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Key Performance Indicators (KPIs) as Agents for Balancing Industry Needs and Biodiversity Conservation in Manufacturing

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Article History	Abstract
    CC License CC-BY-NC-SA 4.0	*The manufacturing industry has a significant negative impact on animals and their habitats. This paper explores the potential of sustainable manufacturing practices to mitigate these impacts. We conducted a comprehensive study of key performance indicators (KPIs) and their influencing factors for sustainability in manufacturing for small and medium-sized enterprises (SMEs) in India. Our findings suggest that KPIs such as social innovation, health and safety, green innovation, waste management, energy conservation, customer lifetime values, and net profit margin are all important factors in sustainability. We also found that these KPIs have high reliability, with Cronbach's alpha of 0.8 and McDonald's index of 0.75. Our research provides a framework for assessing sustainability in manufacturing and identifies opportunities for SMEs to reduce their negative impact on animals and their habitats.* **Keywords:** *Manufacturing, Framework, Habitat and Performance*

1. Introduction

The manufacturing industry has a significant and multifaceted impact on the environment, including wildlife and ecosystems. This impact is manifested through various activities, such as resource extraction, waste generation, and pollution. These activities can lead to habitat loss, fragmentation, and degradation, directly affecting animal populations and the broader biodiversity of the natural world.

One of the most direct and detrimental impacts of the manufacturing industry on animals is habitat loss. The expanding footprint of manufacturing facilities, along with associated infrastructure development, encroaches upon natural habitats, displacing animal species and disrupting their ecological relationships. Habitat fragmentation, the breaking up of large, continuous habitats into smaller, isolated patches, further exacerbates the problem. This fragmentation reduces the area available for animal movement, reproduction, and resource utilization, making it difficult for populations to thrive. Manufacturing processes often generate a range of pollutants, including air and water contaminants, as well as hazardous waste. These pollutants can directly harm animals through exposure to toxic substances, affecting their health, reproductive success, and survival. In aquatic ecosystems, pollution can disrupt food chains, leading to cascading effects throughout the ecosystem.

The manufacturing industry relies heavily on natural resources, such as water, minerals, and forests. The ex- traction and processing of these resources can lead to depletion and degradation of natural environments, indirectly affecting animal populations. Additionally, the energy-intensive nature of manufacturing processes contributes to greenhouse gas emissions, exacerbating climate change and its associated impacts on wildlife. Addressing the in- dustry's negative impact on animals and their habitats requires a paradigm shift towards sustainable manufacturing practices. Sustainable manufacturing encompasses a holistic approach that minimizes environmental impact while ensuring economic viability and social responsibility. This approach involves adopting cleaner technologies, reduc- ing resource consumption, implementing effective waste management strategies, and promoting renewable energy sources.

Key performance indicators (KPIs) are measurable metrics that can be used to assess and track progress towards sustainability goals. In the context of manufacturing, KPIs can help companies identify areas for improvement, monitor the effectiveness of sustainability initiatives, and benchmark their performance against industry standards.

Small and medium-sized enterprises (SMEs) play a crucial role in the manufacturing industry, contributing significantly to employment and economic growth. However, SMEs often face unique challenges in adopting sustainable practices due to resource constraints and limited access to information and expertise. India, as a rapidly growing economy with a burgeoning manufacturing sector, faces the challenge of balancing economic development with environmental stewardship. The Indian government has implemented various policies and initiatives to promote sustainable manufacturing practices, recognizing the importance of environmental protection and sustainable resource management.

2. Literature Review

While multinational corporations (MNCs) and large-scale companies typically constitute around 1% of a nation's economy, it is Small and Medium-Sized Enterprises (SMEs) that wield the predominant economic influence, con- tributing nearly 99% to the economic landscape. The European Commission employs size-based categorizations for these enterprises: 'micro' companies have fewer than 10 employees, 'small' companies employ fewer than 50 individuals, and 'medium' companies maintain a workforce of less than 250 employees. Nevertheless, it is imperative to recognize that sustainable development in SMEs extends beyond mere employee headcounts, encompassing factors such as turnover and investment.

Table 1: Categorization of enterprises based on investment and annual turn-over

Enterprises	Turnover	Investment	Manufacturing Turnover	Service Investment
Micro	Rs. 5 Crore	Less than Rs. 1 Crore	Rs. 5 Crore	Less than Rs. 50 Lakh
Small	Rs. 50 Crore	More than Rs. 1 Crore but less than Rs. 10 Crore	Rs. 50 Crore	More than Rs. 50 Lakhs but less than Rs. 2 Crores
Medium	Rs. 250 Crore	More than Rs. 10 Crore but less than 50 Crores	Rs. 250 Crore	More than Rs. 2 Crore but does not exceed Rs. 5 Crore

Over the past five decades, the Micro, Small, and Medium Enterprises (MSME) sector has evolved into a pivotal and dynamic component of the Indian economy, making substantial contributions to both economic and social development. Figure 1 illustrates the distribution of MSMEs across various states in India. According to the Ministry of Micro, Small, and Medium Enterprises of the Government of India, the country hosts a total of 630.52 thousand micro-industries, 3.31 thousand small industries, and 0.05 thousand medium-sized industries, amounting to a total of 633.88 thousand MSMEs. Within this estimated count, 324.88 lakh MSMEs (51.25%) are located in rural areas, while 309 lakh MSMEs (48.75%) operate in urban regions.

