



“A STUDY ON SUSTAINABLE PRACTICES IN MANUFACTURING COMPANIES”

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Abstract: *The manufacturing sector plays a crucial role in the global economy, but its impact on the environment can be substantial. To address this challenge, many companies are embracing sustainable practices, aiming to minimize their environmental footprint while remaining competitive. This study delves into these practices, exploring their potential to benefit both the environment and the companies themselves. Manufacturing processes can significantly impact the environment. This study explores the adoption of sustainable practices within manufacturing companies. It aims to identify key areas where sustainability can be implemented and analyze the potential benefits. By examining many factors of sustainability, the study aims to provide valuable insights for manufacturers seeking to operate more sustainably and responsibly.*

Keywords – Sustainable Manufacturing, Environmental Impact, Sustainable Practices.

I. INTRODUCTION

Background

The manufacturing sector is a giant of the global economy, but it also leaves a big environmental footprint. There's a growing push for manufacturers to become more sustainable, reducing their environmental impact and operating responsibly. Sustainable manufacturing strives for a balance between environmental responsibility and economic viability.

This study focuses on sustainable practices within manufacturing companies. Traditionally, manufacturing has been linked to environmental issues like pollution from waste and energy use, along with depletion of natural resources. Sustainable manufacturing aims to lessen these effects while keeping businesses profitable. Companies that adopt sustainable practices can see benefits like cost savings through reduced waste and energy consumption, an improved brand image for being environmentally responsible, and compliance with stricter environmental regulations.

Need for the study

The study on sustainable practices in manufacturing companies is essential for several reasons.

- Sustainable practices can lead to cost reductions through minimized waste and energy consumption.
- Companies adopting sustainable practices gain a positive reputation for environmental responsibility.
- Sustainable practices ensure adherence to stricter environmental regulations.
- Promoting and understanding sustainable practices is crucial for a responsible and successful future for manufacturing.
- There's a growing need for sustainable practices to lessen this impact and ensure the long-term health of the environment.

Theoretical implication of the study

The research determines how well-performing current sustainable practices are in actual production environments. This can support established ideas or point out places where the frameworks that are now in use need to be improved. The study helps illuminate the difficulties businesses encounter when putting sustainable strategies into effect. Using this information, frameworks for the effective incorporation of sustainability into industrial processes may be created that are more flexible and useful. By embracing sustainable

practices, companies must overcome several obstacles, which policymakers can better comprehend. This can assist them in creating policies and procedures that are more workable and efficient for industry acceptance.

Recent trends related to the study.

- The integration of digital technologies and Industry 4.0 concepts enables manufacturing companies to optimize processes, monitor resource consumption in real time, and implement more sustainable production methods
- Many manufacturing companies are investing in renewable energy sources such as solar and wind power to reduce reliance on fossil fuels and lower carbon emissions associated with production processes.
- Governments worldwide are implementing stricter environmental regulations and standards, compelling manufacturing companies to adopt sustainable practices to comply with legal requirements and market expectations.
- There's a growing demand for manufacturing companies to transparently report their sustainability initiatives and performance metrics, driven by increased investor, consumer, and regulatory scrutiny.
- Advancements in green manufacturing technologies, including additive manufacturing (3D printing), sustainable materials, and eco-friendly processes, are enabling companies to produce goods with reduced environmental impact.

Literature review

Domnia Frill, and Horaiu Rotaru, (2017) examine Additive Manufacturing (AM) as a sustainable option. AM creates complex parts with minimal waste, reducing material use compared to traditional methods. However, challenges like lack of standards and high costs hinder wider adoption. The study explores AM's environmental benefits and proposes solutions for these challenges, highlighting its potential for a more sustainable future.

Aditi Saha (2018) explores the rise of Sustainable Manufacturing driven by environmental and economic factors. Lean Manufacturing and Six Sigma are presented as valuable tools for achieving sustainability. Lean focuses on waste reduction through process optimization, leading to cost savings and lower environmental impact. Six Sigma utilizes statistics to minimize defects and process variation, improving quality and reducing waste.

Pathak and Singh (2020) examine Sustainable Manufacturing Concepts (SMCs) through a review of academic literature. They highlight the challenge of balancing social responsibility, environmental impact, and economic performance in manufacturing. SMCs offer a framework to navigate this complexity. The study analyzes 78 papers to identify core concepts of SMCs. Their approach combines quantitative and qualitative data to provide a comprehensive picture. They develop a new classification system for SMCs and reveal gaps in knowledge for further research. This study goes beyond categorization, offering a deeper understanding of how SMCs interact and influence sustainable manufacturing. It serves as a guide for future research and development of sustainable practices.

