. If measures are chosen without a clear connection to strategy, the scorecard may become a collection of unrelated performance statistics rather than an implementation system. The movement of the Balanced Scorecard from theory to practice therefore requires the specification of objectives, indicators, targets, initiatives, responsibilities, and review mechanisms [9]. Moreover, the causal assumptions linking the perspectives should be examined rather than accepted automatically. For example, employee training may contribute to process improvement only when the training is relevant, effectively delivered, and supported by opportunities for application. Similarly, improved internal processes may enhance customer satisfaction only when process outcomes correspond to customer priorities. A robust implementation model must therefore be able to analyze the interdependence of indicators rather than merely report their individual values.

The Balanced Scorecard is also closely related to strategic management accounting because it links strategy, measurement, managerial decision-making, and organizational control. Strategic management accounting extends accounting information beyond conventional financial reporting by incorporating market, competitor, customer, process, and long-term strategic information. From this viewpoint, performance systems should provide decision-relevant information that assists managers in allocating resources, evaluating strategic initiatives, and monitoring value creation across organizational activities [10]. The Balanced Scorecard supports this function by combining financial information with operational and developmental measures. Nevertheless, the effectiveness of the system depends on the quality of the selected indicators, the reliability of the underlying data, and the analytical methods used to interpret relationships among the dimensions.

Empirical research has shown that the Balanced Scorecard can contribute to organizational performance and sustainable development when it is implemented as an integrated strategic management system. Its effects are not limited to measurement; the framework can improve strategic alignment, managerial understanding, organizational learning, and the coordination of performance priorities. Research using partial least squares structural equation modeling has demonstrated that the Balanced Scorecard can influence sustainable development through improvements in organizational performance [11]. This finding is important because it indicates that nonfinancial and operational capabilities may mediate the relationship between strategic management systems and final organizational outcomes. Consequently, the assessment of strategy implementation should consider both direct outcomes and the causal pathways through which organizational capabilities generate those outcomes.

Despite its advantages, the Balanced Scorecard has several practical limitations. First, causal relationships among its perspectives are often assumed conceptually rather than verified empirically. Second, conventional scorecards may not adequately represent uncertainty, ambiguity, nonlinear relationships, or complex combinations of conditions. Third, managers may encounter difficulties when different indicators provide conflicting signals. A company may, for example, demonstrate improved financial results while experiencing deteriorating employee capabilities or customer relationships. Fourth, traditional scoring systems frequently aggregate indicators through fixed weights or simple averages, which may obscure the conditional importance of specific attributes. Fifth, organizational experts often express evaluations linguistically, using terms such as very low, low, moderate, high, and very high rather than precise numerical judgments. These limitations indicate the need to integrate the Balanced Scorecard with analytical methods capable of processing uncertainty and identifying conditional decision patterns.

Fuzzy logic provides an appropriate foundation for addressing ambiguity in organizational decision-making. Conventional binary logic classifies a condition as either belonging or not belonging to a set, whereas fuzzy logic allows partial membership and therefore better represents gradual distinctions. In strategic evaluation, concepts such as high profitability, moderate customer satisfaction, low process efficiency, or strong employee development do not necessarily have universally fixed boundaries. Their meanings may depend on expert judgment, organizational

context, historical performance, and strategic expectations. Fuzzy membership functions allow these linguistic categories to be represented mathematically while preserving their gradual nature. This approach is particularly useful when quantitative data and qualitative managerial assessments must be integrated within a single model.

Decision trees offer another valuable analytical mechanism for strategy implementation. A decision tree classifies observations by recursively dividing data according to the attributes that provide the greatest information gain or the strongest capacity to distinguish among outcome classes. The resulting structure is hierarchical and interpretable, allowing decision-makers to trace how combinations of conditions lead to particular outcomes. Data-mining literature identifies decision trees as widely used classification tools because they can model complex decision rules, accommodate multiple predictors, and produce transparent if-then rules [12]. In organizational applications, this transparency is especially important because managers must understand why a model produces a particular classification. Unlike opaque analytical methods, a decision tree provides explicit pathways that can be evaluated by experts and translated into managerial actions.

Entropy is a central concept in the development of many decision-tree algorithms. It measures the degree of uncertainty or impurity within a dataset and enables the identification of the attribute that most effectively separates observations into homogeneous classes. Attributes with greater information gain are generally selected earlier in the tree because they contribute more strongly to classification. In a strategy implementation model, entropy can therefore assist in identifying which Balanced Scorecard perspective or indicator has the greatest discriminatory value in determining the level of strategic objective achievement. This is analytically valuable because the importance of an indicator is not assumed in advance but is derived from the structure of the available knowledge base.

The integration of fuzzy logic and decision trees combines the interpretability of rule-based classification with the capacity to represent uncertain and gradual conditions. A fuzzy decision tree does not require every organizational indicator to be assigned rigidly to a single category. Instead, an indicator may possess different degrees of membership in adjacent linguistic categories. This feature is consistent with the way managers and experts frequently evaluate organizational conditions. The rules extracted from the tree can subsequently be incorporated into a fuzzy inference system, in which multiple inputs are processed to

generate an output representing the degree of strategy implementation or strategic objective achievement. Defuzzification then converts the aggregated fuzzy output into a numerical value that can be interpreted and compared.

Machine-learning methods further reinforce the analytical foundations of such models. Contemporary machine learning provides tools for classification, prediction, model validation, feature evaluation, and the analysis of complex patterns in multidimensional data [13]. Although advanced machine-learning models may achieve high predictive accuracy, managerial applications require an appropriate balance between accuracy and interpretability. In strategy implementation, decision-makers must be able to understand the logic of the model, assess whether its conclusions are consistent with organizational knowledge, and identify which attributes require intervention. A fuzzy decision-tree approach is therefore attractive because it combines data-driven classification with transparent rules and linguistically meaningful categories.

