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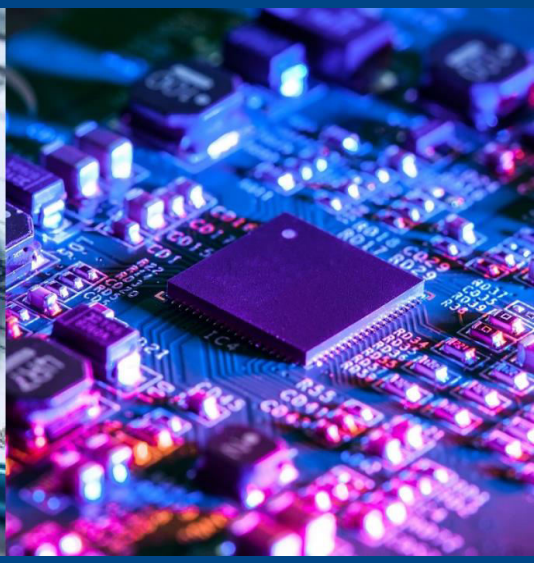

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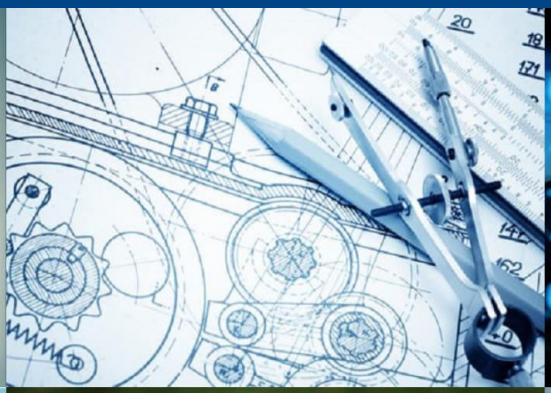

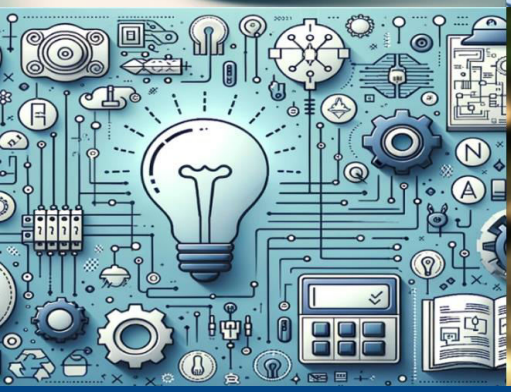

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Business Analytics for Measuring ESG Performance in the Manufacturing Industry: An Empirical and Analytical Study

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ABSTRACT: Environmental, Social, and Governance (ESG) factors have become central to how manufacturing companies are evaluated by investors, regulators, and the public. This paper examines how business analytics can be used to measure and improve ESG performance in the manufacturing industry. The study is based on primary data collected from 45 respondents through a structured questionnaire. The results show that awareness of both ESG and business analytics is high among participants. Most respondents recognize that manufacturing has a significant environmental impact and support regular ESG monitoring. Business analytics is widely seen as an effective tool for improving ESG measurement and decision-making. Key challenges include lack of awareness, limited data availability, high implementation costs, and a shortage of skilled professionals. A Chi-Square test confirms that the relationship between business analytics and ESG performance is statistically significant. The study concludes that business analytics is a critical enabler of ESG integration, and companies that adopt it are better placed to achieve sustainable growth.

KEYWORDS: ESG Performance, Business Analytics, Manufacturing Industry, Sustainability, Data-Driven Decision Making, Corporate Governance.

I. INTRODUCTION

In recent years, the way companies are judged has changed significantly. Financial performance alone is no longer enough. Stakeholders — investors, customers, regulators, and the public — now expect businesses to demonstrate responsibility in how they operate, how they treat people, and how honestly they are governed. ESG (Environmental, Social, and Governance) has become the framework through which this broader accountability is measured.

For the manufacturing sector, ESG is especially relevant. Manufacturing involves resource extraction, high energy use, waste generation, and large workforces. Each of these has a direct ESG dimension. Manufacturers face some of the strongest regulatory scrutiny and public pressure of any industry when it comes to sustainability.