The Brundtland report defines sustainability as the endeavour to "meet the needs of the present generation with- out compromising the ability of future generations to meet their own needs." ([1]) In 2014, Garbie ([2])introduced a conceptual framework for sustainability consisting of three pillars: economic, social, and environmental. These pillars serve as foundational elements integrated into the concept of sustainable development in manufacturing. Hence, it is crucial for Micro, Small, and Medium Enterprises (MSMEs) to conduct their operations in accordance with nine fundamental sustainability principles. These encompass Ethics, Governance, Transparency, Business Relationships, Financial Return, Community Involvement, Values of Products and Services, Employment Practices, and Environmental Protection.
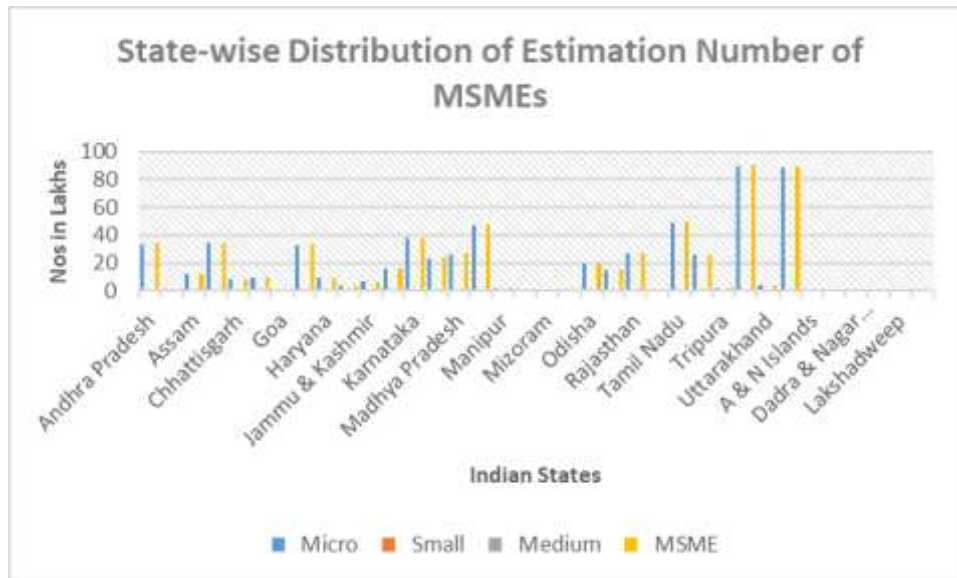
Figure 1: **State-wise Distribution of Estimated Number of MSMEs**

Lee (2009) ([3]) delved into the process of green management adoption in small and medium-sized enterprises, emphasizing the achievement of green entrepreneurship through organizational and strategic adjustments. In the industrial context, "green" or "sustainable" goods refer to products designed to conserve energy and resources while contributing to a greener habitat. The primary focus of green entrepreneurship revolves around reducing or eliminating harmful agents, pollution, and waste. This underscores the significance of sustainable goods for environmental preservation.

Green entrepreneurship holds significant implications for industries, incorporating diverse definitions, such as generating value through ecological innovations and products, with a strong emphasis on environmental preservation to promote economic and societal welfare. It involves the recognition, evaluation, and utilization of environmental resources. Moreover, it encompasses the process of recognizing, evaluating, and capitalizing on commercial opportunities arising from ecological market inefficiencies. Additionally, green entrepreneurship exemplifies the initiatives of business individuals driven by environmental considerations alongside financial goals.

Efficient asset management, encompassing both financial and human resources, stands as a vital component of organizational progress and triumph. This is particularly crucial in MSMEs, where formal systems may be less established, underscoring the heightened significance of effective asset management.

As a result, key performance indicators (KPIs) tied to the three fundamental sustainability pillars including Green Entrepreneurship, Waste Management, Energy Conservation, Customer Lifetime Value, Net Profit, Energy Efficiency, Health and Safety, and Social Innovation, become pivotal. These KPIs collectively serve as benchmarks for assessing and enhancing sustainability practices within MSMEs.

Factors Shaping KPIs in SMEs for Sustainable Manufacturing

Following an extensive review of the literature, we have identified the primary drivers of sustainable manufacturing. The pivotal factors capable of influencing key performance indicators (KPIs) have been pinpointed and broadly categorized into eight main areas, namely:

- Product Design (PD)
- Skill Development (SD)
- Financial Management (FM)
- Human Resource Strategy (HRS)
- Sustainable Entrepreneurship (SUSE)
- Customer Satisfaction and Loyalty (CSL)
- Customer Acquisition Cost (CAC)
- Social Entrepreneurship (SE)

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These categories encompass the significant determinants that play a pivotal role in shaping the KPIs associated with sustainable manufacturing in SMEs."
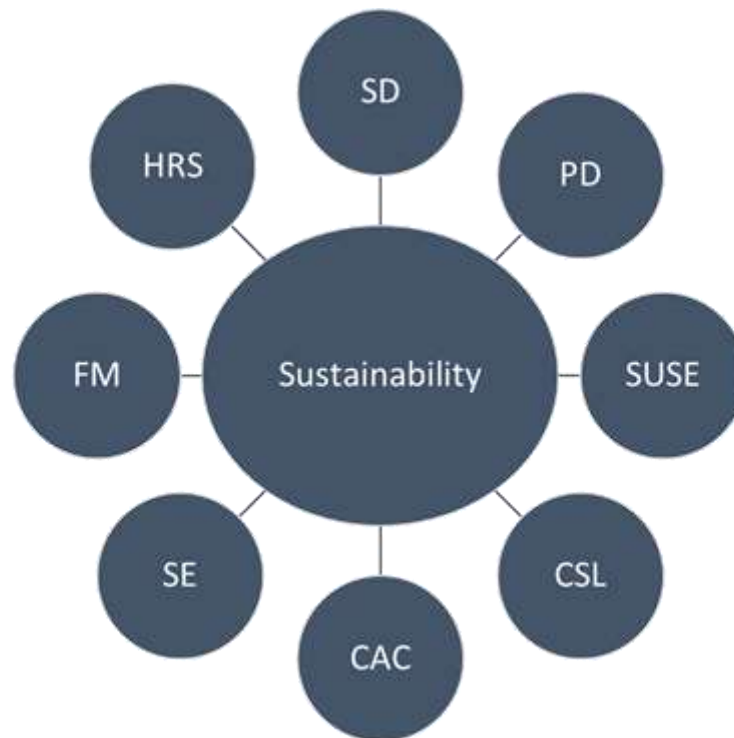

