APPLICATION OF STRUCTURAL EQUATION MODELS TO EVALUATE THE EFFECTIVENESS OF STRATEGIC PLANNING IN SUBNATIONAL GOVERNMENTS

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ABSTRACT

This study presents a rigorous application of Structural Equation Modeling (SEM) to analyze the effectiveness of strategic planning in subnational governments. Using a quantitative approach that combines exploratory factor analysis and SEM modeling on a simulated database of 500 observations, five latent constructs are evaluated: strategic planning effectiveness, institutional capacity, citizen participation, governance, and financial sustainability, each represented by observable indicators. The analysis identified five key factors: (1) institutional capacity, negatively correlated with goal achievement, showing that more complex structures can decrease effectiveness; (2) financial sustainability, positively linked to citizen participation; (3) governance, reflected in transparency and administrative efficiency, closely related to operational capacity; (4) planning and participation, where citizen inclusion improves effectiveness; and (5) resource management, which shows tensions with institutional structures. Although the direct effects of the factors on effectiveness were not statistically significant, the covariances between governance, institutional capacity, and financial sustainability revealed relevant structural relationships. The model fit indicators support the theoretical and statistical validity of the approach used. The study concludes that effective strategic planning in the public sector requires a comprehensive approach that considers both structural and participatory and financial factors. Future research is recommended to explore mediating effects in diverse contexts.

KEYWORDS: Strategy, Governance, Public Management, Models, Planning.

1. INTRODUCTION

Structural equation modeling (SEM) has evolved significantly since its inception, with roots stretching back to the early 20th century. Initially, SEM was developed in the context of genetics and later transitioned to the social sciences. This shift was marked by the influential work of sociologist H.M. Blalock, whose 1964 book on causal inferences established fundamental ideas for SEM in non-experimental research (Grace, 2022). In the late 1960s and early 1970s, SEM gained traction when researchers such as Otis Dudley Duncan advanced the application of Sewall Wright's path analysis, facilitating a better understanding of causal relationships between variables (Bollen et al., 2022).

The 1970s marked a revival of SEM, particularly with the creation of the journal Social Science Research in 1972, which coincided with increased attention to SEM within the social and behavioral sciences 9Kabongo & Mbonigaba, 2024). This period saw the publication of significant texts and articles, including the Blalock -edited volume on causal models that brought together diverse contributions across several disciplines 9Decius et al., 2024) .

The methodological rigor of SEM has been reinforced by the integration of multiple statistical techniques to address both the measurement and structural components of the models 9Asil , 2019, Memon et al., 2021)
As a result, SEM became a vital tool for researchers aspiring to blend qualitative knowledge with quantitative frameworks, thus enabling a broader approach to social research 9Purwanto , & Sudargini , 2021; Harlow , 2023).

Throughout its history, SEM has undergone continuous refinement, with methodological advances in model fitting and estimation techniques, including the development of software packages designed to facilitate SEM analysis [3]. The ongoing evolution of SEM reflects its adaptability and relevance for addressing complex research questions in diverse fields, including strategic planning in subnational governments 9Hair et al., 2021; Moshagen & Bader , 2024).

Structural equation modeling (SEM) is a quantitative methodology that allows researchers to specify and evaluate hypotheses of causal networks between variables 9Sarstedt et al., 2022., Magno et al., 2024)

In the context of strategic planning in subnational governments, SEM serves as a valuable tool for understanding the relationships between latent constructs—unobserved variables deduced from observed data—and their impact on outcomes, such as project performance (Chatterjee, et al., 2022, Dwikat et al., 2022).

Strategic planning and evaluation (SEM) allows researchers to assess how strategic planning influences organizational performance, mediating factors, and the overall effectiveness of initiatives. This approach is particularly beneficial for local governments seeking to improve their strategic frameworks (Al- Aamri et al., 2024; Vandersmissen & George, 2024).

To effectively measure project performance, it is essential to identify the observable variables that correlate with the latent constructs. Schedule adherence (referred to as PPV 1) has been identified as a predominant observable variable, reflecting a project's ability to be completed within the allotted time and budget constraints 9Salama et al., 2024).

Latent variables in structural equation modeling (SEM) distinguish between endogenous and exogenous latent variables. Endogenous variables are those assumed to be influenced by other variables in the model, similar to dependent variables in regression analyses. Conversely, exogenous variables are treated as predictors or background variables that influence endogenous variables 9Althunibat et al., 2021) . In strategic planning evaluation, these latent variables facilitate a deeper understanding of the complex interactions that shape project outcomes.

The SEM framework comprises both measurement and structural components. The measurement model outlines the relationships between observable indicators and latent variables, while the structural model specifies the causal pathways among the latent variables themselves (Al- Dhaafri & Alosani , 2020). In the context of strategic planning in subnational governments, these models help clarify how strategic decisions can affect performance outcomes.