The three pillars of ESG cover different but related concerns:

- Environmental factors include carbon emissions, energy consumption, waste management, and water use.
- Social factors cover worker safety, fair wages, community engagement, and human rights in supply chains.
- Governance factors refer to corporate transparency, ethics, compliance, and leadership accountability.

Implementing ESG practices is complex, especially when it comes to measurement. This is where business analytics becomes essential. Analytics uses data, statistical tools, and technology to help organizations monitor what is actually happening — not just what they intend to happen. By integrating analytics into ESG strategy, companies can track sustainability metrics in real time, spot inefficiencies, improve reporting accuracy, and make better decisions.

This study focuses on understanding how business analytics can support and strengthen ESG performance in the manufacturing sector, based on a primary survey of 45 respondents.

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Objective:

- To examine the level of awareness of ESG practices among respondents.
- To analyse the perceived importance of ESG in the manufacturing industry.
- To evaluate the role of business analytics in ESG performance measurement.
- To identify the key challenges faced in implementing ESG practices.
- To assess the benefits associated with ESG adoption.
- To provide recommendations for improving ESG performance using business analytics.

II. RESEARCH METHODOLOGY

Research Design: Descriptive research methodology used.
Data Collection: Primary data (structured questionnaire) and Secondary data (research papers and journals).
Sample Size: 45 respondents including students, working professionals, and individuals familiar with business or ESG concepts.

Sampling Method: Convenience sampling.
Tools Used: Microsoft Excel, Percentage Analysis, Frequency Distribution, and Chi-Square Test.
Variables Studied: ESG awareness, importance of ESG dimensions, environmental concerns, technology for ESG measurement, implementation challenges, role of business analytics, and long-term performance impact.

III. LITERATURE REVIEW

Eccles, Ioannou and Serafeim (2014), This study examined the long-term performance of firms with strong sustainability policies. Over an 18-year period, companies that adopted high sustainability standards significantly outperformed those that did not, on both stock market returns and accounting measures. The study established that ESG integration is linked to better risk management and stakeholder engagement.

Friede, Busch and Bassen (2015), This paper synthesized findings from over 2,000 empirical studies on the relationship between ESG and financial performance. The results show a predominantly positive connection.

Companies that focus on ESG factors relevant to their industry — such as emissions and energy use for manufacturers — tend to outperform those taking a broad, unfocused approach.

Khan, Serafeim and Yoon (2016), This research showed that focusing on material ESG issues — those most relevant to a specific industry — produces the strongest financial results. For manufacturing, this means prioritizing environmental metrics like carbon output and energy efficiency rather than addressing every ESG dimension with equal effort.

Kumar and Firoz (2022), This study examined ESG disclosure practices among Indian manufacturing firms following the introduction of the Business Responsibility and Sustainability Reporting (BRSR) framework. The findings show that disclosure quality has improved significantly, indicating that regulatory frameworks play an important role in driving ESG adoption.

Wamba et al. (2017), This paper argues that business analytics directly enhances the quality and transparency of ESG reporting. The ability to process large and complex datasets — something analytics tools are built for — is particularly useful when tracking emissions, supply chain risks, and resource consumption over time.

Kotsantonis, Pinney and Serafeim (2016), This study points to the absence of standardized ESG metrics as a major obstacle. Without common definitions and measurement frameworks, comparing ESG performance across companies is unreliable, and internal tracking becomes inconsistent. The paper calls for industry-level standards to address this gap.

Delmas and Burbano (2011), This research raises concerns about greenwashing — the practice of making misleading environmental claims. The study finds that weak reporting standards and insufficient verification mechanisms create conditions where companies can overstate their ESG performance without meaningful accountability.

IV. DATA ANALYSIS AND INTERPRETATION

Based on the survey responses from 45 respondents:

Graph 1 – Awareness of ESG
Interpretation: 88.9% of the 45 respondents are aware of ESG, while only 11.1% are not. This shows a high level of familiarity with the concept among participants.
Conclusion: ESG awareness is strong among respondents, making them well-suited for further analysis on ESG-related questions.