Figure 2: **Various factors that affect the sustainability.**

Skill Development: In today's rapidly evolving technological landscape, entrepreneurs must continually enhance and update their skills through workshops, training sessions, and certification courses to ensure the sustain- ability of their ventures. A study by Wiek's team in 2011 explored key competencies, including strategic skills, critical thinking abilities, normative skills, interpersonal skills, and anticipatory abilities, which can be developed through skill development training ([4]).

Product Design: This facet offers essential insights into diverse aspects of product development. Sustainable Entrepreneurship involves minimizing all forms of solid and liquid waste generation, reducing water pollution, and minimizing energy and resource consumption in the manufacturing process. Establishing a safe and healthy work environment, a crucial element of sustainable entrepreneurship, also encompasses the reduction of hazardous waste to protect worker well-being. Ineffectual material utilization and lack of organization in the manufacturing process lead to pollution, thereby amplifying the financial strain associated with managing wasteful materials.

Customer Satisfaction and Loyalty: The financial well-being of an organization relies on the cash flow generated by its customers, making them the most vital and valuable asset. Sustained growth in customer-generated cash flow is essential for ongoing organizational success. An integral component of a firm's profit and loss statement is Customer Profitability Analysis (CPA). Evaluating levels of customer satisfaction can pose a significant challenge. Research by Reichheld & Sasser has revealed that retaining loyal customers can significantly enhance a firm's profitability, as they often refer others and are willing to pay premium prices for products ([5]). Additionally, maintaining existing clients can boost revenue more effectively than constantly acquiring new ones.

Customer Acquisition Cost: Developing a loyal customer base relies on Personal Relationship Marketing, a strategic approach that encompasses understanding customer needs and preferences. Conventional marketing metrics, such as brand awareness/attitude and market share, often fall short in measuring the effectiveness of marketing expenditures (Rust et al.). Empirical research suggests that the customer acquisition and retention processes are intricately linked ([6]).

Social Entrepreneurship: Social Entrepreneurship encompasses the enhancement of human development by implementing health and safety measures, and nurturing social capital through innovative social initiatives within organizations. This approach leads to various positive social outcomes, which extend beyond tangible forms of capital to include intangible aspects such as well-

being and enhanced social relations. Social innovation involves individuals in activities that contribute to the betterment of society, thus fostering enterprises with social objectives and pioneering initiatives.

Financial Management: Maximizing profitability is a primary objective for any enterprise, and effective financial management plays a pivotal role in attaining this aim. Financial managers and accountants are dedicated to minimizing expenses while optimizing profit margins. Considering the significant uncertainties that influence business revenues, financial management becomes a crucial component of sustainable management practices, underpinning the adoption of sustainable business practices and fostering growth.

Human Resource Strategy: Human Resource Management (HRM) embodies a modern approach aimed at augmenting organizational efficiency and effectiveness through strategic and sustainable management of human resources. This, in turn, leads to heightened productivity and efficiency within organizations. HR professionals take charge of all facets of organizational affairs and functions, dealing with matters related to personnel and employees.

As per literature there are 11 characteristics of Human Resource Strategy (HRS), eight of which significantly impact organizational sustainability. These include long-term orientation, employee care, profitability, employee development, external partnerships, flexibility, employee cooperation, and fairness and equality. Progress toward sustainability can be achieved by implementing practices related to these eight characteristics. These factors serve as external variables and independent considerations when addressing Key Performance Parameters for the sustain- ability of MSMEs.

Figure 2 presents all these variables as integral components of sustainability. In this paper, a model based on multiple-criteria decision making is employed, considering various criteria during the decision-making process.

3. Materials And Methods
Research approach

The initial phase of this research involved identifying the Key Performance Parameters (KPIs), considered as the dependent variables for sustainability, and the corresponding influencing factors (FIs), categorized as independent variables, through an extensive review of the literature.

The model illustrating the interconnected relationship between the independent variables (FIs) and dependent variables (KPIs) is presented in Figure 3.
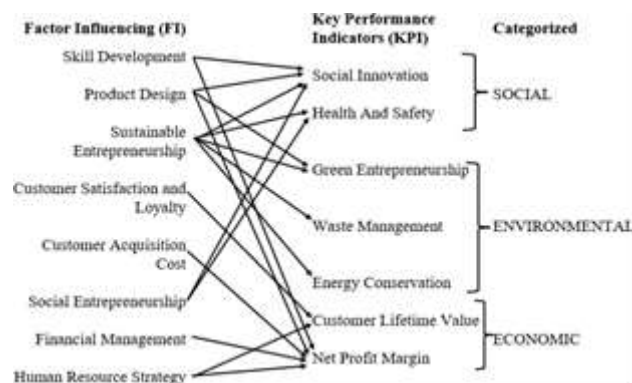