Previous research has demonstrated the applicability of fuzzy decision-tree methods in strategic analysis. A fuzzy decision-tree approach has been used in the design and analysis of the Strategic Position and Action Evaluation matrix for formulating marketing strategies in foreign-exchange services [14]. This application illustrates the capacity of fuzzy decision trees to integrate strategic variables, expert judgments, and classification logic within a decision-support framework. Nevertheless, the use of such an approach specifically for evaluating strategy implementation through the Balanced Scorecard remains comparatively limited. Existing BSC applications commonly focus on indicator design, weighting, ranking, performance comparison, or causal modeling, whereas fewer studies have developed an integrated mechanism that transforms scorecard indicators into explicit implementation rules and a final quantitative estimate of strategic achievement.

The need for such an integrated model is particularly evident in large manufacturing organizations. Cement companies operate in environments characterized by capital-intensive production, high energy consumption, environmental obligations, market fluctuations, transportation costs, quality requirements, maintenance needs, and continuous pressure to control production expenses. Their strategic performance cannot be evaluated adequately through a single financial measure. Profitability may depend on production efficiency, line downtime, energy consumption, product quality, sales capacity, market

development, employee competencies, and compliance with environmental commitments. These variables interact rather than operate independently. Accordingly, an implementation model for a cement company should be capable of representing relationships among financial performance, customer and market outcomes, internal processes, and growth and learning.

Soufian Cement Company provides a relevant context for the development and application of such a model. The company's strategic objectives include profitability improvement, cost management, market maintenance and development, production-efficiency enhancement, employee competency development, product-related improvement, and the implementation of organizational resolutions. These objectives correspond closely to the principal Balanced Scorecard perspectives. However, evaluating their implementation requires an analytical framework that can integrate multiple indicators, incorporate expert knowledge, establish causal and classificatory relationships, and generate an interpretable estimate of overall strategic achievement.

Structural equation modeling can support this process by assessing relationships between latent constructs and their observed indicators. It enables the researcher to examine whether questionnaire items adequately represent the intended dimensions and whether the hypothesized relationships among organizational variables are statistically supported. Nevertheless, structural equation modeling alone does not necessarily provide a rule-based classification system for determining the overall level of strategy implementation. Conversely, a decision tree can classify outcomes but may not independently establish the measurement validity of latent constructs. Integrating structural equation modeling, entropy-based decision-tree construction, fuzzy membership functions, and fuzzy inference can therefore provide a more comprehensive methodological framework.

Such integration addresses several shortcomings of conventional strategy implementation assessment. Structural equation modeling evaluates measurement relationships and causal paths; entropy identifies the relative information contribution of attributes; the decision tree generates transparent implementation rules; fuzzy logic represents gradual linguistic evaluations; and defuzzification produces an interpretable numerical output. The resulting system can show not only the estimated level of strategy implementation but also the combinations of financial, market, process, and learning conditions associated with different levels of

strategic achievement. This capability can assist managers in identifying weak pathways, prioritizing interventions, and understanding how improvements in one dimension may influence broader strategic outcomes.

The development of an operational and interpretable strategy implementation model is consistent with the broader emphasis in the literature on transforming strategic plans into measurable organizational realities. Strategy implementation research repeatedly stresses the need for alignment, communication, leadership commitment, performance monitoring, organizational learning, and adaptive control [15]. The Balanced Scorecard offers a structured architecture for linking these concerns to performance dimensions, while fuzzy decision trees provide a mechanism for managing uncertainty and deriving explicit decision rules. Their integration can therefore contribute both theoretically and practically by connecting strategic objectives, organizational indicators, expert judgment, causal analysis, and computational inference within a unified framework.

Accordingly, the aim of this study was to design and analyze a novel Balanced Scorecard-based strategy implementation model using a fuzzy decision-tree approach and to evaluate its application in measuring the achievement of strategic objectives at Soufian Cement Company.

2. Methodology

This study was quasi-experimental and was conducted through the following stages:

1. Identification of the existing BSC indicators. To delimit the scope of the study, only BSC indicators were used; however, one of the advantages of the proposed model is that it allows the inclusion of other discretionary and heterogeneous indicators.
2. Classification of each attribute using linguistic variables such as small, medium, and large; low, medium, and high; or a five-point Likert scale.
3. Identification of the measurement variables associated with the intended indicators, namely the latent variables.
4. Development of the questionnaire.
5. Specification of causal relationships and development of the conceptual and theoretical structure of the study based on existing theories and documentary research, followed by the construction of a Balanced Scorecard-based strategy map.
6. Collection of opinions from the supervisors, advisors, and strategic management experts to establish a database based on the company's strategic objectives.
7. Calculation of attribute entropy using Shannon Entropy Solver software.
8. Final development of the decision-tree model.
9. Formulation of the rules generated by the decision tree.
10. Fuzzification of the attributes and classes using the questionnaire data, following an analysis of the questionnaire through structural equation modeling and SmartPLS software.
11. Entry of each attribute as an input, the organization's ultimate objectives as outputs, and the rule base into the fuzzy-logic module of MATLAB.
12. Fuzzy inference, followed by defuzzification and final interpretation, including the assessment of the extent to which strategic objectives were achieved or the effectiveness of strategy implementation.

3. Findings and Results

In the present case study, Soufian Cement Company was selected for the application of the strategy implementation model using the fuzzy decision-tree approach.

Because the study involved a decision-tree model, data collection initially involved theoretical and documentary research. Subsequently, face-to-face semi-structured interviews were conducted with university professors, doctoral students, and experts to identify the specific indicators incorporated into the Balanced Scorecard. The opinions of the supervisors, advisors, and subject-matter experts, together with documentary studies, existing theories, and structural equation modeling, were then used to specify the causal relationships within the theoretical model. Finally, a questionnaire was administered to a statistical population of 150 experts, managers, and operational supervisors to collect the data required for analyzing relationships and evaluating the extent to which strategic objectives had been achieved. Therefore, documentary research, expert and academic opinions, and the questionnaire constituted the principal data-collection instruments used in this study.