The study Ali Bastas (2021) explores recent trends in sustainable manufacturing technologies. With a growing population and environmental concerns, manufacturers face a challenge to balance economic growth with sustainability. The research examines how technology can help achieve this. The study analyzes areas like sustainable machining processes and how to measure sustainability performance effectively. It highlights the complexity of implementing sustainable practices and emphasizes the need for better measurement methods. Finally, it proposes a framework for future research and development in sustainable manufacturing technologies, encouraging collaboration between academics and businesses for a future that prioritizes both responsibility and profitability.

Kumar and Mani (2022) analyze methods for assessing sustainability in manufacturing. Manufacturers use various tools to evaluate environmental, economic, and energy performance across different levels. Sustainability assessment has become central, leading to new methods and practical applications. The focus has broadened to include global impact and resource use. However, challenges remain. Despite advancements in assessment methods, real-world impact is limited. Social aspects get less focus compared to environmental and economic ones. Industry practices often prioritize internal efficiency over overall environmental benefits. Assessments often measure resource use per product, neglecting long-term life cycle impacts.

Nico Hanenkamp, Oliver Zipse (2023) discuss making sustainability practical in factories. Balancing social, environmental, and economic factors is key, with potential for hidden efficiency gains. Innovation is crucial for real sustainability. Future factories will be electric, with closed material and energy loops. Digitalization and AI pave the way for a greener future. Leading companies see sustainability as a strategic advantage, envisioning AI-powered, sustainable factories. This essay highlights the complexity and promise of sustainable manufacturing, urging a progressive approach.

The study (Anoop et al., 2023) investigates how committed manufacturers are to sustainable practices across their supply chains. It analyzes their methods and seeks best practices for ethical and environmentally friendly operations. The research aims to understand the impact on company performance and the environment, while also exploring challenges faced in building eco-friendly supply chains.

Research gap

Sustainable practices which include socially conscious, ecologically beneficial, and financially feasible methods are becoming more and more valued across a range of sectors. On the other hand, study is scarce on their uptake, especially with regard to Micro, Small, and Medium Enterprises (MSMEs). MSMEs confront particular difficulties that prevent the broad adoption of sustainable practices, even in spite of the increased public awareness of sustainability issues.

Principal Ideas Illustrating the Research Gap:

- Adoption Rates are limited
- Lack of Education and Awareness
- Limitations of Resources
- Perception of Risk and Long-Term Strategies
- Competition from Well-Established Entities
- Complexity of Regulations

Objectives of the study

- To identify various sustainable practices adopted by manufacturing companies.
- Exploring potential opportunities arising from sustainable practices.
- Identifying key challenges associated with integrating sustainable practices into manufacturing operations
- Formulating recommendations for manufacturing companies considering or currently implementing sustainable practices.

Scope of the study

- The study solely focuses on the manufacturing industry
- The study mainly focuses on identifying various sustainable practices in manufacturing companies.
- The study identifies sustainable practices and analyzes their benefits and challenges

Research methodology and data collection

Data Collection Method

- I. Primary data – questionnaire
- II. Secondary data – Company websites, academic journals, magazines.
- III. Sample design
 - a. Population - Senior management of manufacturing companies
 - b. Sample size – 100

Data analysis technique

The association of variables is generally significant if the asymptotic significance is less than 0.05. The probability of observing whether the variables are independent is known as asymptotic significance often indicated as p value. If P value is less than the level of significance then null hypothesis is rejected and if P value is more than the level of significance then the null hypothesis is accepted and alternate hypothesis is rejected.

Correlation is also performed to support the analysis by determining the association of variables.

Statistical tools for analysis

In our research paper, we employed a combination of graphical analysis and the chi-square test using SPSS and correlation using JMP software to analyze the relationship between various factors of sustainable practices in manufacturing companies. Graphs, such as bar charts and line graphs, were used to visually represent the data and provide insights into trends and patterns. These graphical representations were instrumental in identifying potential relationships and guiding further analysis. Additionally, the chi-square test in SPSS and correlation in JMP software was utilized to statistically test the hypotheses regarding the relationships between different variables. This statistical tool enabled us to determine the significance of these relationships and draw meaningful conclusions from the data. By using both graphical analysis and the chi-square test, we were able to conduct a comprehensive analysis of the data and provide valuable insights into the dynamics of sustainable practices in manufacturing companies.

Limitations of the study

- Difficulties in obtaining accurate and comprehensive data from manufacturing companies, particularly regarding their sustainability practices and performance.
- Respondents may provide biased or inaccurate information due to social desirability bias or lack of understanding about sustainable practices, leading to unreliable results.
- Limited time and resources may constrain the scope of the study.

Data analysis and interpretation.