Graph 2 – Familiarity with Business Analytics
Interpretation: 88.9% of respondents are familiar with business analytics, while 11.1% are not. Most participants understand the basics of the subject.
Conclusion: The high level of analytics literacy supports the reliability of the study, as respondents can meaningfully assess its role in ESG performance.

Graph 3 – Environmental Impact of Manufacturing
Interpretation: Out of 44 respondents, 72.7% believe that manufacturing has a significant environmental impact. 15.9% are unsure and 11.4% disagree.
Conclusion: A strong majority acknowledges the environmental footprint of manufacturing, highlighting the importance of ESG adoption in this sector.

Graph 4 – Should Companies Measure ESG Regularly?
Interpretation: 73.3% of respondents agree that companies should measure ESG performance regularly. 15.6% are uncertain and 11.1% disagree.
Conclusion: Most respondents support ongoing ESG monitoring, which is consistent with best practice in sustainability management.

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Graph 5 – ESG and Sustainability in Academic Curricula
Interpretation: 66.7% of respondents support incorporating ESG and sustainability into academic courses. 20% are neutral and 13.3% are opposed.
Conclusion: The majority favours ESG education, indicating that future professionals expect sustainability to be part of their training.

Graph 6 – Most Important ESG Factors for Manufacturing
Interpretation: 53.3% of respondents believe all three ESG factors are equally important. Among those who selected one, Environmental leads at 24.4%, followed by Social at 20%. Governance received very little individual support.
Conclusion: Respondents prefer a balanced approach to ESG rather than focusing on a single dimension, reflecting the interconnected nature of the framework.

Graph 7 – Top Environmental Concerns in Manufacturing
Interpretation: Carbon emissions and energy consumption are each cited by 48.9% of respondents as top environmental concerns. Waste management follows at 46.7%, and water usage at 37.8%.
Conclusion: Manufacturing companies should prioritize emission control and energy efficiency, while also maintaining strong waste and water management practices.

Graph 8 – Best Technologies for ESG Measurement
Interpretation: 51.1% of respondents believe that data analytics, AI, and IoT are all collectively useful for ESG measurement, rather than any single technology on its own.
Conclusion: An integrated approach to technology is considered more effective than relying on one tool, reflecting the complexity of ESG data.

Graph 9 – Benefits of ESG Adoption
Interpretation: 55.6% of respondents feel that ESG adoption delivers multiple benefits simultaneously — improved reputation, better investment prospects, and sustainable operations — rather than a single advantage.
Conclusion: ESG is seen as delivering broad, interconnected value across different parts of the business, not just in one area.

Graph 10 – Challenges in Implementing ESG
Interpretation: Lack of awareness is the biggest barrier, cited by 55.6% of respondents. Lack of data and high implementation costs are both flagged by 44.4%, while shortage of skilled professionals is noted by 42.2%.
Conclusion: Improving awareness and strengthening data systems should be the first priorities for organizations looking to adopt ESG practices effectively.

Challenge	% of Respondents
Lack of awareness	55.6%
Lack of data / poor data systems	44.4%
High implementation cost	44.4%
Shortage of skilled professionals	42.2%

Graph 11 – ESG Practices and Company Reputation
Interpretation: A majority of respondents agree that strong ESG practices improve a company's reputation, with the highest proportion showing agreement and only a small group remaining neutral or disagreeing.
Conclusion: ESG adoption is widely perceived as a positive driver of corporate reputation and stakeholder trust.

Graph 12 – Business Analytics and ESG Measurement
Interpretation: Most respondents agree that business analytics is an effective tool for measuring ESG performance, with responses concentrated on the agreement side of the scale.

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Conclusion: Business analytics is broadly recognized as a valuable and practical tool for improving how ESG performance is measured and managed.

Graph 13 – Should ESG Reporting Be Mandatory?
Interpretation: An overwhelming 95.6% of respondents support making ESG reporting compulsory for manufacturing companies, with very minimal opposition.
Conclusion: There is near-unanimous consensus that voluntary disclosure is not sufficient and that mandatory reporting is needed to ensure accountability.

