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UNLOCKING SUSTAINABLE SUCCESS IN INNOVATIVE SMES: LEVERAGING A BUSINESS INTELLIGENCE MODEL WITH CONFIRMATORY FACTOR ANALYSIS

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Abstract
This study's purpose is to examine how business intelligence (BI) can enhance sustainability in innovative small and medium-sized enterprises (SMEs). Business intelligence contributes to achieving sustainability by analyzing data and providing strategic insights.
The study seeks to identify an appropriate BI measurement model and analyze its impact on sustainability, particularly since there is no standard model for measuring the impact of business intelligence on sustainability in innovative SMEs in Algeria. The study aims to fill this gap by developing a suitable measurement model.
We used the First-Order Confirmatory Factor Analysis (CFA) using both Covariance-Based Structural Equation Modelling (CB-SEM) and Partial Least Squares Structural Equation Modelling (PLS-SEM) with Smart PLS software. We collected Data from a random sample of 350 innovative SMEs in Algeria.
The results showed that the appropriate BI measurement model relies on two key dimensions: strategic planning and data mining. The study found a positive relationship and a moderate effect of 51.9% between business intelligence and sustainability in SMEs.
The study recommends that SMEs adopt business intelligence to enhance their sustainability. This can help improve governance, compliance with laws, and innovation, leading to comprehensive sustainability. It is expected that this will have a positive impact on enhancing competitiveness and resilience in the market for innovative SMEs.
Keywords: Business Intelligence, Sustainability, BI Measurement Model, Strategic Planning, Data Mining, Innovative SMEs.

1. INTRODUCTION

The emergence of sustainability has facilitated the achievement of traditional economic development while ensuring equity and environmental protection. It represents a philosophy, approach, or practice that efficiently utilizes today's resources to guarantee their availability and sufficiency for current and future needs, aiming to achieve desirable social, economic, and environmental outcomes (Ozili P. K., 2022, p. 3). Sustainability in institutions is supported by integrating three key areas: economy, society, and environment. This model emphasizes the importance of balancing social justice, environmental sustainability, and financial success. For instance, reducing environmental footprints through actions like lowering emissions and using renewable energy sources is essential. Additionally, eliminating waste and implementing sustainable resource management are

primary goals of environmental sustainability. Efficient resource use and waste reduction can also lower material costs and disposal fees (Singh, 2024, p. 9).

The importance of sustainability in institutions lies in cost reduction through investments in environmental sustainability. Such investments can lead to significant cost savings by reducing resource and energy consumption (Choudhuri, 2019, p. 2). Adhering to environmental standards protects institutions from fines and legal penalties while strengthening relationships with regulatory bodies (Oral, 2020, p. 3). Sustainability practices improve operational efficiency and reduce costs by employing energy-saving technologies, minimizing waste, and streamlining supply chains. For example, implementing energy management systems and utilizing renewable energy sources can lower utility expenses (Singh, 2024, p. 9).

To achieve sustainability, institutions must adopt intelligent management systems that enable them to excel and outperform competitors through business intelligence. This approach transforms raw data into actionable knowledge, allowing organizations to make strategic data-driven decisions (Upadhyay, 2018, p. 621). Institutions store activity data using software programs that provide specific information about each process for appropriate application through business intelligence (Necochea-Chamorro & Luigui Larrea, 2023, p. 1). Business intelligence encompasses extensive IT systems that utilize data reports and analytics to support decision-making at all organizational levels (Ramirez-Aristzabal & Oliveira Moraes, 2023, p. 2). It plays a pivotal role in institutions by accomplishing various tasks and is considered one of the most critical technological investments for gaining a competitive advantage (Dorti & Akdemir, 2021, p. 1).

Business intelligence analyzes historical data collected from business operations to provide comprehensive metrics and indicators for setting performance benchmarks and trends. It helps assess the current business situation to implement improvements effectively. Business intelligence solutions enable the creation of customized reports and dashboards with key performance indicators for informed decision-making (Macias & Borges, 2024, p. 3). Combining insights with data visualization represents best practices for helping institutions make better decisions (Bhosale et al., 2021, p. 80).

This study aims to enhance our understanding of the importance of business intelligence in innovative small and medium-sized enterprises, both scientifically and practically. Scientifically, it seeks to identify an optimal business intelligence measurement model, explore its impact on achieving sustainability, and verify its constituent dimensions, such as strategic planning, data mining, decision-making, and organizational culture. Practically, the study aims to assist innovative small and medium-sized enterprises in improving their performance, making informed decisions, and enhancing their competitive advantage by effectively applying business intelligence.

The primary research question is: What is the impact of business intelligence on achieving sustainability in innovative SMEs, and how can an appropriate business intelligence measurement model be developed to enhance this impact?

To address this question, the study explores the following sub-questions:

- What are the key dimensions of business intelligence that contribute to sustainability in innovative SMEs?
- How does business intelligence influence governance, commitment, and innovation in innovative SMEs?
- What is the most effective measurement model for assessing the impact of business intelligence on sustainability in innovative SMEs?

These questions are crucial for understanding how business intelligence can be leveraged to enhance sustainability in SMEs.

2. LITERATURE REVIEW

Business intelligence (BI) is a broad concept designed to support and improve decision-making processes, which can lead to increased organizational efficiency. However, implementing a BI system alone does not guarantee satisfactory outcomes (Tunowski, 2015, p. 2). BI also encompasses a set of methods aimed at improving business decision-making by utilizing reality-based support systems. It facilitates the analysis of data extracted from internal or external sources and presents it in the form of actionable information (Effy, 2009, p. 215). This data is collected, stored, and analyzed using analytical tools to provide complex internal and competitive insights for decision-makers (Dadkhah & Lagzian, 2018, p. 10).

BI is characterized as a framework through which organizations gather, transform, and present information. It reduces the time required to access critical business data and enhances efficiency in administrative decision-making processes. This allows for dynamic data presentation, retrieval, examination, and clarification of requirements (Heang & Mohan, 2017, p. 2). BI simplifies access to information, facilitates its discovery and transformation, and develops a deeper understanding of it, leading to improved decision-making processes (Kimball et al., 2009, p. 20). BI tools provide businesses with insights that enable real-time decisions, enhance operational efficiency, identify new opportunities, and differentiate themselves in competitive markets. BI functions as an ecosystem comprising databases, architectures, business applications, and methodologies that assist managers in making timely decisions based on available data analysis (Tripathi et al., 2020, p. 2).

The key components of BI include:

- Strategic Planning: This involves defining primary objectives, strategies, and policies governing resource allocation to achieve organizational goals (Gandrita, 2023, p. 2). Strategic planning supports current decision-

making while preparing for future events and activities expected to occur due to changes in systems or environments (Valjevae et al., 2018, p. 5).