Hypothesis Testing Using Chi-Square Test and Correlation

Hypothesis 1

Implementing sustainable practices and long-term success in manufacturing company

 H_{01} - There is no significant relationship between implementing sustainable practices and long-term success in a manufacturing company H_{A1} - There is a significant relationship between implementing sustainable practices and long-term success in manufacturing company

Chi-Square Tests			
	Value	df	Asymptotic significance (2-sided)
Pearson Chi-Square	128.533 ^a	16	0.000
N of Valid Cases	100		
Source - SPSS			

Interpretation

- Degree of freedom – 16
- Significance level – 0.05
- Here $p < 0.05$
- Observed value – 128.533

As the chi-square has given values of p less than 0.05 sig. Level, the null hypothesis has been rejected and the alternate has been accepted.

Hence, there is a significant relationship between implementing sustainable practices and long-term success in manufacturing company

Correlation					
Variable	Mean	Std Dev	Correlation	Signif. Prob	Number
5	4.09	0.766667	0.390261	<.0001*	100
6	4.12	0.80754			
Source – JMP					

Interpretation

The correlation between implementing sustainable practices and long-term success in manufacturing companies is 0.390, which signifies that there is a moderately positive correlation between the two variables.

Hypothesis 2

Implementing sustainable practices and financial performance of manufacturing company

 H_{02} - There is no significant relationship between Implementing sustainable practices and the financial performance of the manufacturing company H_{A2} - There is a significant relationship between Implementing sustainable practices and the financial performance of the manufacturing company

Chi-Square Tests			
	Value	df	Asymptotic significance (2-sided)
Pearson Chi-Square	81.556 ^a	12	0.000
N of Valid Cases	100		
Source - SPSS			

Interpretation

- Degree of freedom – 12
- Significance level – 0.05
- Here $p < 0.05$
- Observed value – 81.556

As the chi-square has given values of p less than 0.05 sig. Level, the null hypothesis has been rejected and the alternate has been accepted.

Hence, there is a significant relationship between Implementing sustainable practices and the financial performance of the manufacturing company

Correlation					
Variable	Mean	Std Dev	Correlation	Signif. Prob	Number
7	4.01	0.75872	0.377203	0.0001*	100
6	4.12	0.80754			
Source – JMP					

Interpretation

The correlation between implementing sustainable practices and the financial performance of manufacturing companies is 0.377, which signifies that there is a moderately positive correlation between the two variables.

Hypothesis 3

Implementing sustainable practices and consumer behaviour

H_{03} - There is no significant relationship between Implementing sustainable practices and consumer behaviour

H_{A3} - There is a significant relationship between Implementing sustainable practices and consumer behaviour

Chi-Square Tests			
	Value	df	Asymptotic significance (2-sided)
Pearson Chi-Square	159.424 ^a	12	0.000
N of Valid Cases	100		
Source - SPSS			

Interpretation

- Degree of freedom – 12
- Significance level – 0.05
- Here $p < 0.05$
- Observed value – 159.424

As the chi-square has given values of p less than 0.05 sig. Level, the null hypothesis has been rejected and the alternate has been accepted.

Hence, there is a significant relationship between Implementing sustainable practices and consumer behavior

Correlation					
Variable	Mean	Std Dev	Correlation	Signif. Prob	Number
8	4.2	0.752101	0.592072	<.0001*	100
6	4.12	0.80754			
Source - JMP					

Interpretation

The correlation between implementing sustainable practices and consumer behaviour in manufacturing companies is 0.592, which signifies that there is a moderately positive correlation between the two variables.

Findings

- Implementing sustainable practices can lead to increased efficiency and productivity.
- Sustainable companies attract a wider pool of environmentally conscious investors and talent.
- Consumers increasingly value brands that prioritize sustainability, boosting brand image and customer loyalty.
- Sustainable practices can lead to improved working conditions and employee well-being.
- Companies committed to sustainability contribute to a healthier environment for communities.
- Lack of financial resources and upfront investment costs can hinder adoption of sustainable practices.
- Integrating new technologies and processes requires training and adaptation for the workforce.
- Technological advancements are creating new opportunities for sustainable manufacturing, like 3D printing and bio-based materials.
- Lean manufacturing principles promote waste elimination and process optimization.
- Leading companies adopting sustainable practices can pave the way for new industry standards and regulations that further promote environmental responsibility.

Recommendation

- Promoting the positive impact of sustainable practices on employee morale and engagement encourages employee participation in sustainability initiatives and sharing success stories to strengthen this connection.
- While everyone is familiar with sustainable practices, not everyone fully understands their significance. Educational programs and industry best practices can help emphasize the long-term benefits for manufacturing companies.
- Technology can be a powerful tool for implementing sustainable practices. Encouraging knowledge sharing and showcasing successful technology integration to bridge the gap between those who see its potential and those who haven't yet leveraged it.
- The future of manufacturing is undoubtedly sustainable. Staying informed on evolving regulations, consumer preferences, and technological advancements will allow companies to stay ahead of the curve.
- Emphasizing the financial advantages of sustainability, such as cost savings, access to new markets, and improved brand image helps in the broader adoption of sustainable practices in manufacturing companies.
- Many companies have begun incorporating sustainable practices, but some haven't reached their full potential. Highlighting success stories and showcasing the financial advantages (cost savings, new markets) to incentivize helps further adoption.
- Developing a central repository or platform showcasing successful technology integration examples across different manufacturing sectors. This can inspire and guide other companies in identifying and adopting relevant technologies for their specific needs.
- Encouraging collaborations between universities, industry players, and government agencies to explore and develop new technologies and best practices for sustainable manufacturing.