Figure 3: **Multiple Criteria Decision Modeling (MCDM) between FI and KPI**

We conducted a systematic review of secondary resources as part of the research methodology for this paper. The review process was meticulously designed, adhering to a methodical, systematic, and visually-oriented search approach. This approach has been recognized for its capacity to enhance the quality of the review process, aligning with the principles emphasized in business management studies. To foster sustainable entrepreneurship, our data collection strategy involved the organization of data into a structured format for subsequent analysis. We focused on extracting documents that contained key search terms deemed relevant to our research, including "sustainable," "entrepreneurship," "customer," "product," "human," and "small and medium businesses." Our study primarily concentrated on articles published in peer-reviewed journals. We also considered correspondence, book chapters, review articles, invited papers, and consultation papers as acceptable forms of submission. Peer-reviewed journal articles are commonly perceived as highly effective sources of information, which guided our choice. Consequently, we reviewed and manually assessed a total of 369 peer-reviewed articles, carefully selecting those that were closely related to our research objectives. Non-business-related and irrelevant English articles were excluded from our final sample.

To determine the appropriate sample size for our scrutiny, we applied Cochran's formula, which is represented as:

$$n = \frac{z^2 \, pq}{d2}$$

Where,

'n' represents the sample size,

'Z^2' denotes the abscissa of the normal curve that defines an area α at the tails, 'p' signifies the variability of the population,

'q' corresponds to (1 − p),

'd' indicates the precision level.

In our analysis, we assumed a maximum population variability of 0.5 (indicating maximum variability), a confidence level of 90%, and a precision level of ± 2.5%. For a 90% confidence level, the corresponding 'Z' value

is 1.645. Consequently, the calculated sample size according to Cochran's formula was: n = (1.645)^2 * (0.5) * (0.5) / (0.025)^2 = 1082.41

This signifies that, with a 90% confidence level, a sample size of 1082 or more survey responses is required to ensure a real value within ± 2.5% of the responses.

Questionnaire

Our data collection process commenced with a structured quantitative methodology, focusing primarily on articles, keywords, journals, and papers relevant to Small and Medium-Sized Enterprises (SMEs). This initial phase of data gathering yielded valuable insights into the current landscape, laying the groundwork for the subsequent development of a research questionnaire.

The questionnaire, designed to address specific problem areas, was meticulously crafted after conducting structured interviews with industry experts, academic scholars, and startup professionals. These interviews facilitated candid discussions on the three pillars of sustainability: Economic, Social, and Environmental. In line with Hammersley & Atkinson's recommendation, an open-ended questionnaire approach was adopted during the interview process. Beyond demographic queries, the questionnaire delved into various factors influencing the environment, including aspects such as workplace conditions and the surrounding ecological context.

Concerning the social dimension, the questionnaire probed into areas such as social support, human resources, customer orientation, and employee training, recognizing their critical role in the sustainable operations of SMEs.

Throughout this process, survey questions were revised and refined based on the feedback received, aiming to eliminate any ambiguity, vagueness, or difficulties in comprehension, thus ensuring a clear and comprehensive understanding for respondents.

The questionnaire was organized into three distinct sections. The initial section collected data on the personal attributes of the study population. The second section featured four open-ended questions aimed at comprehending and evaluating the respondents' initial perceptions of entrepreneurship. The concluding section consisted of a 29-item quiz pertaining to sustainability.

The questionnaire used in this study was further categorized into two major sections, which included sector- specific details and geographical location:

    (a) Personal Attributes

    (b) Entrepreneurial Knowledge About Sustainability

Each question within the questionnaire was carefully mapped to specific factors influencing sustainability, as illustrated in Table 2.

Table 2: Mapping of questions w.r.t to independent variables

Independent Variables	No of questions	Notations
Skill Development	3	SD1-SD3
Product Design	4	PD1-PD4
Sustainable Entrepreneurship	6	SE1-SE6
Customer Satisfaction and Acquisition Cost	4	C1-C4
Social Entrepreneurship	5	SoE1-SoE5
Financial Management	2	F1-F2
Human Resource Strategy	8	HR1-HR8

Data Collection

We gathered data from various Micro, Small, and Medium Enterprises (MSMEs) located in different states and cities across India through a comprehensive survey. The survey was meticulously structured to collect quantitative data pertaining to the adoption of sustainable manufacturing practices, the factors influencing their adoption, and the Key Performance Indicators (KPIs) utilized to assess their sustainability performance. Respondents were asked to provide their ratings on these critical aspects using a Likert scale. The primary objective of this survey was to systematically rate and evaluate key components of Small Enterprises (SEs) with a specific focus on Small and Medium-Sized Enterprises (SMEs). To achieve this goal, the survey was distributed to a representative sample of MSMEs in India. The selection of this sample was carried out using a stratified random sampling technique, ensuring a balanced and representative representation of MSMEs from diverse regions and sectors across the country.

Validity and Reliability Analysis

The questionnaire underwent a validation process with an initial focus on face validity. Subsequently, the reliability and internal consistency of the primary items related to the Factors Influencing (FIs) were rigorously assessed using two statistical measures: Cronbach's alpha coefficients (α) and McDonald's ω. To conduct this analysis, we utilized Jamovi version 2.3.21, an open-source software tool specifically designed for comprehensive data analysis. Reliability, as assessed by Cronbach's Alpha, was deemed acceptable when scores exceeded the 0.7 threshold. In cases where scores fell below 0.7, questions regarding the reliability of the data were raised and scrutinized in greater detail.

3. Results and Discussion

The analysis aimed to determine the degree of internal correlation among the items matched with the questions. In addition to reliability statistics, the correlation heat map played a crucial role in this assessment. The cells within the correlation heat map depicted the correlation coefficients between pairs of items.