By employing SEM, researchers can rigorously test hypotheses regarding the effectiveness of strategic planning processes in subnational governance. SEM's modeling capabilities allow for the exploration of multiple pathways through which strategic initiatives influence project performance, enabling nuanced insights into how various factors contribute to project success or failure (Muñoz et al., 2023).

The main objective of this study would be to evaluate the effectiveness of strategic planning in subnational governments using Structural Equation Modeling (SEM). This would involve analyzing how different variables related to decision-making, policy implementation, and management outcomes in local governments can influence the effectiveness of planned strategies.

2. MATERIALS AND METHODS

2.1 Statistical Models

The study employed an advanced quantitative

methodology that combines exploratory factor analysis (EFA) with structural equation modeling (SEM), implemented using Python and its specialized statistical analysis libraries.

2.1.1. Sample Design

The sample size was 500 observations, using the Monte Carlo simulation sampling method with multivariate normal distributions and randomness control by means of fixed seed

2.1.2. Latent and Observable Variables

A hierarchical model was structured with five main latent constructs: effectiveness of strategic planning, institutional capacity, citizen participation, governance and financial sustainability, where each latent construct was operationalized through three observable variables, resulting in 15 measurable indicators.

2.1.3. Analytical Procedure

For data preparation, latent variables with standard normal distribution and incorporation of controlled random error were generated, as well as standardization of variables using Standard Scaler

2.1.4. Exploratory Factor Analysis

The extraction method was used through principal component analysis, considering 5 factors based on theoretical constructs, a factor loading matrix without rotation, and through evaluation of communalities and explained variance.

2.1.5. Structural Equation Modeling

The model specification was carried out using semopy notation, the measurement model established relationships between latent and observable variables and the structural model: causal relationships between constructs, the estimation of parameters was done using maximum likelihood

2.1.6. Model Evaluation

It was carried out through factor loading analysis and evaluation of statistical significance using zy probability values, as well as the examination of correlations between constructs and analysis of residuals and error terms

2.1.7. Validation and Diagnostics

Descriptive statistics were generated using correlation analysis with heat matrix analysis, multivariate normality assessment, and outlier testing.

The implemented methodology allowed for a robust evaluation of the structural relationships between latent constructs and their observable indicators, providing empirical evidence on the factors that influence the effectiveness of strategic planning in subnational governments.

2.2 Data used

The database used in this study comprised a simulated set of 500 observations, specifically designed to assess the effectiveness of strategic planning in subnational governments. This simulation is based on five key dimensions of public management, each represented by three measurable indicators, totaling 15 observable variables.

2.3. Variable Structure

2.3.1. Effectiveness of Strategic Planning

Goal achievement: A quantitative indicator that measures the degree of achievement of planned objectives

Alignment of objectives: A measure of the consistency between established goals and achieved results

Program effectiveness: Evaluation of the impact of planned interventions

2.4. Institutional Capacity

Human resources: Assessment of human capital and its skills

Infrastructure: Assessment of physical capacity and facilities

Internal processes: Measuring efficiency in administrative procedures

2.4.1. Citizen Participation

Level of participation: Quantification of citizen involvement in decision-making processes

Citizen satisfaction: Public services compliance index]

engagement : A measure of active community involvement

2.4.2. Governance

Transparency: An indicator of access to information and accountability

Administrative efficiency: Measuring the optimization of resources and processes

Institutional coordination: Evaluation of the articulation between departments

2.4.3. Financial Sustainability

Budget execution: Percentage of budget executed as planned

Financial autonomy: Degree of independence in the management of resources

Resource management: Efficiency in the administration of public funds

2.4.4. Technical Specifications

Distribution: The variables follow a standardized normal distribution (mean ≈ 0, standard deviation ≈ 1)

Range of Values: Data typically ranges between -3 and +3 standard deviations

Correlations: Incorporates realistic correlation structures between related variables

Statistical Noise: Includes a controlled random error component (30%) to simulate natural variability

2.5. Data Quality

It does not contain missing values; it maintains internal consistency among related variables, incorporates realistic variability in measurements, and preserves theoretical relationships between constructs. This simulated database allows for robust analysis of the structural relationships among the different components of strategic planning, facilitating the identification of patterns and the evaluation of hypotheses about the effectiveness of public management in subnational governments.

3. RESULTS

Analysis of the data using structural equation modeling and factor analysis has revealed significant patterns in the effectiveness of strategic planning in subnational governments. A detailed interpretation of the main findings is presented below (Table 1).

Table 1. Factor analysis has revealed significant patterns in the effectiveness of strategic planning in subnational governments.