- Data Mining: A process aimed at discovering previously unknown patterns, relationships, or useful information from large and complex datasets using computational and statistical methods (Kolling et al., 2021, p. 2). Computational techniques identify trends, forecasts, and behavioral patterns that might remain hidden in traditional analyses (Bertoni & Larsson, 2017, p. 307).
- Decision-Making: A rational analytical process involving the selection of an alternative from several possible options to solve a problem or achieve a specific goal (Santoso et al., 2022, p. 3). This process includes steps such as problem identification, gathering relevant data and information, evaluating alternatives based on defined criteria and objectives, selecting the optimal alternative, and implementing it (Pacheco-Velázquez et al., 2023, p. 3).
- Organizational Culture: Defined as a set of shared assumptions, norms, values, behaviors, and beliefs among members of an organization that are passed on to newcomers (Tadesse Bogale & Lemi Debela, 2024, p. 2). This culture promotes knowledge sharing, risk-taking, and openness to new ideas—creating an environment where employees feel empowered to contribute their unique perspectives and participate in problem-solving (Alateeg & Alhammadi, 2024, p. 3).

Sustainability is the ability to make responsible decisions regarding the use and allocation of resources in economic and non-economic activities to achieve specific goals and social, economic, and environmental outcomes (Ozili P., *Sustainability and Sustainable Development Research around the World*, 2022, p. 5). It also focuses on meeting current needs without compromising the ability of future generations to meet their own needs (Ogryzek, 2023, p. 7). Sustainability is not only an ethical responsibility but also a necessary business strategy that fosters resilience, innovation, and competitiveness in the contemporary global market. Investing in sustainability can enable organizations to achieve lasting success and leave a positive legacy for future generations (Yifan et al., 2025).

Sustainability involves integrating political, economic, and social processes while maintaining a natural balance between economic development, environmental sustainability, social well-being, and the continuity of essential natural processes to ensure society's basic needs are met (Ingaldi, 2015, p. 30). This paradigm shift highlights the importance of addressing present needs without jeopardizing those of future generations (Zhivkova, 2022, p. 76). Sustainability encompasses three main dimensions: environmental, economic, and social. It aims to promote balance among these aspects to achieve integrated and continuous progress (Mensah, 2019, p. 5). The environmental dimension is fundamental to sustainability and focuses on protecting ecosystems and natural resources while reducing the environmental impact of human activities. Practices such as waste reduction, renewable resource utilization, pollution prevention, careful resource management, biodiversity conservation, ecosystem balance maintenance, recycling, and mitigating environmental consequences are essential. This dimension addresses issues like resource overuse, biodiversity loss, environmental degradation due to pollution or ozone depletion, and CO_2 accumulation (Bahedh & AL-TAMIMI, 2024, p. 3).

The economic dimension involves efficient resource utilization and investments in technologies and processes that promote economic growth. However, this growth often correlates with increased energy consumption and may occur at the expense of natural resources or ecosystem services. The goal is to ensure maximum well-being for both current and future generations while maintaining fairness and effectiveness in resource distribution (Kyllikki Jeronen, 2023, p. 1; Ozili P., 2022, p. 4).

The social dimension emphasizes enhancing well-being and social justice by working toward equality, supporting local communities, and improving living and working conditions (BAUM, 2021, p. 10). It includes implementing excellent measures that help organizations meet stakeholder accountability requirements while ensuring transparency and gaining a competitive advantage (Elsheikh et al., 2024, p. 3).

To achieve sustainability in economic institutions, it is essential to define the fundamental requirements that include governance, commitment, and innovation. Governance refers to the implementation of transparent and ethical management practices, while commitment involves adherence to laws and regulations, and innovation means developing new solutions to improve performance. These requirements can be integrated into the economic, social, and environmental dimensions through comprehensive strategies (Yixi, 2024, p. 1).

In the economic dimension, governance can be enhanced by effectively managing financial resources, committing to economic laws, and innovating through the application of new technologies to improve production. In the social dimension, governance can be strengthened by improving working conditions, adhering to social standards, and innovating through professional development programs. In the environmental dimension, eco-friendly practices can be applied, environmental regulations can be adhered to, and innovation can occur in clean energy technologies. By doing so, institutions can achieve balance among these three dimensions and enhance their long-term sustainability (Praveen Kumar & et al, 2024, p. 1).

Business intelligence can significantly impact the fulfillment of sustainability requirements in innovative small and medium-sized enterprises, particularly regarding governance, commitment, and innovation. Business intelligence relies on collecting and analyzing data from various sources, which helps in making informed decisions based on facts rather than personal intuition. In terms of governance, business intelligence can enhance

transparency and integrity by providing a clear view of internal performance and analyzing financial and operational data (Antwi-Adjei & et al, 2020, p. 80).
Regarding commitment, business intelligence can assist in monitoring compliance with laws and regulations by analyzing data and identifying potential risks. In the realm of innovation, business intelligence can provide companies with opportunities to improve processes and develop new products and services by analyzing consumer behavior and market trends. By integrating these elements, small and medium-sized enterprises can enhance their sustainability and improve their overall performance (Motalebi & et al, 2025, p. 2).

3. RESEARCH METHODOLOGY

To achieve the study's results and determine the best business intelligence measurement model and examine its impact on sustainability, innovative small and medium-sized enterprises were studied as case studies. This involved testing first-order confirmatory factor analysis and structural equation modeling using the Smart PLS 4 program through the CB-SEM and PLS-SEM methodologies.

3.1. Analysis Techniques

The study population consisted of all SMEs in Algeria, totaling approximately 1,300,000 enterprises (ALGERIA PRESS SERVICE, 2024). A simple random sample of 390 enterprises was selected using the Thompson sampling formula, ensuring that the sample was statistically significant. Out of these, 350 responses were collected and analyzed, achieving a response rate of 89.74%.
The simple random sample of 390 enterprises was selected using the Thompson sampling formula (Thompson, 2012, p. 51), as follows:

$$n = \frac{N \times p(1-p)}{\left[[N-1 \times (d^2 \div z^2)] + p(1-p)\right]}$$

N: population size,
z: standard score corresponding to the significance level of 0.95, which equaled 1.96,
d: margin of error, which equaled 0.05,
p: proportion of the characteristic's presence and neutrality = 0.50.

$$n = \frac{1{,}300{,}000 \times 0.05(1-0.05)}{\left[[1{,}300{,}000-1 \times (0.50^2 \div 1.96^2)] + 0.05(1-0.05)\right]} \approx 390$$

Out of these, 350 questionnaires were returned and deemed analyzable, resulting in a response rate of 89.74%.