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.00	0.712	0.702	0.712

Figure 4: Reliability analysis the factor skill development

The strength of the relationships between various variables is determined by correlation coefficients, which can range from -1 to +1. As the value moves closer to +1, it indicates a stronger positive correlation between the items. Conversely, as it approaches -1, it signifies a stronger negative correlation. The intensity of these correlations is visually represented by color gradients, with bright red indicating a poor correlation, bright green denoting an excellent correlation, and light shades of green representing a medium correlation.

In Figure 4 and 5, which illustrates the analysis for skill development, the correlation heatmap demonstrates that the correlation between the items falls within the medium range. This level of correlation provides acceptable reliability according to Cronbach's α.

When considering product design, as evident from the correlation heatmap in Figure 6 and 7, it's clear that there is a medium correlation between PD1, PD2, and PD4, while PD3 exhibits a moderate correlation. However, it's important to note that all these items are correlated, and the removal of any single item would result in a decrease in the value of Cronbach's α.
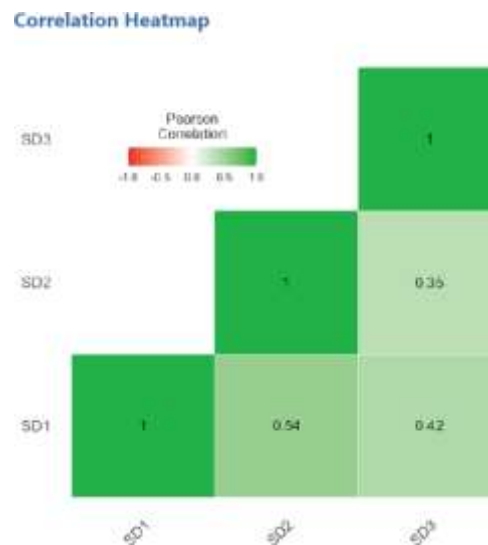

Figure 5: **Analysis for the factor skill development**

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.51	0.561	0.759	0.763

Figure 6: Reliability analysis for the factor Product Design

In Figure 8 and 9 shows the correlation heatmap for sustainable entrepreneurship reveals a negative correlation with item SE6. As a result, it was decided to remove this particular item from the analysis. After excluding SE6, both the reliability and the correlation between the remaining items improved, as illustrated in Figure 10 and 11.

Figures 12 and 13 illustrate the analysis concerning customer satisfaction and acquisition cost. The correlation of C4, i.e., expenditure on marketing, exhibits almost negligible correlation with other items of customer satisfaction, such as customer feedback, cost of the product, and customer discounts. Consequently, item C4 was excluded. Subsequent re-analysis demonstrated not only a high correlation among the remaining items but also an increased reliability from 0.711 to 0.873. Figures 14 and 15 depict these findings.

Within the domain of social entrepreneurship, all items exhibit a high level of correlation, with the exception of SoE1, which displays a moderate correlation. However, it was observed that removing SoE1 from the analysis would result in reduced reliability. Therefore, it is assumed that SoE1 may have an impact on the performance
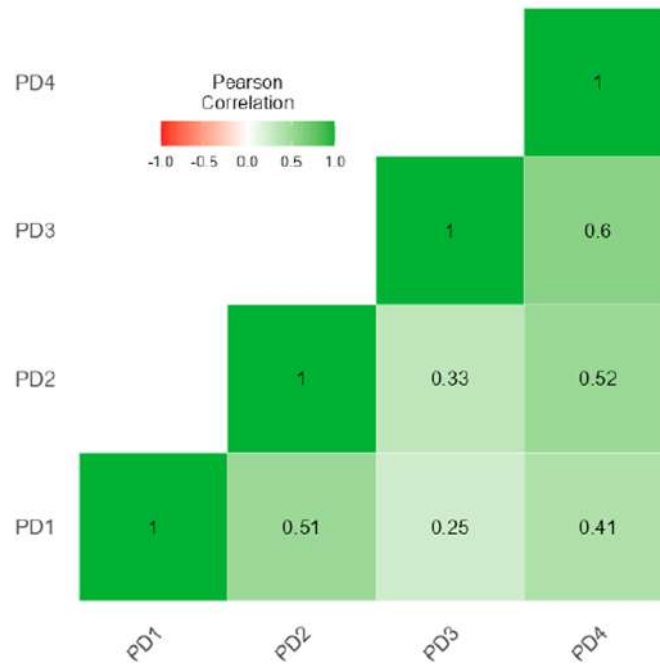
Correlation Heatmap

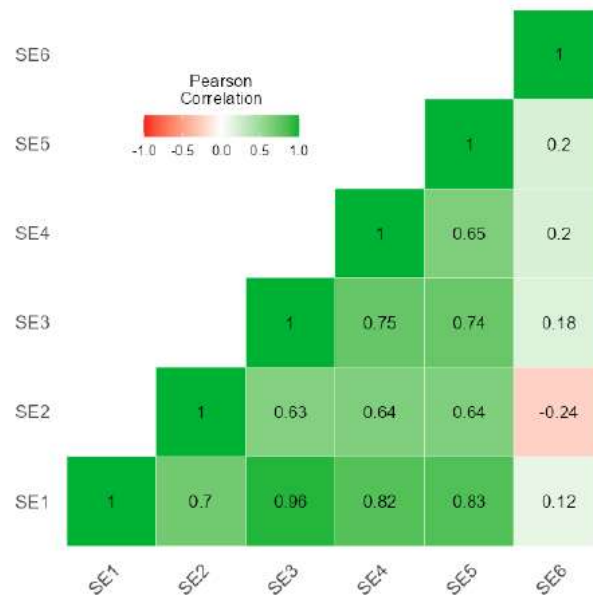Figure 7: **Analysis for the factor Product D esign**