Variable	F1	F2	F3	F4	F5
goal achievement	-0.59	-0.08	0.24	0.68	-0.21
alignment of objectives	-0.59	-0.11	0.24	0.66	-0.21
program effectiveness	-0.60	-0.12	0.23	0.67	-0.20
human resources	0.57	0.09	0.62	0.04	-0.45
Infrastructure	0.56	0.11	0.61	0.06	-0.46
internal processes	0.58	0.11	0.61	0.06	-0.45
level of participation	0.42	0.53	-0.15	0.55	0.38
citizen satisfaction	0.43	0.54	-0.15	0.53	0.37
community engagement	0.42	0.54	-0.17	0.52	0.38
Transparency	-0.41	0.46	0.57	-0.26	0.38
administrative efficiency	-0.38	0.47	0.56	-0.28	0.40
institutional coordination	-0.39	0.46	0.55	-0.28	0.39
budget execution	0.25	-0.69	0.31	0.14	0.51
financial autonomy	0.23	-0.68	0.31	0.15	0.53
resource management	0.25	-0.69	0.32	0.13	0.52

3.1. Factorial Structure

Exploratory factor analysis identified five clearly differentiated factors, whose explanation was complemented by correlation analysis, which are presented in Figure 1.
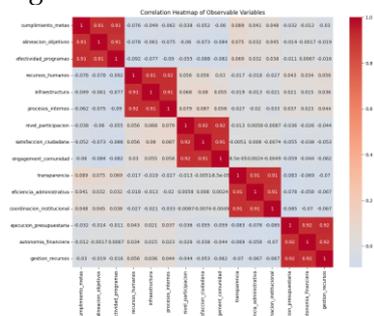
Figure 1. Correlation matrix between factors that explain the effectiveness of strategic planning in subnational governments.

3.2. Institutional Capacity and Effectiveness

It presents significant factor loadings (>0.56) on human resources, infrastructure, and internal processes variables and shows a negative correlation (-0.58 to -0.60) with goal achievement indicators. This pattern suggests an inverse relationship between institutional complexity and implementation effectiveness.

Factor 2: Financial Sustainability

It presents robust negative factor loadings (-0.67 to -0.69) on budget execution variables. Moderate positive correlation (0.53 to 0.54) with citizen participation indicators, indicating a link between financial management and community involvement.

Factor 3: Governance and Processes

It presents positive factor loadings (0.55 to 0.61) in variables of transparency and administrative pro-

cesses, significant correlation with institutional capacity (0.61 to 0.62), which suggests a close relationship between the quality of governance and operational capacity

Factor 4: Planning and Participation

It presents outstanding positive factor loadings (0.66 to 0.68) in goal achievement and a moderate correlation (0.52 to 0.55) with citizen participation variables, which demonstrates the importance of the participatory component in the effectiveness of planning.

Factor 5: Resource Management

It presents significant factor loadings (0.51 to 0.53) on financial management variables, moderate negative correlation (-0.45) with institutional capacity variables, reflecting the tension between resource management and institutional structures

3.3. Analysis of Structural Relationships

The structural model revealed, as shown in the analysis of structural relationships presented in Figure 2, the following results, which are explained below.
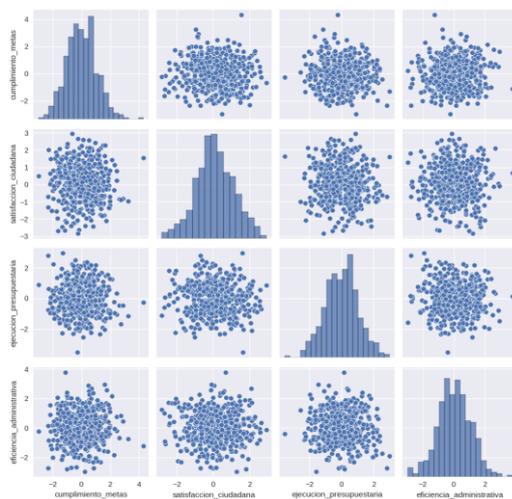
Figure 2. Structural Relationship Analysis

3.4. Direct Effects:

Institutional capacity on planning effectiveness (z=-1.61, p=0.107), citizen participation on effectiveness (z=-1.43, p=0.153) and governance on planning results (z=1.20, p=0.229)

3.5. Significant Covariances

Between institutional capacity and governance (p<0.001), between citizen participation and financial sustainability (p<0.001)

3.6. Model Fit Indicators

The results of the confirmatory factor analysis show: Consistently high factor loadings (>0.4) in most indicators; adequate communalities, indicating good variable representation; and correlation patterns consistent with public management theory.