The reliability of the questionnaire was assessed by calculating Cronbach's alpha in SPSS and evaluating the questionnaire constructs through structural equation

modeling in SmartPLS. The overall reliability coefficient was 0.913. The reliability test results are presented in Table 1.

Table 1. Results of the Research Reliability Test

Perspective	Number of Objectives	Number of Indicators	Cronbach's Alpha
Financial	2	4	0.756
Customer	2	5	0.724
Internal processes	2	6	0.796
Growth and learning	2	3	0.786
Objectives	—	8	0.821

The validity of the questionnaire in terms of its capacity to measure the characteristics under investigation was confirmed by the supervisor and advisor. Questionnaire

validity was also evaluated through structural equation modeling in SmartPLS. The validity test results are presented in Table 2.

Table 2. Results of the Research Validity Test

Perspective	Number of Objectives	Number of Indicators	Reliability Coefficient (rho_A)
Financial	2	4	0.753
Customer	2	5	0.734
Internal processes	2	6	0.809
Growth and learning	2	3	0.829
Objectives	—	8	0.827

The model's knowledge base was developed on the basis of the analyses conducted through documentary research, the opinions of experts and specialists, the final assessments of the supervisors and advisor, and the specification of the relationships between the independent and dependent variables. The knowledge base was structured according to a five-point Likert scale. The following abbreviations were used in constructing the model:

(O_i) = extent of objective achievement;

(F) = financial perspective;
(M/C) = customer/market perspective;
(P) = internal-process perspective;
(G) = growth and learning perspective; and
(C_i) = decision-tree attribute class, where (i = 1, 2, 3, 4, 5).

The final knowledge base was developed as presented in Table 3.

Table 3. Knowledge Base of the General Model

Case	Attribute Level	Growth and Development (G)	Internal Processes (P)	Customer/Market (M/C)	Financial (F)	Extent of Objective Achievement—Class (O)
1	Very low	Very low	Very low	Very low	Very low	C1: Very low (O1)
2	Low	Very low	Very low	Very low	Very low	C1: Very low (O1)
3	Low	Low	Very low	Very low	Very low	C1: Very low (O1)
4	Low	Low	Low	Very low	Very low	C1: Very low (O1)
5	Low	Low	Low	Low	Low	C2: Low (O2)
6	Moderate	Very low	Very low	Very low	Very low	C1: Very low (O1)
7	Moderate	Low	Very low	Very low	Very low	C1: Very low (O1)
8	Moderate	Low	Low	Very low	Very low	C1: Very low (O1)
9	Moderate	Low	Low	Low	Low	C2: Low (O2)
10	Moderate	Moderate	Low	Very low	Very low	C1: Very low (O1)
11	Moderate	Moderate	Very low	Very low	Very low	C1: Very low (O1)
12	Moderate	Moderate	Moderate	Moderate	Moderate	C3: Moderate (O3)
13	High	Moderate	Low	Very low	Very low	C1: Very low (O1)

14	High	Moderate	Very low	Very low	Very low	C1: Very low (O1)
15	High	Moderate	Moderate	Moderate	Moderate	C3: Moderate (O3)
16	High	High	Moderate	Moderate	Moderate	C3: Moderate (O3)
17	High	High	High	High	High	C4: High (O4)
18	Very high	High	Moderate	Moderate	Moderate	C3: Moderate (O3)
19	Very high	High	High	High	High	C4: High (O4)
20	Very high	Very high	High	High	High	C4: High (O4)
21	Very high	Very high	Very high	Very high	Very high	C5: Very high (O5)

The company's strategic objectives across the financial, revenue, customer and market, and growth and learning perspectives were as follows:

Increasing profitability, managing costs, maintaining and expanding the market, improving organizational conditions, increasing production efficiency, developing employees' competencies, and implementing approved resolutions (Soufian Cement Company, 2025).

Based on the entropy calculations, the first stage of which is presented as an example below, the decision-tree model and rule base were developed. The same procedure was followed in the subsequent stages. The entropy of the attributes was calculated using the database and Shannon Entropy Solver software because of the complexity of the calculations and the need to reduce computational time.

Table 4. Entropy of the Attributes

Measure	Financial (F)	Customer/Market (M)	Internal Processes (P)	Growth and Learning (G)
Deviation from criterion	0.06042	0.04450	0.03017	0.01995
Entropy	0.93958	0.95550	0.96983	0.98005
Weight	0.38967	0.28702	0.19461	0.12870

Class	F	M	P	G
C1	1	1	1	1
C2	1	1	1	2
C3	1	1	2	2
C4	1	2	2	2
C5	2	2	2	2
C6	1	1	1	3
C7	1	1	2	3
C8	1	2	2	3
C9	2	2	2	3
C10	1	2	3	3
C11	1	1	3	3
C12	3	3	3	3
C13	1	2	3	4
C14	1	1	3	4
C15	3	3	3	4
C16	3	3	4	4
C17	4	4	4	4
C18	3	3	4	5
C19	4	4	4	5
C20	4	4	5	5
C21	5	5	5	5

Because the entropy value of the financial attribute, 0.93958, was the lowest among the examined attributes, it was selected as the root node.

By continuing this procedure, the general decision-tree model and rule base were obtained as follows.