3.2. Research Measurements

To test the relationships between the study variables and build a valid model, a self-developed questionnaire; Steps were followed in developing the questionnaire by conducting reviews by experts in the field to ensure that the questions cover all relevant aspects of the topic. These reviews helped us make adjustments to the questionnaire items.
We relied on an electronic survey prepared using Google Forms, which was distributed to a simple random sample of Algerian SMEs. The survey targeted SMEs that innovation among their objectives.
We conducted a pilot test of the questionnaire by distributing it to a small exploratory sample of SMEs. This pilot test helped us improve the quality of the questions and participants' understanding of them, and the results were used to modify the questions and enhance their clarity.
Using Likert scales and depending on the previous studies was designed, comprising 24 questions divided into two axes. The first axis focused on business intelligence, covering questions 1 through 13. The second axis dealt with sustainability, covering questions 14 through 24.

Table 1. Descriptive statistics for the variables.

Construct	Item code	Means	Standard Deviation	R	P-value	Statement
Strategic planning	r1	3.39	0.256	0.344	0.000	Your organization defines strategic goals it aims to achieve.
	r2	3.45	1.126	0.563	0.000	Your organization establishes specific indicators to measure these goals.
	r3	3.16	1.012	0.334	0.000	Your organization creates a comprehensive dashboard that visually displays key indicators and their performance.
	Tot 1	**3.32**	**0.142**	**0.330**	**0.000**	**Strategic planning**
Data mining	tech 1	3.15	0.225	0.324	0.000	Your organization identifies the primary sources it relies on for data collection.

	tech 2	3.34	0.118	0.234	0.000	Your organization strives to ensure that data is accurate and complete.
	tech 3	3.41	0.167	0.554	0.000	Your organization uses statistical methods to analyze data and extract patterns and trends.
	tech 4	3.20	0.150	0.310	0.000	Your organization builds an appropriate infrastructure for storing data and retrieving it on demand.
	Tot 2	**3.29**	**0.068**	**0.222**	**0.000**	**Data mining**
Decision making	ha 1	3.49	1.265	0.355	0.000	Your organization uses the results obtained from data analysis to support decision-making processes.
	ha 2	3.16	0.136	0.445	0.000	Your organization identifies opportunities to improve operations and increase efficiency.
	ha3	3.45	0.321	0.336	0.000	Your organization employs supportive systems for decision-making, such as Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), and Supply Chain Management.
	Tot 3	**3.35**	**1.146**	**0.322**	**0.000**	**Decision making**
Organizational culture	**S1**	3.43	1.364	0.445	0.000	Your organization provides training and awareness programs for employees about business intelligence.
	S2	3.35	1.223	0.365	0.000	Your organization secures support from senior leadership to implement business intelligence strategies.
	S3	3.28	1.098	0.226	0.000	Your organization encourages collaboration between various departments through information and expertise sharing.
	Tot4	**3.40**	**1.116**	**0.345**	**0.000**	**Organizational culture**
Commitment	i1	3.46	0.145	0.314	0.000	Your organization is committed to improving efficiency to achieve sustainable economic growth.
	i2	2.84	0.023	0.219	0.000	Your organization strives to reduce carbon emissions, minimize natural resource consumption, and manage waste responsibly.
	i3	3.14	0.256	0.366	0.000	Your organization respects human rights and works to improve working conditions.
	i4	3.30	1.013	.0353	0.000	Your organization develops an action plan outlining the objectives and measures required to achieve sustainability.
	Tot5	**3.19**	**0.158**	**0.445**	**0.000**	**Commitment**
Innovation	in1	3.35	1.194	0.255	0.000	Your organization promotes a culture of innovation and continuous learning among employees.

	in2	3.48	0.168	0.297	0.000	Your organization continuously seeks innovative solutions for environmental and social challenges.
	in3	3.36	0.249	0.343	0.000	Your organization adopts innovative technologies for cleaner production and recycling.
	Tot6	**3.20**	**0.064**	**0.298**	**0.000**	**Innovation**
Governance	h1	3.50	1.460	0.445	0.000	Your organization builds partnerships with suppliers and customers to enhance sustainability.
	h2	3.40	1.026	0.324	0.000	Your organization raises awareness about the importance of sustainability among all stakeholders.
	h3	3.32	1.216	0.289	0.000	Your organization publishes sustainability reports that detail its environmental and social performance.
	h4	3.24	1.198	0.330	0.000	Your organization takes responsibility for the environmental and social impacts of its activities.
	Tot7	**3.40**	**1.360**	**0.445**	**0.000**	**Governance**

Source: Prepared by researchers using Smart PLS 4.

Through the table, we observe that the arithmetic mean for each element of business intelligence and sustainability achieved a moderate to high score, exceeding 2.60 and ranging between 2.84 and 3.50 at a significance level less than 0.05. Therefore, we can say that innovative small and medium-sized enterprises possess a moderate to high level of business intelligence and sustainability. Additionally, we notice a positive and statistically significant relationship at a significance level less than 0.05 among all elements of the study variables.

3.3 Testing Confirmatory Factor Analysis for Business Intelligence Dimensions in Innovative SMEs:

Business intelligence in SMEs consists of four elements: strategic planning, data mining, decision-making, and organizational culture. To validate this model, we employed confirmatory factor analysis to confirm its structure. We tested various configurations, including two elements of business intelligence, three elements, and all four combined, as follows:

3.3.1 Testing Confirmatory Factor Analysis for Two Dimensions of Business Intelligence:

Below is a presentation of the unrestricted model related to two dimensions of business intelligence in innovative SMEs. This can be illustrated through the following table.

Table 2.Fit Indices for the Two Dimensions of Business Intelligence

Measurement Model	**X2/ df**	**NFI**	**CFI**	**TLI**	**RMSEA**	**GFI**	**SRMR**	**Chi-square, X2**	**P value**
Terminology	**Chi-Square Value**	**Standardized Fit Index**	**Comparative Fit Index**	**Tucker-Lewis Index**	**Root Mean Square Error of Approximation (RMSEA)**	**Goodness of Fit Index (GFI)**	**Square Root of Mean Square Error (RMSE)**	**Chi-Square**	**Significance Level**
Acceptance Criterion	**From 1 to 5**	**NFI≥ 0,9**	**CFI≥ 0,9**	**TLI≥ 0,9**	**RMSEA≤0,08**	**GFI≥0.9**	**SRMR ≤0.08**	**The lower, the better**	**P≤0.05**

Strategic planing and data mining	1.505	0.995	0.998	0.989	0.039	0.998	0.013	1.505	0.000
Strategic planing and decision making	3.412	0.971	0.979	0.947	0.071	0.985	0.033	13.648	0.000
Strategic planing and organizational culture	3.132	0.949	0.964	0.932	0.079	0.976	0.048	25.057	0.000
Data mining and decision making	1.223	0.991	0.998	0.996	0.026	0.994	0.015	4.894	0.000
Data mining and organizational culture	2.991	0.961	0.973	0.950	0.077	0.976	0.034	23.926	0.000
Decision making and organizational culture	3.476	0.981	0.986	0.918	0.085	0.995	0.020	3.476	0.000

Source: Prepared by researchers using Smart PLS 4.