Conclusion

An increasing willingness to adopt sustainable practices is driving an enormous shift in the manufacturing sector. This research explores the perceived benefits, awareness, and acceptance of sustainability in industrial organizations, highlighting positive developments as well as areas for future development. Manufacturers are starting to understand sustainability's long-term value proposition. The vast majority agree that it has a favorable effect on both access to new markets and financial performance. A significant percentage of respondents believe that sustainable practices would help in cost savings in the long run, which is another reason why they are becoming more and more popular. Furthermore, the connection between environmental consciousness and a flourishing workforce is being highlighted by the good impact on employee morale and engagement, which is emerging as a critical driver.

However, there are a few obstacles that must be overcome before the manufacturing sector can become completely sustainable. Even if a lot of businesses have started implementing sustainable practices, there are differences in how much of them are being used. For an important portion, encouragement and support are needed to transition from moderate implementation to more extensive practices. This disparity can be closed by presenting instances that illustrate the concrete advantages of sustainability as well as by creating focused materials and instructional initiatives.

The perceived risk of adopting sustainable practices is one of the issues that is limiting widespread adoption. A minority is nonetheless apprehensive even though the majority believes that the risk is little or nonexistent. Training courses that concentrate on risk assessment techniques particular to sustainable practices can be quite beneficial in addressing this. The significance that technology has played in enabling this change cannot be emphasized. Although some businesses acknowledge the capability as a key enabler, a sizeable percentage are still unaware of its noteworthy influence. Its full potential can be realized by promoting knowledge exchange and exhibiting effective technology integration across various production sectors.

As a conclusion of this study, the industrial sector is beginning to recognize sustainability as a critical strategic need. Through focused education, risk assessment training, information exchange, and technical developments, the sector may strengthen its commitment to a sustainable future by resolving identified obstacles. This route not only keeps manufacturing competitive and successful in the long run, but it also makes the world healthier for future generations. The industrial sector can take the lead in creating a more sustainable future through joint efforts and ongoing research and development.

References

- Bakkari, M., and A. Khatory. (2017). "Industry 4.0: Strategy for More Sustainable Industrial Development in Smes." In Proceedings of the International Conference on Industrial Engineering and Operations Management – IEOM 2017, 1693–1701. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85018958197&partnerID=40&md5=4cef81f5b5f86467e0f11e4bd76b77bb>.
- Domnia Frill, and Horaiu Rotaru, (2017) "Additive manufacturing – a sustainable manufacturing route" MATEC Web of Conferences 94:03004. <https://www.researchgate.net/publication/312073799>
- Dr. Sumit Gupta, G. S. Dangayach, Nageswara Rao Posinasetti. (2018). "Implementation of sustainable manufacturing Practices in Indian manufacturing companies" <https://www.researchgate.net/publication/323014555>
- EPA. (2018). "Sustainable Manufacturing." <https://www.epa.gov/sustainability/sustainable-manufacturing>.
- Miss. Aditi Saha (2018) "Sustainable Manufacturing: A Study on Lean Six Sigma (LSS)" Volume 5 Issue 10
- October-2018. <https://www.jetir.org/view?paper=JETIRI006013>
- Priyanka Pathak, Dr. M. P. Singh. (2020). "Sustainable manufacturing concepts: a literature review" <https://www.researchgate.net/publication/341140148>
- Ali Bastas (2021) "Sustainable Manufacturing Technologies: A Systematic Review of Latest Trends and Themes" Sustainability 2021, 13(8), 4271; <https://doi.org/10.3390/su13084271>
- Manish Kumar, Monto Mani (2022) "Sustainability Assessment in Manufacturing for Effectiveness: Challenges and Opportunities" Frontiers in Sustainability 3:837016. <https://www.researchgate.net/publication/359519432>
- Nico Hanenkamp, Oliver Zipse (2023) "Sustainability in Manufacturing Transforming: Envisioning the Factory of the Future" <https://www.researchgate.net/publication/375733662>
- Anoop K G, Jitendra Sharma, Raji Rajan, Subharun Pal, Maulik Chandnani (2023) "Examining Manufacturing Companies Integrity towards Sustainability in Supply Chain Process & Impact on Overall Performance" Frontiers in Sustainability 3:837016. <https://www.researchgate.net/publication/359519432>