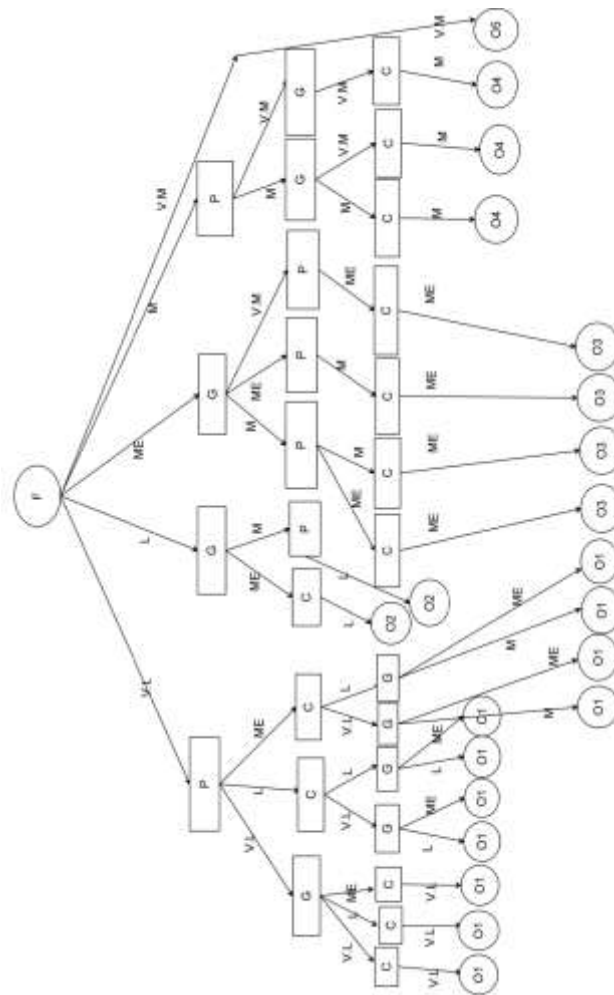


Figure 1. Final decision tree

Based on the final decision-tree model, the rules extracted from the tree were formulated as follows:

1. If the financial attribute is very low, internal processes are very low, growth and development are very low, and customer/market performance is low, then the level of strategy implementation, or achievement of strategic objectives, is very low.
2. If the financial attribute is very low, internal processes are very low, growth and development are low, and customer/market performance is very low, then the level of strategy implementation is very low.
3. If the financial attribute is very low, internal processes are very low, growth and development are moderate, and customer/market performance is very low, then the level of strategy implementation is very low.
4. If the financial attribute is very low, internal processes are low, customer/market performance is very low, and growth and development are low, then the level of strategy implementation is very low.
5. If the financial attribute is very low, internal processes are low, customer/market performance is very low, and growth and development are moderate, then the level of strategy implementation is very low.
6. If the financial attribute is very low, internal processes are low, customer/market performance is low, and growth and development are low, then the level of strategy implementation is very low.
7. If the financial attribute is very low, internal processes are low, customer/market performance is low, and growth and development are moderate, then the level of strategy implementation is very low.
8. If the financial attribute is very low, internal processes are moderate, customer/market performance is low, and growth and development are low, then the level of strategy implementation is very low.

performance is very low, and growth and development are high, then the level of strategy implementation is very low.

9. If the financial attribute is very low, internal processes are moderate, customer/market performance is very low, and growth and development are moderate, then the level of strategy implementation is very low.
10. If the financial attribute is very low, internal processes are moderate, customer/market performance is low, and growth and development are high, then the level of strategy implementation is very low.
11. If the financial attribute is very low, internal processes are moderate, customer/market performance is low, and growth and development are moderate, then the level of strategy implementation is very low.
12. If the financial attribute is low, growth and development are moderate, and customer/market performance is low, then the level of strategy implementation is low.
13. If the financial attribute is low, growth and development are high, and internal processes are low, then the level of strategy implementation is low.
14. If the financial attribute is moderate, growth and development are high, internal processes are moderate, and customer/market performance is moderate, then the level of strategy implementation is moderate.
15. If the financial attribute is moderate, growth and development are high, internal processes are high, and customer/market performance is moderate, then the level of strategy implementation is moderate.
16. If the financial attribute is moderate, growth and development are moderate, internal processes are

high, and customer/market performance is moderate, then the level of strategy implementation is moderate.

17. If the financial attribute is moderate, growth and development are very high, and internal processes are moderate, then the level of strategy implementation is moderate.
18. If the financial attribute is high, internal processes are high, growth and development are high, and customer/market performance is high, then the level of strategy implementation is high.
19. If the financial attribute is high, internal processes are high, growth and development are very high, and customer/market performance is high, then the level of strategy implementation is high.
20. If the financial attribute is high, internal processes are very high, growth and development are very high, and customer/market performance is high, then the level of strategy implementation is high.
21. If the financial attribute is very high, then the level of strategy implementation is very high.

In accordance with the research methodology, the subsequent stages of the study were conducted as follows.

Using structural equation modeling and SmartPLS 3, the relationships and magnitudes of the effects between the latent variables and the principal Balanced Scorecard indicators were determined.

Structural equation modeling is a comprehensive statistical approach used to test hypotheses concerning relationships between observed and latent variables. Observed variables are variables measured during the data-collection process, whereas latent variables are measured indirectly through their associations with observed variables because they cannot be measured directly. Considering the observed and latent variables and the questionnaire data obtained using a five-point Likert scale, the model was entered into SmartPLS.

Table 5. Latent and Observed Variables

Latent Variable	Observed Variables—Questionnaire Items
Growth and development (G)	G1: Implementation of approved resolutions; G2: Training courses; G3: Effectiveness of training courses
Internal processes (P)	P1: Cost of goods manufactured; P2: General expenses; P3: Production-line downtime; P4: Increased production; P5: Energy consumption; P6: Environmental activities
Customer/market (M/C)	M1: Exports; M2: Product quality; M3: Product availability; M4: Sales speed; M5: Product variety and differentiation
Financial performance (F)	F1: Operating profit; F2: Net profit; F3: Rate of return; F4: Total sales volume
Strategy implementation—achievement of objectives (O)	O1: Implementation of approved resolutions; O2: Competency development; O3: Efficiency; O4: Product diversification; O5: Cost management; O6: Product development; O7: Profitability; O8: Environmental commitments

Using SmartPLS and the data obtained from the questionnaire, the factor loadings were analyzed and the model hypotheses were tested.