Graph 14 – Analytics Tools and Environmental Impact Reduction
Interpretation: 60% of respondents believe that analytics tools help reduce environmental impact. 24.4% are unsure and 15.6% disagree.
Conclusion: Analytics tools are widely seen as effective in reducing environmental impact, though greater awareness and implementation can strengthen adoption further.

Graph 15 – ESG Practices and Long-Term Company Performance
Interpretation: 66.7% of respondents believe that ESG practices improve long-term company performance. 24.4% are uncertain and 8.9% disagree.
Conclusion: There is strong confidence among respondents that ESG is a driver of long-term business success, consistent with findings in the academic literature.

Hypothesis Testing:

- H_0 (Null Hypothesis): Business analytics has no significant impact on ESG performance in manufacturing companies.
- H_1 (Alternative Hypothesis): Business analytics has a significant impact on ESG performance in manufacturing companies.

Statistical Test Used:
A Chi-Square (χ^2) test was applied to examine whether the observed responses differ significantly from expected responses, under the assumption that analytics has no impact on ESG outcomes.

Data and Calculation:
Data from Q21 — whether analytics tools help reduce environmental impact:

- Observed (O): Yes = 27, No = 7, Maybe = 11
- Total = 45

Expected frequency (E) assuming equal distribution: $E = 45 \div 3 = 15$

Chi-Square value is calculated using:

$$\chi^2 = \Sigma [(O - E)^2 / E]$$

$$\chi^2 = [(27-15)^2/15] + [(7-15)^2/15] + [(11-15)^2/15] = 9.60 + 4.27 + 1.07 = 14.94$$

Test Parameter	Value
Degrees of Freedom (df)	2
Critical Value at 5% significance	5.99
Calculated χ^2 value	14.94
Decision	χ^2 (14.94) > 5.99 → Significant
Result	H_0 Rejected — H_1 Accepted

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Conclusion: Since χ^2 (14.94) is greater than the critical value (5.99), the null hypothesis is rejected and the alternative hypothesis is accepted. This confirms that business analytics has a statistically significant impact on ESG performance in manufacturing companies.

V. RESULTS AND FINDINGS

High level of ESG awareness — 88.9% of respondents are familiar with ESG, indicating that the concept is well understood among the study group.
Strong recognition of manufacturing's environmental impact — nearly 73% acknowledge that the sector significantly affects the environment.

Regular ESG measurement is widely supported — most respondents agree that ongoing monitoring is essential for accountability and improvement.

Positive attitude towards business analytics — the majority agree that analytics plays a key role in measuring and improving ESG performance, which is statistically confirmed by the Chi-Square test ($\chi^2 = 14.94 > 5.99$).
Integrated technology is preferred — over half of respondents favour combining data analytics, AI, and IoT rather than relying on a single tool.

Key barriers identified — lack of awareness, high costs, limited data, and a shortage of skilled professionals are the main obstacles to ESG adoption.

Near-unanimous support for ma ndatory reporting — 95.6% believe ESG reporting should be compulsory for manufacturing companies.

VI. DISCUSSION

The findings suggest that ESG is no longer a fringe concept — it is increasingly seen as a strategic priority for manufacturing companies. Respondents understand that the sector's environmental and social footprint is significant, and they broadly support the kind of formal, data-driven accountability that ESG frameworks require.

Business analytics emerges as the key enabler in this shift. Without reliable data, ESG commitments remain aspirational rather than actionable. Analytics tools — whether tracking emissions, monitoring energy use, or assessing supply chain risks — make it possible to measure what actually matters and respond to problems before they escalate.

The study also highlights that the biggest barrier is not technology — it is awareness. Organizations cannot use analytics to improve their ESG performance if the people within them do not understand why it matters or how the tools work. This points to an urgent need for education and training at both the academic and professional level.

The overwhelming support for mandatory ESG reporting is a strong signal. It suggests that most people who think carefully about sustainability do not trust voluntary disclosure to produce meaningful accountability. For manufacturing companies, this is a warning: regulatory tightening is likely, and those who are already prepared will be at a significant advantage.