From the table above, it is clear that business intelligence is represented by two dimensions: strategic planning and data mining, strategic planning and decision-making, strategic planning and organizational culture, data mining and decision-making, data mining and organizational culture, decision-making and organizational culture. After subjecting the model to confirmatory factor analysis, it became evident that there was no acceptable fit for the proposed model to measure business intelligence (lack of fit quality) for the following combinations: strategic planning and decision-making, strategic planning and organizational culture, data mining and decision-making, data mining and organizational culture, decision-making and organizational culture. Most indicators did not meet the criteria. The appropriate model for measuring business intelligence was for the two dimensions (strategic planning and data mining), where all indicators were fulfilled.

Here, the goodness-of-fit index (GFI) was 0.998, the standardized root mean square residual (SRMR) was 0.013, the comparative fit index (CFI) was 0.998, and the root mean square error of approximation (RMSEA) was 0.039. The Tucker-Lewis index (TLI) was 0.989, the chi-square (X^2) was 1.505, and the chi-square/degrees of freedom (Chisqr/df) was 1.505. This indicates that all indicators achieved a good fit for the adjusted measurement model of business intelligence at a significance level of 0.000.

This can be further illustrated through the following figure.

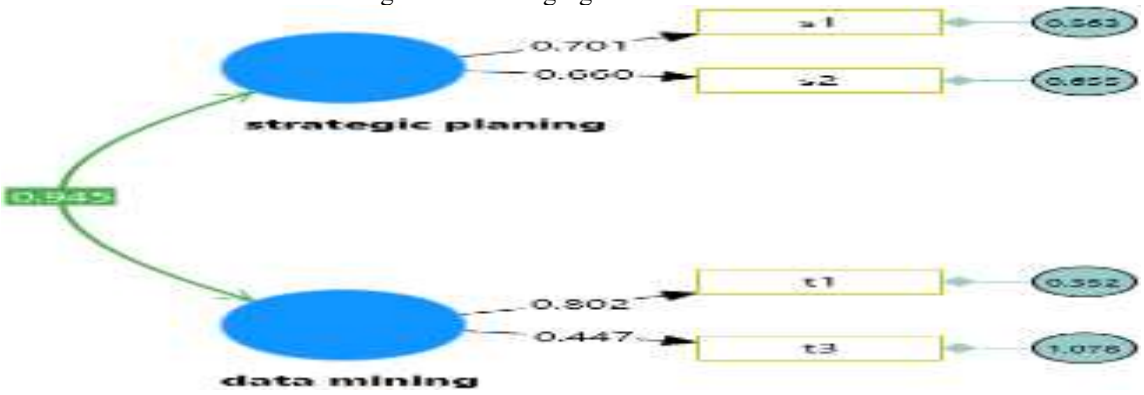

Figure 1. Diagram of the Confirmatory Factor Model for Technological Intelligence

Source: Prepared by researchers using Smart PLS 4.

From the figure, it is evident that all correlation coefficients (factor loadings) between the items and the latent variables were high. The relationship between the two dimensions (strategic planning and data mining) was high, with a value of 0.945.

3.3.2 Testing Confirmatory Factor Analysis for Three Dimensions of Business Intelligence:

Below is a presentation of the unrestricted model related to three dimensions of business intelligence in innovative small and medium-sized enterprises (SMEs). This can be illustrated through the following table.

Table 3. Fit Indices for the Three Dimensions of Business Intelligence

Measurement Model	X2/ df	NFI	CFI	TLI	RMSEA	GFI	SRMR	Chi-square, X2	P value
Terminology	**Chi-Square Value**	**Standardized Fit Index**	**Comparative Fit Index**	**Tucker-Lewis Index**	**Root Mean Square Error of Approximation (RMSEA)**	**Goodness of Fit Index (GFI)**	**Square Root of Mean Square Error (RMSE)**	**Chi-Square**	Significance Level
Acceptance Criterion	**From 1 to 5**	**NFI≥ 0,9**	**CFI≥ 0,9**	**TLI≥ 0,9**	**RMSEA≤0,08**	**GFI≥0.9**	**SRMR ≤0.08**	**The lower, the better**	P≤0.05
Strategic planing and data mining and decision making	2.920	0.933	0.955	0.932	0.075	0.952	0.044	70.076	**0.000**
Strategic planing and data mining and organizational culture	**2.751**	**0.935**	**0.957**	**0.935**	**0.072**	**0.957**	**0.045**	**66.012**	0.000
Data mining and decision making and organizational culture	3.090	0.930	0.951	0.919	0.078	0.962	0.042	52.528	**0000**
Strategic planing and decision making and organizational culture	3.123	0.905	0.911	0.901	0.078	0.909	0.043	80.230	**0.000**

Source: Prepared by researchers using Smart PLS 4.

From the table above, it is clear that business intelligence is represented by three dimensions: strategic planning, data mining, and decision-making; strategic planning, decision-making, and organizational culture; data

mining, decision-making, and organizational culture. After subjecting the model to confirmatory factor analysis, it became evident that there was no acceptable fit for the proposed model to measure business intelligence (lack of fit quality) for the following combinations: strategic planning, data mining, and decision-making; data mining, decision-making, and organizational culture. Most indicators did not meet the criteria. The appropriate model for measuring business intelligence was for the three dimensions (strategic planning, data mining, and organizational culture), where all indicators were fulfilled.

Here, the goodness-of-fit index (GFI) was 0.957, the standardized root mean square residual (SRMR) was 0.045, the comparative fit index (CFI) was 0.957, and the root mean square error of approximation (RMSEA) was 0.072. The Tucker-Lewis index (TLI) was 0.935, the chi-square (X^2) was 66.012, and the chi-square/degrees of freedom (Chisqr/df) was 2.751. This indicates that all indicators achieved a good fit for the adjusted measurement model of business intelligence at a significance level of 0.000.

This can be further illustrated through the following figure.