Correlation Heatmap

Figure 8: Analysis for the factor Sustainable Entrepreneurship

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.37	0.492	0.853	0.896

Figure 9: Reliability analysis for the factor Sustainable Entrepreneurship

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.54	0.553	0.933	0.935

Figure 10: Reliability analysis for the factor Sustainable Entrepreneurship after dropping SE6
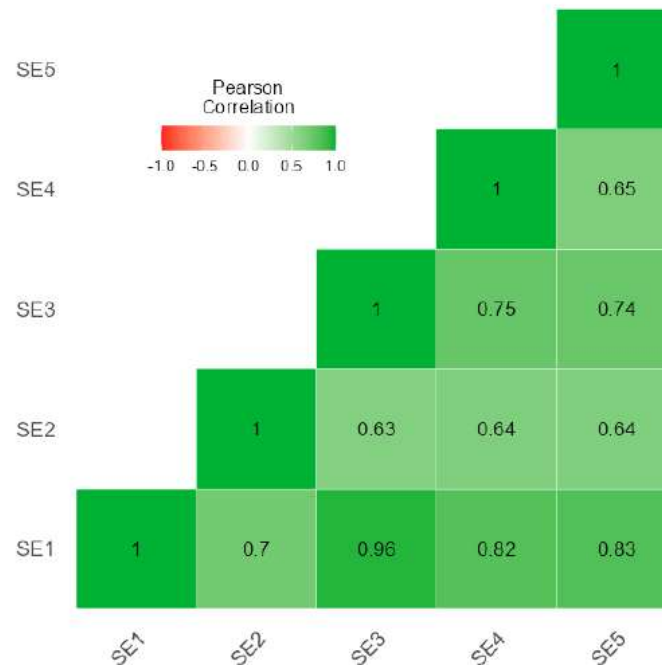
Correlation Heatmap

	SE1	SE2	SE3	SE4	SE5
SE5					1
SE4				1	0.65
SE3			1	0.75	0.74
SE2		1	0.63	0.64	0.64
SE1	1	0.7	0.96	0.82	0.83

Pearson Correlation
-1.0 -0.5 0.0 0.5 1.0

Figure 11: **Analysis for the factor Sustainable Entrepreneurship after dropping SE6**

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	3.60	0.547	0.711	0.796

Figure 12: Reliability analysis for Customer Satisfaction and Acquisition Cost

Correlation Heatmap

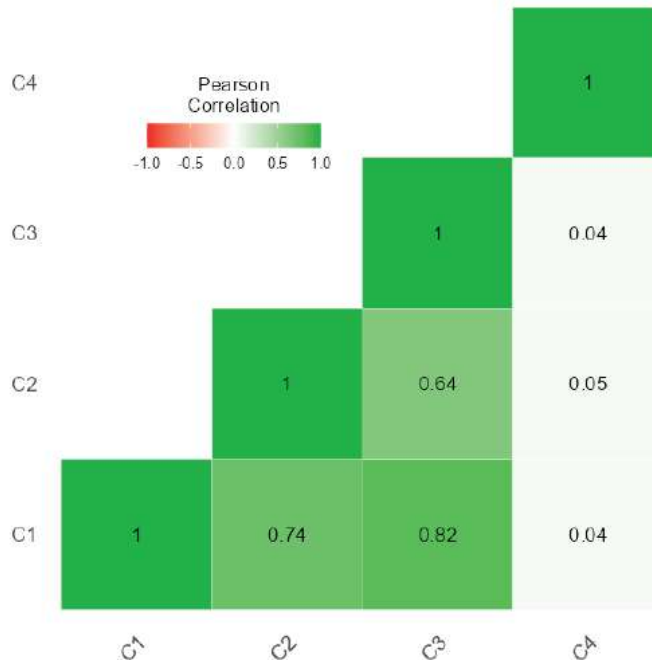Figure 13: **Analysis for Customer Satisfaction and Acquisition Cost**

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.28	0.676	0.873	0.897

Figure 14: Reliability analysis for Customer Satisfaction and Acquisition Cost after dropping C4
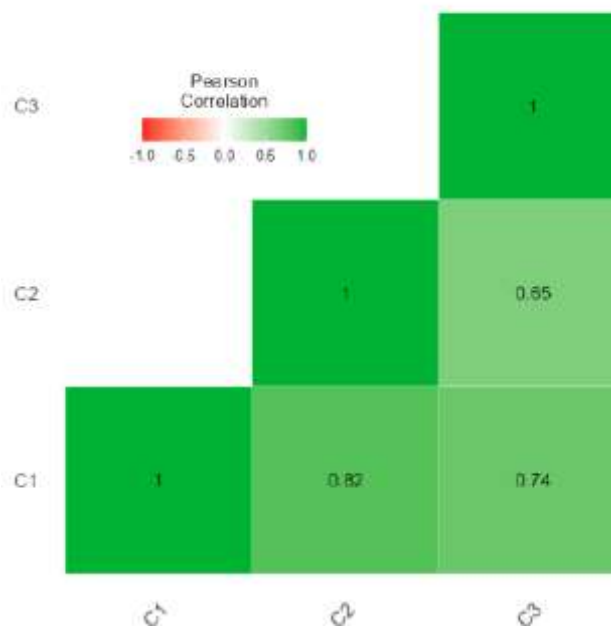
Correlation Heatmap

Figure 15: **Analysis for Customer Satisfaction and Acquisition Cost after dropping C4**

parameters to be analyzed in the subsequent stages. The correlation heatmap and reliability analysis are depicted in Figure 16 and Figure 17.