VII. CONCLUSION

The study examines how business analytics can support ESG performance in the manufacturing sector and produces a consistent, well-supported set of conclusions:

- Respondents have strong awareness of ESG and business analytics, making them well-positioned to assess how the two relate.
- Manufacturing's environmental impact is widely acknowledged, and regular ESG monitoring is seen as necessary rather than optional.
- Business analytics is recognized as a practical and effective tool for measuring ESG performance and enabling better sustainability decisions.

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- The Chi-Square test confirms a statistically significant relationship between analytics use and ESG outcomes ($\chi^2 = 14.94 > 5.99$).
- Key barriers — awareness gaps, data limitations, high costs, and skills shortages — remain significant, but are not insurmountable.
- There is near-universal support for mandatory ESG reporting, signalling that voluntary disclosure is considered insufficient.

Overall, ESG is not just a compliance requirement — it is a strategic imperative for manufacturers. Companies that invest in both genuine ESG frameworks and the analytics capability to support them are better placed to manage regulatory risk, attract investment, and build lasting competitive advantage.

VIII. RECOMMENDATIONS

- **Increase Awareness and Education:** Institutions and organizations should promote ESG knowledge through workshops, training programmes, and curriculum integration. The biggest barrier identified in this study is not cost or technology — it is awareness.
- **Adopt Integrated Analytics Tools:** Manufacturing companies should invest in combining data analytics, AI, and IoT for ESG measurement rather than relying on individual tools. The study shows that integrated approaches are considered far more effective.
- **Strengthen Data Management Systems:** Reliable ESG measurement depends on clean, standardized, and consistently collected data. Organizations should focus on building strong data infrastructure before scaling up their analytics capabilities.
- **Develop Internal Skills:** Companies should invest in training existing employees in both sustainability concepts and data tools, rather than waiting for the external talent market to catch up.
- **Adopt a Phased Approach to Implementation:** High costs need not be a permanent barrier. Starting with the highest-impact ESG areas and building gradually is a realistic path for companies with limited initial budgets.
- **Prepare for Mandatory Reporting:** Given the overwhelming support for compulsory ESG disclosure, regulatory tightening is likely. Companies that build strong reporting systems now will be better prepared when requirements arrive.

IX. LIMITATIONS OF THE STUDY

- Small Sample Size: The study is based on 45 respondents, which may not fully represent the broader population of manufacturing professionals.
- Geographical Limitation: Data was collected from a specific region, which may limit the generalizability of findings to other areas or countries.
- Perception-Based Responses: The study relies on respondents' opinions, which may be subjective and may not reflect actual organizational practices.
- Time Constraint: The research was conducted within a limited academic timeframe, restricting deeper analysis and broader data collection.
- Limited Statistical Tools: Only percentage analysis and the Chi-Square test were used. More advanced techniques could provide deeper insights into variable relationships.

REFERENCES

1. Cunha, I.G.F., Meira, E., Orsato, R.J. and Pagell, M. (2025) A systematic review of ESG indicators and corporate performance. Available at: https://link.springer.com/article/10.1186/s43093-025-00539-1
2. Delmas, M.A. and Burbano, V.C. (2011) The drivers of greenwashing. California Management Review, 54(1), pp. 64–87.
3. Eccles, R.G., Ioannou, I. and Serafeim, G. (2014) The impact of corporate sustainability on organizational processes and performance. Management Science, 60(11), pp. 2835–2857.

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International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

4. Friede, G., Busch, T. and Bassen, A. (2015) ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. Journal of Sustainable Finance and Investment, 5(4), pp. 210–233.
5. Halid, S., Rahman, M. and Islam, R. (2023) A literature review on ESG score and its impact on firm performance. Available at: https://www.researchgate.net/publication/368459551
6. Jing, H. and Zhang, S. (2024) The impact of artificial intelligence on ESG performance of manufacturing firms. MDPI Systems, 12(11). Available at: https://www.mdpi.com/2079-8954/12/11/499
7. Khan, M., Serafeim, G. and Yoon, A. (2016) Corporate sustainability: First evidence on materiality. The Accounting Review, 91(6), pp. 1697–1724.

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