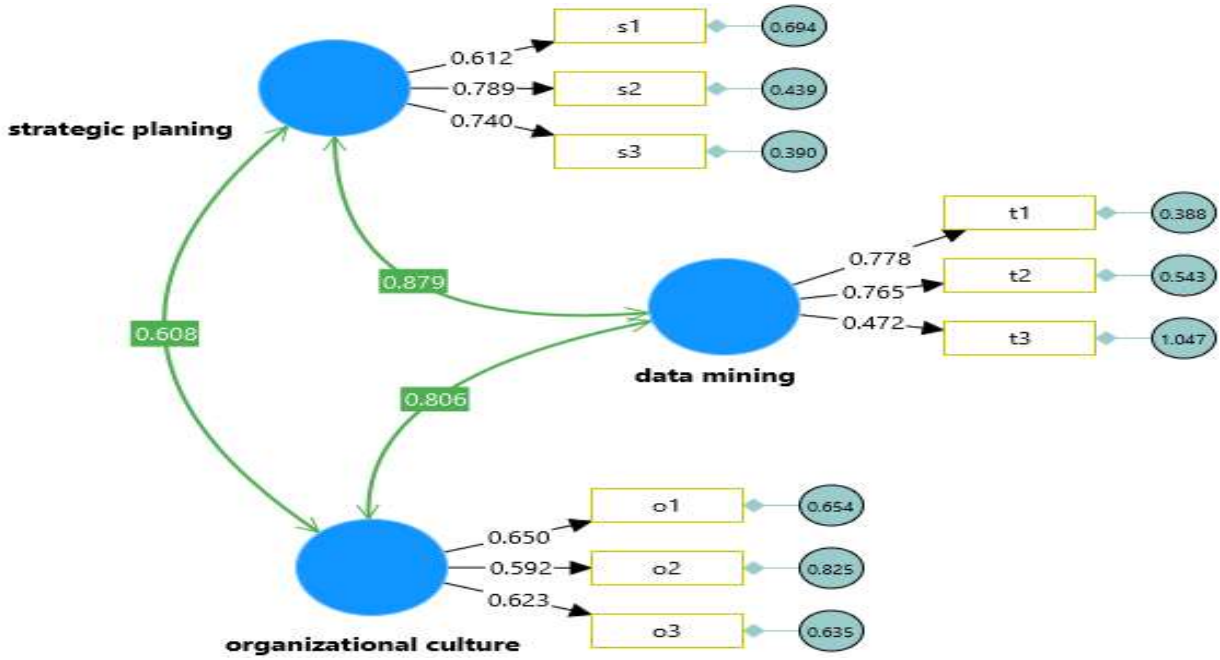

Figure 2. Diagram of the Confirmatory Factor Model for the Three Dimensions of Business Intelligence
Source: Prepared by researchers using Smart PLS 4.

From the figure, it is evident that all correlation coefficients (factor loadings) between the items and the latent variables were high. The relationship between the dimensions (strategic planning and data mining) was high, with a value of 0.879. The relationship between data mining and organizational culture was also high, with a value of 0.806. Meanwhile, the relationship between strategic planning and organizational culture was moderate, with a value of 0.608.

3.3.3Testing Confirmatory Factor Analysis for Business Intelligence Dimensions:

Below is a presentation of the unrestricted model related to the dimensions of business intelligence in innovative small and medium-sized enterprises (SMEs). This can be illustrated through the following table.

Table 4. Fit Indices for the Four Dimensions of Business Intelligence

Measurement Model	X2/ df	NFI	CFI	TLI	RMSEA	GFI	SRMR	Chi-square, X2	P value
Acceptance Criterion	**From 1 to 5**	**NFI≥ 0,9**	**CFI≥ 0,9**	**TLI≥ 0,9**	**RMSEA≤0 ,08**	**GFI≥0 .9**	**SRMR ≤0.08**	**The lower, the better**	P≤0.05
Strategic planing, data mining, decision making,	**2.830**	**0.932**	**0.954**	**0.929**	**0.073**	**0.953**	**0.044**	**82.056**	0.000

organizational culture									
Decision	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	Achieved

Source: Prepared by researchers using Smart PLS 4.

From the table above, it is clear that business intelligence is represented by four dimensions: strategic planning, data mining, decision-making, and organizational culture. After subjecting the model to confirmatory factor analysis, it became evident that there was an acceptable fit for the proposed model to measure business intelligence, specifically for the dimensions of strategic planning, data mining, decision-making, and organizational culture, where all indicators met the criteria.

This can be further illustrated through the following figure.

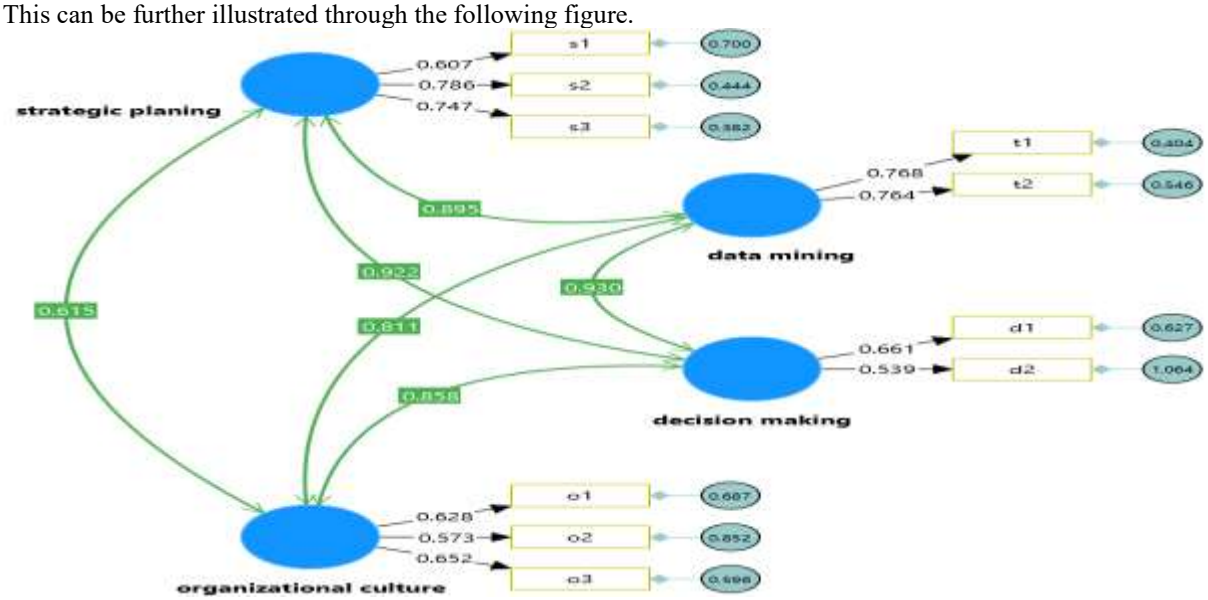

Figure3 . Schematic Diagram of the Confirmatory Factor Model for the Four Dimensions of Business Intelligence

Source: Prepared by researchers using Smart PLS 4.