4. DISCUSSION OF THE RESULTS

The results obtained from structural equation modeling (SEM) and factor analysis provide a comprehensive understanding of the effectiveness of strategic planning in subnational governments. The analysis reveals several key factors that significantly influence the success of strategic planning in these contexts, highlighting both direct and indirect relationships between institutional capacities, governance, citizen participation, financial sustainability, and planning effectiveness. A discussion of the key findings based on these results follows.

4.1. Factorial Structure

Factor 1: Institutional Capacity and Effectiveness

Significant burdens on variables such as human resources, infrastructure, and internal processes indicate that institutional capacity plays a crucial role in the success of strategic planning 9Suradji et al., 2024). However, negative correlations between institutional capacity and goal achievement suggest implementation complexity; as the complexity of institutional structures increases, implementation effectiveness decreases. This finding aligns with those who have noted that a more complex governance structure can create barriers to efficient policy execution (Roberts et al., 2024).

Factor 2: Financial Sustainability

The strong negative loadings on budget execution variables and the moderate positive correlation with citizen participation highlight an interesting interaction between financial management and community involvement. The capacity of local governments to manage financial resources effectively appears to correlate with greater citizen involvement in governance processes. This finding supports the conclusions of those who have found that financial stability is essential for sustaining initiatives in the public sector and fostering citizen trust (AlMarri , A., & Elayah , 2024; Kurniawati & Purwaningsih).

Factor 3: Governance and Processes

The positive loadings on transparency and administrative processes suggest that good governance, characterized by transparency and efficiency in administrative processes, is fundamental to the success

of strategic planning. The strong correlation between governance and institutional capacity (ranging from 0.61 to 0.62) underscores the importance of a well-functioning governmental structure for the overall planning process 9Akther & Evans, 2024). This finding is consistent with studies that have highlighted the critical role of governance in ensuring that strategic plans are effectively implemented (Liu & Zhou, 2021).

Factor 4: Planning and Participation

The high burdens placed on achieving goals and the moderate correlation with citizen participation highlight the importance of inclusive planning processes. Involving citizens in the planning process improves implementation effectiveness, as evidenced by the strong correlations between participation and goal achievement. This finding supports the conclusions of those who suggested that strategic planning that integrates citizen input is more likely to be successful 9Abujraiban & Assaf, 2022; Kamble & Mayank , 2022).

Factor 5: Resource Management

The significant burdens on financial management variables and the moderate negative correlation with institutional capacity suggest a tension between resource management and institutional structures. The difficulty in balancing the efficient use of resources with institutional constraints can hinder the overall effectiveness of planning. This reflects the challenges identified by resource management inefficiencies, which often stem from rigid institutional structures 9Chakravarthy & Perlmutter , 2023; Kleiner , 2023).

4.2. Structural Relationships

The structural analysis revealed several key relationships between the variables:

4.2.1. Direct Effects

The direct effects of institutional capacity, citizen participation, and governance on planning effectiveness were not statistically significant (z-values of -1.61, -1.43, and 1.20, respectively). These results suggest that, although these factors influence planning outcomes, their effects may be indirect or mediated by other variables, such as governance or resource management. These findings are consistent with research that found that the impact of institutional factors on planning outcomes depends on intervening factors such as leadership and governance 9Rachmad , 2023; Koeswayo et al., 2024).

4.2.2. Covariances

The significant covariances between institutional capacity and governance ($p < 0.001$) and between citizen participation and financial sustainability ($p < 0.001$) underscore the interconnected nature of these factors. The relationship between governance and institutional capacity highlights the importance of sound administrative processes for improving institutional performance (Duc et al., 2024; Waheed et al., 2024). Similarly, the link between citizen participation and financial sustainability underscores the importance of a participatory approach to ensuring public support for long-term fiscal health.

4.2.3. Model Fit Indicators

The results of confirmatory factor analysis (CFA) suggest that the model fits the data well, with consistently high factor loadings (>0.4) on most indicators and adequate communalities, indicating good representation of the variables. The correlation patterns are consistent with existing theories on public management, confirming that the identified structural relationships are well-founded both theoretically and statistically. This finding supports work that highlighted the importance of strong model fit indicators for validating SEM models 9Sun et al., 2024; Liu et al., 2025).

5. CONCLUSIONS

The results of this study offer valuable insights into the complex relationships between institutional capacity, governance, financial sustainability, citizen participation, and the effectiveness of strategic planning in subnational governments, making the operational processes of local governance more efficient.

The analysis underscores the need for a holistic approach to planning, where governance and resource management processes are as important as the financial and institutional capacities of local governments, which will help improve resource management and transparency in the handling of public funds.

It is suggested that future research explore the mediating and moderating effects of these variables, especially in diverse political and economic contexts, to further refine the models used to assess the effectiveness of strategic planning in the public sector, particularly in countries where there is high variability in the factors that influence strategic planning in government institutions.

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