Regarding financial management, an analysis of two items—financial support to employees and financial contribu- tion to society—is shown in Figure 18 and 19. This analysis revealed a very high correlation between these two items and demonstrated excellent reliability.

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	4.44	0.571	0.797	0.803

Figure 16: Reliability analysis for Social Entrepreneurship

Under the human resource strategy 8 items were considered, the analysis resulted in the acceptable range of reliability but the inter correlation between the items is medium, especially the correlation between item HR8 and HR4 is negative but overall, the impact on each other is acceptable. Figures 20 and 21 shows the analysis for the same. Even if the items are dropped no considerable change is observed. These can be some of the barriers in SMEs which are discussed further in the coming section.
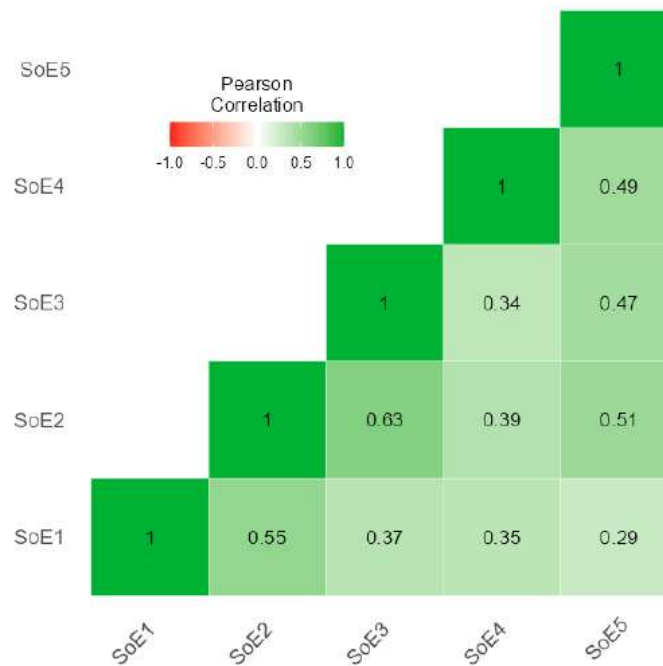
Correlation Heatmap

Figure 17: **Analysis for Social Entrepreneurship**

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	3.96	0.908	0.914	0.914

Figure 18: Reliability analysis for Financial Management

Table 3: **Result of Reliability analysis using Cronbach' alpha coefficients.**

Independent Variable	Cronbach's α	McDonald's ω
Skill Development	0.702	0.712
Product Design	0.759	0.763

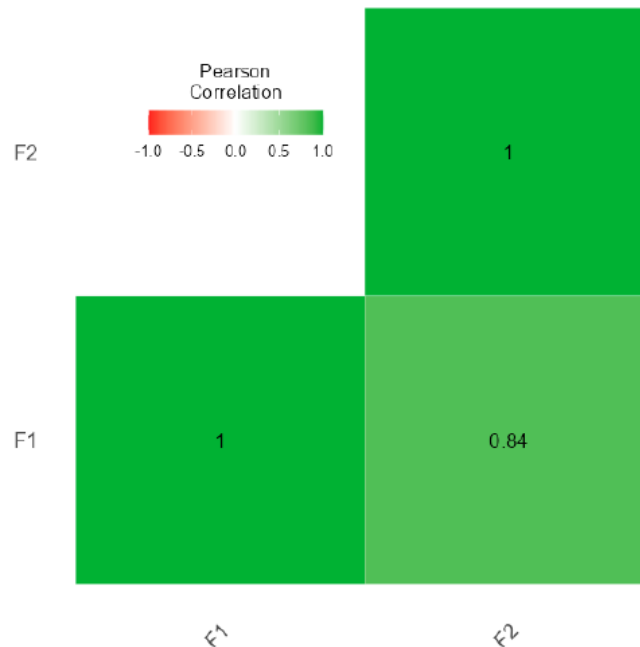|		
Sustainable Entrepreneurship	0.933	0.935
Customer Satisfaction and Acquisition Cost	0.873	0.897
Social Entrepreneurship	0.797	0.803
Financial Management	0.914	0.914
Human Resource Strategy	0.719	0.765
Total	**0.814**	**0.827**

Figure 19: **Analysis for Financial Management**

Reliability Analysis

Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	3.47	0.593	0.719	0.765

Figure 20: Reliability analysis for Human Resource Strategy

Table 3 shows that the Cronbach's α of 0.814 indicates the reliability of 81.4% and the remaining 18.6% loss is due to measurement errors. Thus, the questionnaire captures the intended contrive in an efficient manner and that the items under the factors are measuring the same underlying internal consistency.

0.827 value of McDonald's ω further supports the high internal consistency of the questionnaire. Since Mc- Donald's ω and Cronbach's α are approximately similar it implies high reliability of the questionnaire.

BARRIERS TO SMEs

As per the result obtained from Cronbach's coefficient and McDonald's coefficient as shown in table 4 and face validity of the questionnaire showed that social entrepreneurship and human resource management had certain barriers.