From the figure, it is evident that all correlation coefficients (factor loadings) between the items and the latent variables were high. The relationship between strategic planning and data mining was 0.895, indicating a strong relationship. The relationship between data mining and decision-making was 0.930, also strong. The relationship between decision-making and organizational culture was 0.858, showing a strong connection. The relationship between strategic planning and decision-making was 0.922, which is strong. The relationship between strategic planning and organizational culture was 0.615, indicating a moderate connection. Lastly, the relationship between data mining and organizational culture was 0.811, which is strong.

3.3.4Testing Confirmatory Factor Analysis for the Best Business Intelligence Model Achieved by Innovative SMEs:

Below is a presentation of the unrestricted model related to the best business intelligence model achieved by Innovative SMEs. This can be illustrated through the following table.

Table5. Fit indices for the Business intelligence model before and after adjustment.

Measurement Model	X2/ df	NFI	CFI	TLI	RMSEA	GFI	SRMR	Chi-square, X2	P value
Acceptance Criterion	**From 1 to 5**	**NFI≥ 0,9**	**CFI≥ 0,9**	**TLI≥ 0,9**	**RMSEA≤0 ,08**	**GFI≥0. 9**	**SRMR ≤0.08**	**The lower, the better**	P≤0.05
Strategic planing and data mining	**1.505**	**0.995**	**0.998**	**0.989**	**0.039**	**0.998**	**0.013**	**1.505**	**0.000**
Strategic planing and data mining and	2.751	0.935	0.957	0.935	0.072	0.957	0.045	66.012	**0.000**

organizational culture									
Strategic planing, data mining, decision making, organizational culture	2.830	0.932	0.954	0.929	0.073	0.953	0.044	82.056	**0.000**
Decision	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	**achieved**	achieved

Source: Prepared by researchers using Smart PLS 4.

It is evident from the table above that all the values of the business intelligence model indicators are fulfilled and good. However, the binary model related to strategic planning and data mining represents the best model that achieved a good fit compared to the three-dimensional and four-dimensional measurement models for business intelligence.

3.4 **Measuring the Impact of Business Intelligence on Sustainability**

The significance of the pathways is confirmed using the Bootstrapping technique by generating 500 subsamples. The results are visually presented in the following figure:

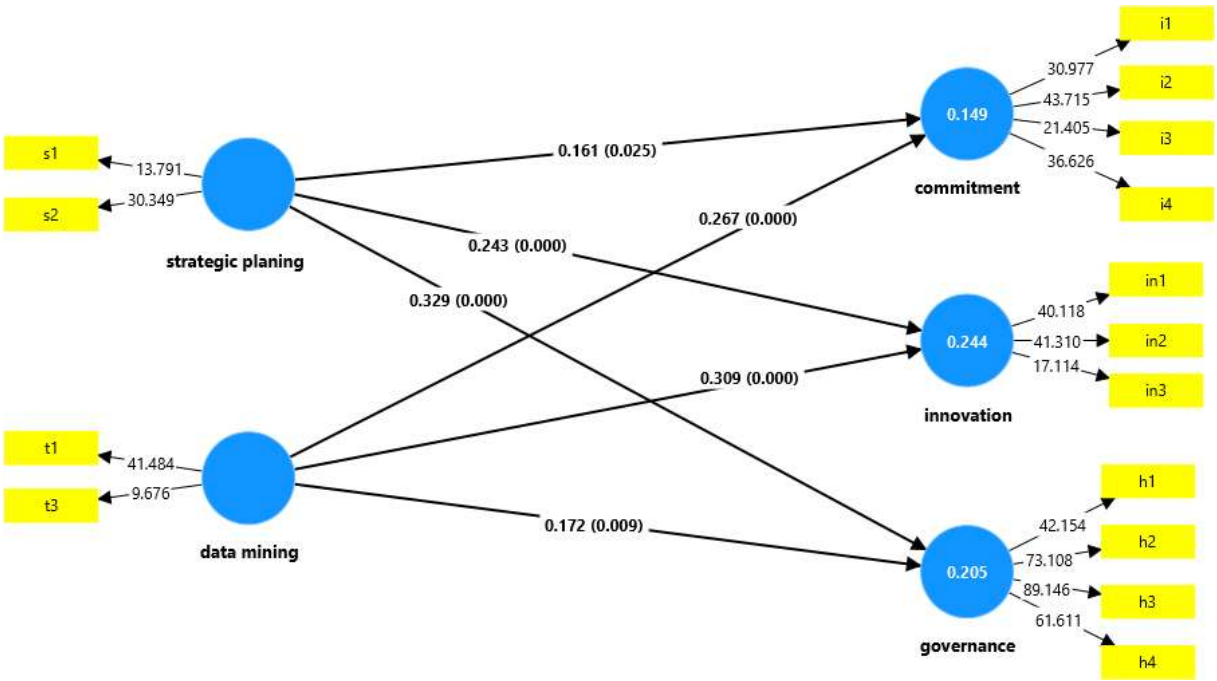

Figure 4. The Structural Model of the Relationship between Strategic Planning, Data Mining, and Sustainability Requirements

Source: Prepared by researchers using Smart PLS 4.

From the figure, it is evident that all correlation coefficients between the items and the latent variables were weak. The relationship between the requirements (strategic planning and commitment) was weak, accounting for 16.1%. The relationship between strategic planning and innovation was also weak, accounting for 24.3%. Meanwhile, the relationship between strategic planning and governance was weak, accounting for 32.1%. We also observe that the relationship between data mining and commitment was weak, accounting for 26.7%. The relationship between data mining and innovation was weak, accounting for 30.9%, while the relationship between data mining and governance was also weak, accounting for 17.2%.

Through estimating the relationships related to the structural model, which represent the hypothesized relationships between constructs, the statistical significance of all relationships was tested using T-values, P-values less than 0.05, and path coefficients. The results of the study for testing the significance of the coefficients are detailed below. (Hair, 2016, p. 206)

Table 6. Structural model coefficient

	Pls-SEM

Structural model analysis	Path coefficient	T values	P values
Strategic planning -> Commitment	0,161	2,237	0,025
Strategic planning -> innovation	0,243	3.711	0,000
Strategic planning -> Governance	0.329	4.949	0.000
Data mining -> Commitment	0.267	3.938	0.000
Data mining -> innovation	0.309	4.610	0.000
Data mining -> Governance	0.172	2.631	0.009

Source: Prepared by researchers using Smart PLS 4.