A factor loading represents the relationship between a latent variable, or construct, and its associated observed variables, or measurement items, and is used to estimate the strength of this relationship (Ghaleb & Yaşlıoğlu, 2024). Various sources regard factor loadings greater than 0.40 as acceptable. For example, Hair et al. (2019) stated that a factor loading indicates the correlation between an observed variable and its underlying factor. When determining the

significance level for interpreting loadings, an approach similar to that used for evaluating the statistical significance of correlation coefficients may be adopted. Nevertheless, research has demonstrated that the standard errors of factor loadings are substantially larger than those associated with conventional correlations. Factor loadings should therefore be evaluated using more stringent criteria. The general guidelines presented in Table 6 summarize the practical or statistical significance of factor loadings in relation to sample size.

Table 6. Guidelines for Factor Loadings Based on Sample Size

Sample Size	Factor Loading
350	0.30
250	0.35
200	0.40
150	0.45
120	0.50
100	0.55
85	0.60
70	0.65
60	0.70
50	0.75

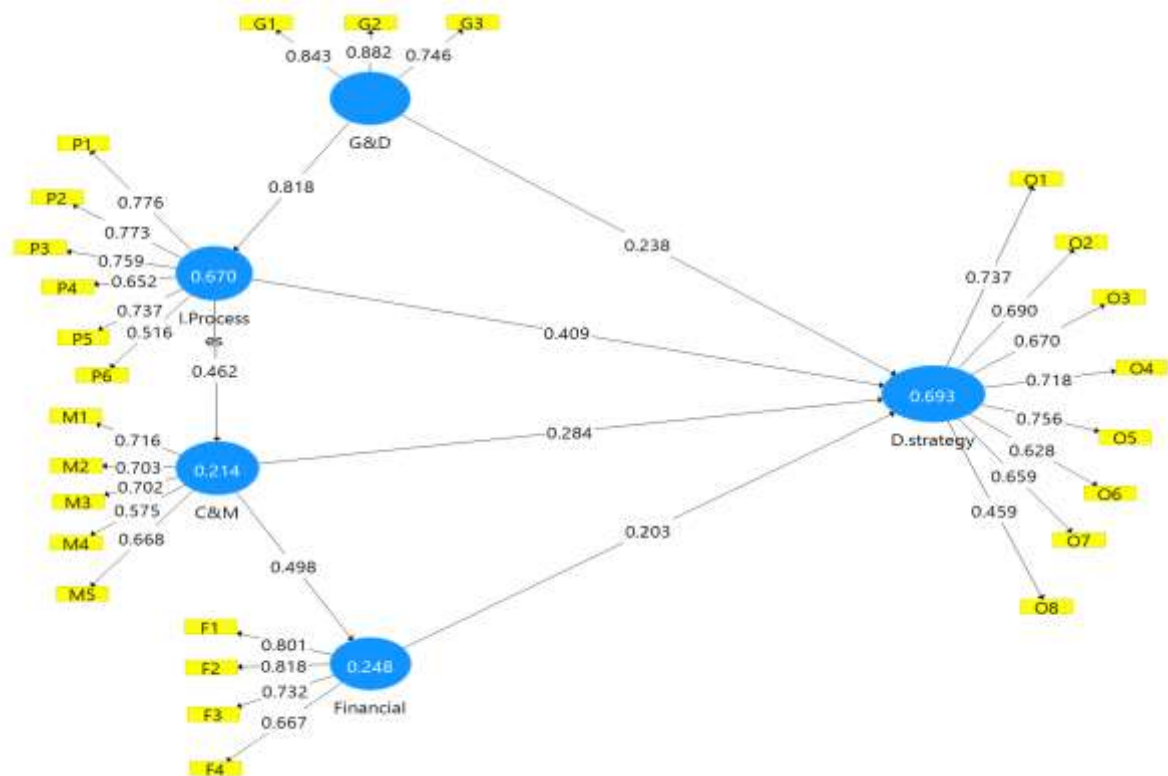


Figure 2. Output of the correlation and factor-loading analysis

As shown in Figure 3, all factor loadings for the observed variables were greater than 0.40, indicating the adequacy of the measurement items. Furthermore, all correlation

coefficients were positive, demonstrating that the variables exerted direct effects.

At this stage, the significance of the relationships among the research variables was assessed and tested.

The results of the SmartPLS analysis are presented in Figure 4. For an acceptable measurement instrument, the p

value should be less than .05 and the t value should be greater than 1.96.

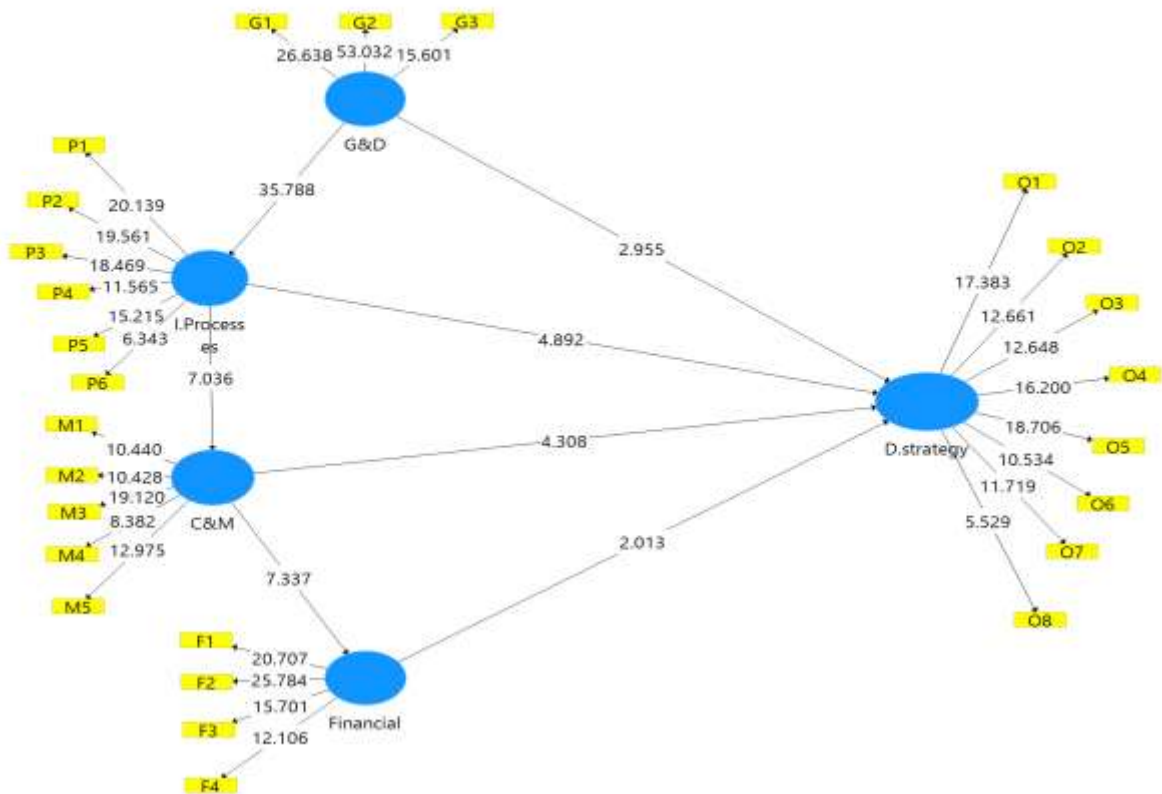


Figure 3. Results of the t-significance test

According to the results of the t test at a significance level of $p = .05$, all t values were greater than 1.96. These results indicate that the relationships among the variables were statistically significant at an error level of .05. Therefore, all relationships specified in the model and conceptual framework were supported.

Because the input and output data were expressed as real numbers, a membership degree had to be defined for each input and output at this stage. For this purpose, triangular fuzzy membership functions based on a five-point Likert scale were used.

The results obtained from the analysis of the questionnaire distributed among members of the statistical population were used to define the membership functions of the linguistic variables—very low (VL), low (L), moderate (M), high (H), and very high (VH)—for all attributes. For example, three five-option questions were designed to

measure the growth and development attribute. The minimum and maximum attainable scores for this attribute were 3 and 15, respectively.

The other attributes were fuzzified using the same procedure.

At this stage, an examination of the decision tree generated through the ID3 algorithm indicated that the tree comprised 21 rules, each of which ultimately led to an output representing the level of strategy implementation. Accordingly, following the procedures described above, the normalized output membership functions were defined as illustrated in Figure 6.

The proposed fuzzy system is a multiple-input, single-output system. Its output represents the extent to which the company's strategic objectives have been achieved or the level at which its strategies have been implemented. The

inference rules for each branch were derived from the decision tree.

Once the inference process is completed, the resulting values take the form of a fuzzy set or several aggregated fuzzy sets. The function of the defuzzifier is to identify the

point that most appropriately represents the output fuzzy set. Several defuzzification methods are available. In the present study, the centroid method was selected because of its interpretability, continuity, and computational simplicity. The software output is presented in Figure 3.



Figure 4. Continued software output

Based on the software output and the input values obtained from the analysis of the questionnaires, as reported in Appendix A—growth and development = 0.63, internal processes = 0.64, customer/market = 0.61, and financial performance = 0.60—the software calculated the level of strategy implementation. The resulting value was 0.611.

4. Discussion and Conclusion

The present study aimed to design and analyze a novel model for strategy implementation based on the Balanced Scorecard and a fuzzy decision-tree approach and to assess its applicability at Soufian Cement Company. The findings showed that the four principal dimensions of the Balanced Scorecard—growth and development, internal processes, customer/market, and financial performance—obtained values of 0.63, 0.64, 0.61, and 0.60, respectively. After these

values were entered into the fuzzy inference system developed in MATLAB, the overall strategy implementation score was calculated as 0.611. This value indicates that the company's strategic objectives were achieved at a level above the midpoint, although the result also suggests that substantial room remains for improving the consistency, integration, and effectiveness of strategy execution. Among the four dimensions, internal processes received the highest value, followed closely by growth and development, whereas the financial dimension received the lowest value. The entropy analysis also identified the financial perspective as the root node of the decision tree because it had the lowest entropy value and, consequently, the greatest discriminatory power in classifying the level of strategy implementation. These findings indicate that although strategy implementation at Soufian Cement Company was supported by relatively favorable internal capabilities and

developmental conditions, its ultimate effectiveness remained strongly dependent on the conversion of these capabilities into measurable financial outcomes.

The overall strategy implementation score of 0.611 supports the proposition that strategy execution should be considered a continuous and multidimensional process rather than a binary condition in which a strategy is classified simply as implemented or not implemented. The fuzzy approach used in this study allowed the level of implementation to be expressed gradually, thereby reflecting the reality that organizations may achieve some strategic objectives more successfully than others. This interpretation is consistent with the view that strategy implementation involves the coordinated translation of strategic plans into structures, behaviors, resource allocations, operational activities, and performance outcomes [3]. The above-average score indicates that the company had developed several enabling conditions for strategy execution, but the distance between 0.611 and a fully satisfactory level reveals that strategic plans had not yet been transformed uniformly into high-level results across all dimensions. This finding corresponds with the argument that the quality of a strategy is ultimately determined by the organization's capacity to implement it through coherent actions rather than by the analytical sophistication of the strategic plan alone [4].

The relatively high value obtained for the internal-process dimension suggests that Soufian Cement Company had achieved comparatively favorable conditions in areas such as production improvement, cost-related processes, production-line continuity, energy consumption, and environmental activities. Internal processes occupy a central position in the Balanced Scorecard because they represent the mechanisms through which organizational resources and employee capabilities are transformed into products, services, and customer value. The result therefore implies that the company possessed a reasonably functional operational foundation for strategy execution. This interpretation aligns with the Balanced Scorecard literature, which emphasizes that process measures connect learning and growth capabilities to customer and financial outcomes [7]. From this perspective, improvements in production efficiency, operational coordination, and resource utilization should eventually contribute to greater market responsiveness and stronger financial performance. However, because the customer/market and financial scores were lower than the internal-process score, the findings suggest that internal improvements had not yet been translated fully into external and economic outcomes.