From the table above, we observe that the relationship between the strategic planning dimension and commitment in innovative small and medium-sized enterprises (SMEs) is statistically significant at a significance level of 0.05, with a p-value of 0.025. The calculated T-value was 2.237, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of strategic planning on commitment was positive, at 0.161, indicating a weak positive effect. Therefore, the impact of strategic planning on commitment in innovative SMEs is weakly positive.
Similarly, the relationship between strategic planning and innovation in innovative SMEs is statistically significant at a significance level of 0.05, with a p-value of 0.000. The calculated T-value was 3.711, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of strategic planning on innovation was positive, at 0.243, indicating a weak positive effect. Therefore, the impact of strategic planning on innovation in innovative SMEs is weakly positive.
We also note from the table that the relationship between strategic planning and governance in innovative SMEs is statistically significant at a significance level of 0.05, with a p-value of 0.000. The calculated T-value was 9.949, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of strategic planning on governance was positive, at 0.329, indicating a weak positive effect. Therefore, the impact of strategic planning on governance in innovative SMEs is weakly positive.
Furthermore, we observe from the table that the relationship between the data mining dimension and commitment in innovative SMEs is statistically significant at a significance level of 0.05, with a p-value of 0.000. The calculated T-value was 3.938, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of data mining on commitment was positive, at 0.267, indicating a weak positive effect. Therefore, the impact of data mining on commitment in innovative SMEs is weakly positive.
We also note from the table that the relationship between data mining and innovation in innovative SMEs is statistically significant at a significance level of 0.05, with a p-value of 0.000. The calculated T-value was 4.610, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of data mining on innovation was positive, at 0.309, indicating a weak positive effect. Therefore, the impact of data mining on innovation in innovative SMEs is weakly positive.
Additionally, the relationship between data mining and governance in innovative SMEs is statistically significant at a significance level of 0.05, with a p-value of 0.009. The calculated T-value was 2.631, which is greater than the tabular T-value of 1.948. The path coefficient (β) for the effect of data mining on governance was positive, at 0.172, indicating a weak positive effect. Therefore, the impact of data mining on governance in innovative SMEs is weakly positive.

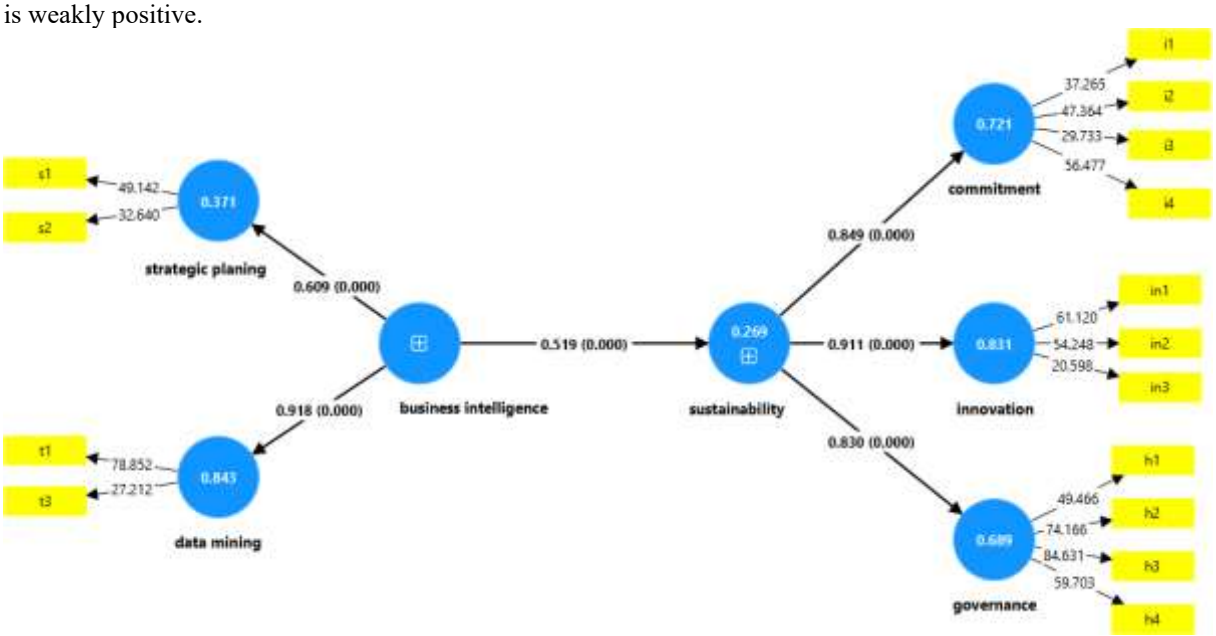

Figure5. The Structural Model of the Relationship Between Business Intelligence and Sustainability
Source: Prepared by researchers using Smart PLS 4.

The previous figure shows that all correlation coefficients between the items and the latent variables were weak but statistically significant. The relationship between business intelligence and sustainability was moderate, accounting for 51.9%. The results of the study for testing the significance of the coefficients are detailed below.

Table 7. Structural model coefficient

	Pls-SEM		
Structural model analysis	**Path coefficient**	**T values**	**P values**
Business intelligence -> Sustainability	0,519	10.285	0,000

Source: Prepared by researchers using Smart PLS 4.

From the table, we observe that the relationship between business intelligence and sustainability in innovative small and medium-sized enterprises (SMEs) is statistically significant at a significance level of 0.05, with a p-value of 0.000. The calculated T-value was 10.285, which is greater than the tabular T-value. However, it seems there might be a typographical error in the comparison of T-values. The path coefficient (β) for the effect of business intelligence on sustainability was positive, at 0.519, indicating a moderate positive effect. Therefore, the impact of business intelligence on sustainability in innovative SMEs is moderately positive.

4. RESULTS

Based on the findings of the study, we can interpret and compare them with research gaps and previous studies to determine the benefit at both the scientific and practical levels, particularly in the socio-economic context of innovative SMEs as follows:

Business intelligence reduces the time required to obtain critical business data and enables efficient decision-making processes, allowing for dynamic organizational information display. Heang & Mohan (2017, p. 2) highlighted that business intelligence plays a pivotal role in every organization by completing various tasks promptly. Organizations evaluate it as one of the most essential technological investments and a crucial factor in achieving sustainability.

Business intelligence significantly enhances strategic planning as a disciplined strategy that helps innovative SMEs adapt to environmental changes and manage disruptions. It enables them to better understand the business environment and continuously learn competitive strategies, as noted by Yazdi Ramezani Mojarad et al. (2014, p. 2). Strategic planning provides SMEs with competitive advantages through intelligent forecasting, evaluation, insights into markets, competitor actions, and internal measures. Valjevae et al. (2018, p. 5) also emphasized that business intelligence supports current decision-making while preparing for future events and activities expected to occur with system and environmental changes.

Sustainability involves making responsible decisions about resource utilization and allocation for economic and non-economic activities to achieve specific goals and social, economic, and environmental outcomes. Ozili P.K. (2022, p. 3) explained that organizations employ energy-saving technologies, reduce waste, and streamline supply chains to cut expenses and increase profits. Singh (2024, p. 9) agreed that organizations implement energy management systems and use renewable energy sources to lower utility costs while achieving operational efficiency and cost savings.