The value of 0.63 for growth and development was also notable and indicates that employee training, implementation of approved organizational resolutions, and the effectiveness of developmental programs contributed positively to strategy implementation. The Balanced Scorecard treats learning and growth as a foundational perspective because the long-term execution of strategy depends on human capital, information capabilities, employee competencies, and organizational learning. The result is consistent with the argument that effective strategy implementation requires employee understanding, managerial capability, organizational commitment, and the development of competencies that support strategic priorities [2]. It also supports the view that strategic management must integrate learning and capability development with implementation and control rather than treating human-resource development as an independent administrative activity [1]. Nevertheless, the growth and development score remained moderate rather than high, indicating that training activities and competency-development mechanisms may not have been sufficiently systematic, strategically targeted, or linked to measurable operational outcomes.

The lower value obtained for the customer/market perspective, 0.61, indicates that market maintenance, product quality, product availability, sales speed, exports, and product differentiation represented relatively weaker components of implementation. Although this score remained above the midpoint, it suggests that the company's operational capabilities were not converted fully into stronger market positioning. In a competitive industrial environment, strategy implementation cannot be evaluated exclusively through internal efficiency; it must also be reflected in the organization's ability to create value for customers, respond to market changes, maintain product quality, and expand sales opportunities. The Balanced Scorecard was developed partly to correct the limitations of systems that concentrated only on internal or financial information, and its practical application requires the integration of customer outcomes with operational and financial indicators [9]. The current result therefore demonstrates the importance of maintaining balance among the scorecard perspectives. A company may improve production and internal efficiency, but if those improvements do not result in enhanced customer value or market development, the broader strategic effect will remain constrained.

The financial perspective obtained the lowest value, 0.60, and was also identified as the most informative root attribute in the decision-tree analysis. This finding is particularly important because financial performance represents the final economic expression of strategic actions. The financial indicators examined in the study included operating profit, net profit, rate of return, and total sales. The relatively lower score implies that the company's implementation efforts had not yet produced their maximum expected effects on profitability, return, and sales. The selection of the financial dimension as the root node further indicates that changes in this attribute exerted a decisive influence on the classification of the overall implementation level. This result corresponds with strategic management accounting principles, according to which financial information remains essential for evaluating whether strategic initiatives create sustainable organizational value, even when nonfinancial indicators are incorporated into the performance system [10]. Thus, the findings do not reduce the importance of nonfinancial dimensions; rather, they indicate that growth, process, and market capabilities must ultimately be connected to improved financial consequences.

The findings also support the logic underlying the Balanced Scorecard as a strategic management system rather than merely a performance-reporting instrument. The four dimensions did not function as isolated measures but as interconnected components contributing to the final strategy implementation score. The relatively close values among the dimensions indicate a degree of balance, yet the differences also reveal bottlenecks in the causal chain. Growth and development and internal processes were comparatively stronger, whereas customer/market and financial performance were weaker. This pattern suggests that organizational learning and operational improvement may require additional time, coordination, or market-oriented initiatives before they can generate stronger external and financial results. The historical development of the Balanced Scorecard has emphasized precisely this movement from a collection of performance indicators to an integrated framework for mapping strategic relationships and monitoring implementation [8]. The current study extends this logic by using a decision tree and fuzzy inference system to convert the relationships among the dimensions into explicit classification rules.

The use of structural equation modeling before fuzzy inference strengthened the measurement foundation of the proposed model. All factor loadings were reported to be greater than 0.40, and the relationships among the variables

were statistically significant, with t values exceeding 1.96. These findings confirm that the observed questionnaire items adequately represented their respective latent constructs and that the conceptual relationships incorporated into the model were empirically supported. The overall Cronbach's alpha coefficient of 0.913 also indicated strong internal consistency, while the rho_A values reported for the dimensions demonstrated acceptable construct reliability. This measurement evidence is important because a decision-support model can produce meaningful outputs only when its input indicators are reliable and valid. The findings are consistent with research demonstrating that the Balanced Scorecard can influence organizational performance when it is implemented as a coherent strategic management system and when its dimensions are evaluated through structural modeling techniques such as partial least squares [11].

The decision-tree component of the model generated 21 explicit rules linking combinations of financial, customer/market, internal-process, and growth-and-development conditions to five levels of strategy implementation. This rule-based structure represents one of the principal contributions of the study. Conventional Balanced Scorecard systems often provide numerical scores but do not clearly show how different combinations of performance conditions lead to a specific implementation outcome. The decision tree addressed this limitation by identifying hierarchical pathways and translating them into understandable if-then rules. This result is consistent with the data-mining literature, which identifies decision trees as useful classification tools because they generate transparent models that can be interpreted by decision-makers [12]. In the context of strategy implementation, interpretability is essential because senior managers must understand which combinations of strengths and weaknesses produce a particular result and where corrective action should be directed.

The application of entropy in selecting decision-tree nodes also enhanced the objectivity of the classification process. Rather than assigning importance to the Balanced Scorecard dimensions solely on the basis of managerial preference, the model evaluated their information content and selected the attribute with the greatest classificatory contribution. The financial perspective was selected as the root node because it had the lowest entropy and highest weight. This finding means that the financial dimension reduced uncertainty more strongly than the other attributes when classifying strategy implementation. Such a result is compatible with the broader use of data-driven methods in

organizational analysis, where algorithms are employed to detect patterns that may not be immediately evident through conventional judgment [13]. At the same time, the inclusion of expert knowledge in constructing the knowledge base ensured that the decision rules remained grounded in the organization's strategic context.

The fuzzy component of the model was also appropriate for the nature of strategy implementation assessment. Organizational performance indicators are rarely interpreted through rigid thresholds. A score may be considered partly moderate and partly high, depending on the organizational context and the judgments of managers and experts. By defining membership functions for the linguistic categories of very low, low, moderate, high, and very high, the model represented this ambiguity more realistically than a conventional crisp classification system. The final score of 0.611 therefore reflected an aggregation of different degrees of membership and rule activation rather than a simple arithmetic average. The usefulness of this approach is supported by previous application of fuzzy decision trees in strategic analysis, where fuzzy classification was used to formulate marketing strategies through the SPACE matrix [14]. The present study expands this application from strategy formulation to strategy implementation and objective achievement.

The study findings also reinforce the importance of organizational alignment in strategy execution. The relatively moderate scores across all four perspectives indicate that no single dimension was critically deficient, but none had reached a very high level either. This pattern suggests that the principal issue may concern the integration of the dimensions rather than the complete absence of strategic capacity. Successful implementation requires the alignment of leadership, organizational culture, communication, employee behavior, performance measurement, and operational action. Research has shown that organizational culture can either strengthen or weaken the relationship between implementation and performance by influencing cooperation, commitment, and the acceptance of strategic priorities [6]. The results at Soufian Cement Company may therefore indicate a need to reinforce cross-functional coordination and ensure that employees understand how their activities contribute to broader strategic outcomes.

The above-average but incomplete implementation score is also compatible with the argument that strategy execution is frequently impeded by organizational barriers even when formal plans and performance systems exist. Strategy

implementation requires persistent managerial attention and cannot be delegated entirely to planning units or performance-management systems. Leadership must communicate priorities, resolve conflicts among objectives, allocate sufficient resources, and maintain accountability for results. The literature emphasizes that many implementation failures stem from weaknesses in managerial commitment, communication, coordination, and follow-through rather than from the absence of strategic plans [15]. The result of 0.611 may therefore reflect the existence of an appropriate strategic architecture without full institutionalization of implementation practices across all organizational levels.

The findings further suggest that the proposed model may improve managerial decision-making by converting multidimensional performance information into a single interpretable output while preserving the underlying rule structure. This is important because a single aggregate score without explanatory pathways could conceal the sources of weak performance. In the proposed model, however, managers can trace the output back through the activated rules and identify the contribution of each perspective. Such functionality is consistent with the view that effective strategy execution requires monitoring systems that not only evaluate outcomes but also enable corrective learning and adaptation [5]. The model can therefore function as both an assessment mechanism and a strategic diagnostic tool.

Overall, the results demonstrate that integrating the Balanced Scorecard with structural equation modeling, entropy analysis, decision-tree classification, and fuzzy inference provides a comprehensive framework for evaluating strategy implementation. The Balanced Scorecard supplies the multidimensional strategic architecture; structural equation modeling validates the measurement relationships; entropy identifies the most informative attributes; the decision tree generates explicit implementation rules; and fuzzy logic accommodates uncertainty and produces a final implementation score. This integrated approach responds to the limitations of conventional performance systems and supports the argument that strategic management tools should connect planning, measurement, interpretation, and action. The result obtained for Soufian Cement Company indicates a moderately favorable level of strategy execution, driven primarily by internal processes and growth capabilities but constrained by comparatively weaker customer/market and financial outcomes. Accordingly, improving strategy implementation requires not merely strengthening individual indicators but ensuring that learning and process

improvements are effectively converted into market and financial results.

The present study had several limitations. First, the empirical application of the model was limited to a single cement company, which restricts the generalizability of the findings to other organizations, industries, and institutional contexts. Second, part of the model's knowledge base was developed using the judgments of experts, supervisors, advisors, and organizational specialists; although such judgments were necessary for defining strategic relationships and linguistic categories, they may have been influenced by subjective interpretations. Third, the questionnaire data were collected from managers, experts, and operational supervisors and may therefore have been affected by common-method bias, social desirability, or differences in respondents' knowledge of organizational strategy. Fourth, the study used cross-sectional data and consequently could not determine whether the observed implementation score remained stable or changed over time. Fifth, the membership functions and decision rules were constructed using a specific five-level linguistic scale, and alternative definitions of the fuzzy sets might produce somewhat different outputs. Finally, the model focused primarily on the four standard Balanced Scorecard perspectives and did not include potentially relevant contextual variables such as leadership style, organizational culture, technological readiness, competitive intensity, supply-chain conditions, or macroeconomic fluctuations.

Future research should test the proposed model in multiple organizations and industries to evaluate its external validity and identify sector-specific differences in decision rules and attribute importance. Longitudinal studies could apply the model at several points in time to examine changes in strategy implementation and determine whether improvements in growth and learning or internal processes subsequently produce stronger customer and financial outcomes. Researchers may also compare the proposed fuzzy decision-tree model with alternative analytical methods, including random forests, neuro-fuzzy systems, Bayesian networks, support vector machines, and artificial neural networks, to assess differences in predictive accuracy and interpretability. Future studies could incorporate additional strategic dimensions such as sustainability, innovation, digital transformation, risk management, organizational culture, and stakeholder value. The design of fuzzy membership functions could also be improved through data-driven optimization techniques rather than relying primarily on expert judgment. Finally, researchers should

investigate whether the model can be transformed into a dynamic decision-support system linked directly to organizational databases and real-time performance dashboards.

Managers at Soufian Cement Company should use the model as a recurring strategy-review instrument rather than as a one-time evaluation tool. Particular attention should be given to the financial and customer/market perspectives because they obtained the lowest values and appear to constrain the conversion of internal capabilities into final organizational outcomes. Management should link employee-development programs more directly to production, sales, quality, and profitability targets and should evaluate whether training activities produce measurable behavioral and operational changes. Cross-functional strategy meetings should be established to examine the causal relationships among learning, internal processes, customer outcomes, and financial performance. The decision rules generated by the model should be incorporated into managerial dashboards so that emerging weaknesses can be identified before they significantly affect strategic results. Responsibility for each strategic indicator should be assigned clearly, and corrective initiatives should include measurable targets, implementation deadlines, and accountable owners. The company should also update the knowledge base, fuzzy membership functions, and strategic indicators periodically to ensure that the model remains aligned with changing market, technological, environmental, and organizational conditions.

Authors' Contributions

Authors equally contributed to this article.

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Declaration of Interest

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Ethical Considerations

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

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