Innovative SMEs can apply business intelligence by focusing on strategic planning, data mining, statistical methods for analyzing data patterns and trends, and creating comprehensive dashboards that visually display key indicators and their performance. Rodrigues Gonçalves & Carvalho de Almeida (2019) noted that organizations use tools and software for data analysis to support decision-making while ensuring proper data storage and retrieval upon request.

Strategic planning has a weak positive impact on commitment in innovative SMEs at 16.1%. This is due to the lack of defined strategic goals or specific indicators to measure them. Kohtamäki et al. (2012) argued that strategic planning enables organizations to engage employees in achieving their strategic goals while enhancing organizational learning and performance. Baarveld et al. added that organizations help employees develop strategies by providing insights into obstacles they need to overcome during planning processes while adapting available tools to sustainable strategic planning approaches.

Strategic planning also has a weak positive impact on innovation in innovative SMEs at 24.3%. This is attributed to the lack of continuous research for innovative solutions to environmental and social challenges or adopting cleaner production technologies like recycling. Karbasi & Rahmanseresht (2020) emphasized that strategic planning significantly influences innovation by fostering creativity and promoting new technologies to address environmental challenges. Almulla et al. (2019) highlighted its importance in achieving sustainability by defining organizational missions and goals.

Business intelligence plays a moderately positive role in achieving sustainability in innovative SMEs at 51.9%. This is due to the lack of strategies promoting economic efficiency among partners, proper data classification for database creation, or tools for data collection and management. Hofmann & English (2018) noted that organizations rely on resource-based views and dynamic capabilities to build competitive advantages while leveraging big data through business intelligence systems. Gaurda et al. (2013) agreed that BI creates a need for

process adaptation supporting decision-making systems while enabling proper database analysis for informed decisions.

Our study stands out from other studies with a set of results, most notably:

The binary model related to strategic planning and data mining is the best model that achieved a good fit compared to the three-dimensional and four-dimensional measurement models of business intelligence in innovative small and medium-sized enterprises (SMEs). This is because organizations do not use the results obtained from data analysis to support the decision-making process. They also fail to identify opportunities to improve processes and increase efficiency. Additionally, they do not conduct training and awareness programs for employees about business intelligence, nor do they receive support from top leadership to implement business intelligence strategies.

Strategic planning has a weak positive impact on governance in innovative SMEs at 32.9%. This is because organizations do not disseminate awareness about the importance of sustainability among all stakeholders, nor do they publish sustainability reports that clarify their environmental and social performance. Our study uniquely highlights this aspect compared to other studies.

Data mining has a weak positive impact on commitment in innovative SMEs at 26.7%. This is because organizations do not use statistical methods to analyze data and extract patterns and trends. They also fail to commit to improving efficiency to achieve sustainable economic growth, which is another unique finding of our study compared to others.

Data mining has a weak positive impact on innovation in innovative SMEs at 30.9%. This is because organizations do not establish an appropriate infrastructure for data storage and retrieval upon request, which is another aspect that distinguishes our study from others.

Data mining has a weak positive impact on governance in innovative SMEs at 17.2%. This is because organizations do not build partnerships with suppliers and customers to enhance sustainability. They also do not take responsibility for the environmental and social impacts of their activities.

5. DISCUSSION

Based on the previous results, we recommend that innovative small and medium-sized enterprises (SMEs) focus on business intelligence due to its positive role in achieving organizational sustainability. Business intelligence serves as a framework where organizations gather, transform, and advance information, reducing the time needed to obtain critical business data and enabling efficient decision-making processes. This allows for dynamic organizational information display, retrieval, examination, and clarification of requirements. It is essential to prioritize sustainability, as it refers to manufacturing strategies aimed at reducing or eliminating waste and harmful emissions during the production process itself. This strategy seeks to achieve resource efficiency and minimize environmental impact, which is crucial for improving environmental performance and preserving the environment for future generations.

Innovative SMEs must use tools and technologies to collect and manage data, and include the goal of obtaining information about competitors in their plans. They should also set strategic goals to achieve and establish specific indicators to measure these goals. Additionally, these SMEs should continuously research innovative solutions to environmental and social challenges, adopt cleaner production technologies and recycling, and work according to strategies that enhance economic efficiency among all partners. They should classify and sort data to create databases, use tools and technologies for data collection and management, and produce products at lower costs compared to competitors.

Furthermore, innovative SMEs should disseminate awareness about the importance of sustainability among all stakeholders, publish sustainability reports that clarify their environmental and social performance, and use statistical methods to analyze data and extract patterns and trends. They must also commit to improving efficiency to achieve sustainable economic growth, establish an appropriate infrastructure for data storage and retrieval upon request, build partnerships with suppliers and customers to enhance sustainability, and take responsibility for the environmental and social impacts of their activities.

6. CONCLUSION

Business intelligence plays a significant role in enhancing sustainability in innovative SMEs, highlighting the importance of this concept in improving performance and competitiveness amidst increasing market challenges. The research demonstrates how business intelligence can contribute to enhancing governance, commitment, and innovation in these organizations, helping achieve economic, social, and environmental sustainability goals. However, there are limitations to the current research, as SMEs face challenges such as the lack of specialized IT professionals, increases and complexities in the acquisition process, and extended implementation times to fully benefit from business intelligence.

One of the key findings of this research is that business intelligence plays a crucial role in improving decision-making processes in SMEs by providing accurate insights and effective data analysis. The research also shows that applying business intelligence can enhance organizations' readiness to benefit from data and analyze it more effectively, contributing to increased competitiveness. Recommendations include developing measurement

models for SMEs' readiness to use business intelligence, enhancing data utilization, and developing training programs to enhance employees' skills in using business intelligence technologies.

The current research is limited to the Algerian context, leaving room for future expansion to include other areas in different countries. Expanding this research could be beneficial in understanding how business intelligence is applied in different contexts, such as developing or advanced countries, thereby contributing to a broader understanding of the importance of this concept in enhancing sustainability and competitiveness for SMEs.

In the future, research in this field can open new avenues for exploring how to enhance SMEs' readiness to effectively adopt business intelligence. Future research could include studying the impact of business intelligence on improving data quality and analysis in these organizations, developing measurement models to determine the readiness of organizations to use business intelligence. Additionally, research could focus on how to promote a culture of continuous improvement and information technology in SMEs, contributing to their sustainability and competitive advantage. Ultimately, future research can contribute to enhancing the understanding of the role of business intelligence in promoting sustainability and competitiveness for SMEs, supporting their growth and development in a constantly changing market.

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