This analysis helped in understanding the difficulties in the adoption of SMEs for ongoing businesses in devel- oping countries like India. Lack of commitment and attitude is something which this analysis helped in knowing

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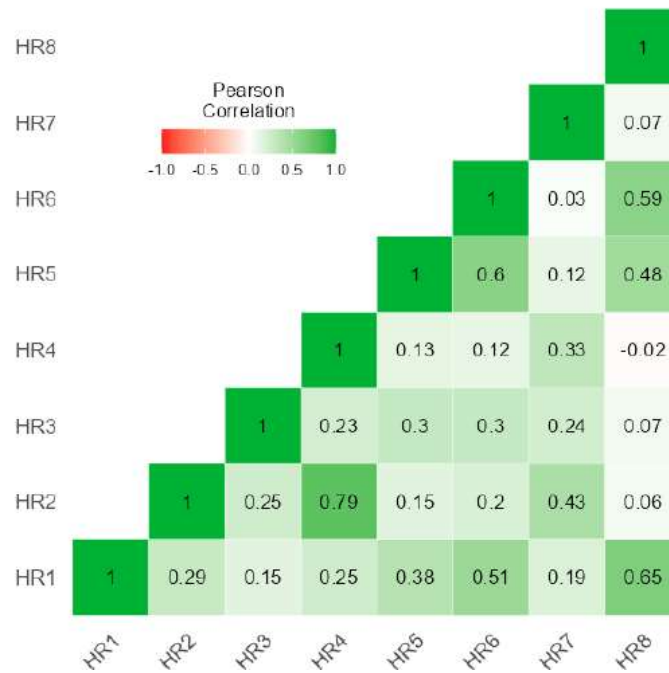
Correlation Heatmap

Figure 21: **Analysis for Human Resource Strategy**

as the major cause of under development of SEs in SMEs. Creating low grade product, almost negligible recycling pattern of SMEs, no proper waste and sewage management system, uneducated and untrained staff members, less awareness regarding socioeconomic and socioenvironmental factors are very few amongst the many parameters affecting SEs development. It also showed majority of entrepreneurs are adopting for Sustainable Entrepreneurship in accordance with balancing Finances along with emphasizing on product design and satisfaction of customers.

4. Conclusion

In conclusion, this study highlights the crucial role of key performance indicators (KPIs) in balancing industry needs and biodiversity conservation in manufacturing. By employing KPIs as assessment tools, manufacturing enterprises, particularly small and medium-sized enterprises (SMEs), can effectively measure and monitor their sustainability performance, identify areas for improvement, and implement strategies to reduce their negative im- pact on animals and their habitats. The utilization of KPIs fosters a holistic approach to sustainability, encompassing environmental, social, and economic dimensions. By integrating sustainability practices into their operations, manufacturing enterprises can contribute to the preservation of biodiversity while maintaining economic viability. The findings of this study reveal the significance of KPIs in guiding SMEs towards sustainable manufacturing practices. The identified KPIs, such as social innovation, health and safety, green innovation, waste management, energy conservation, customer lifetime values, and net profit margin, collectively provide a comprehensive framework for evaluating sustainability performance. The high reliability of these KPIs, as indicated by Cronbach's alpha of 0.8 and McDonald's index of 0.75, further underscores their validity and applicability in assessing sustainability efforts. This study also underscores the importance of incorporating biodiversity conservation into sustainability strategies. By considering the impact of manufacturing activities on animal populations and their habitats, enterprises can adopt measures to minimize their ecological footprint. This approach not only contributes to environmental protection but also enhances the long-term sustainability of manufacturing operations. As manufacturing enterprises strive to balance industry needs with biodiversity conservation, KPIs serve as valuable tools for measuring progress, identifying challenges, and implementing effective solutions. By integrating sustainability principles into their operations, manufacturing enterprises can contribute to a more harmonious relationship between industry and the natural world, ensuring the preservation of biodiversity for future generations.

Declarations

An Ethics statements:

All authors assure that the manuscript fulfills the following statements:

1) This material is the author's original work, which has not been previously published elsewhere.

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2) The paper is not currently being considered for publication elsewhere.

3) The paper reflects the author's own research and analysis truthfully and completely.

4) The paper properly credits the meaningful contributions of co-authors and co researchers. B Availability of data and materials:

Data and code will be made available on reasonable request to the corresponding author.

C Funding statement:

This research has no funding associated with it.

D Author contributions:

Conceptualization was done by Rajesh Behra (RB) and Suresh Deshmukh (SD). The experimental design was done by RB and SD. All the experiments were performed by RB. The

manuscript draft was prepared by RB and corrections were done by SD. Data analysis and graphics designing were done by RB.

E Conflicts of interest or competing interests:

The authors declare that there is no conflict of interest or competing interests.

F Data Availability:

Data will be made available at reasonable request to the Authors.

G Supplementary information: Not applicable.

H Ethical approval:

All the ethics approval was taken by an institutional review board or equivalent ethics committee

References:
1. Gro Harlem Brundtland. *Report of the World Commission on environment and development:" our common future.".* UN, 1987.
2. Ibrahim H Garbie. "An analytical technique to model and assess sustainable development index in manufacturing enterprises". *International Journal of Production Research*, vol. 52, no. 16, 4876–4915, 2014.
3. Ki-Hoon Lee. "Why and how to adopt green management into business organizations? The case study of Korean SMEs in manufacturing industry". *Management decision*, vol. 47, no. 7, 1101–1121, 2009.
4. Arnim Wiek, Lauren Withycombe and Charles L Redman. "Key competencies in sustainability: a reference framework for academic program development". *Sustainability science*, vol. 6, 203–218, 2011.
5. Frederick F Reichheld and W Earl Sasser. "Zero defections: quality comes to services". *1990*, vol. 68, no. 5, 105–111, 1990.
6. Roland T Rust, Katherine N Lemon and Valarie A Zeithaml. "Return on marketing: Using customer equity to focus marketing strategy". *Journal of marketing*, vol. 68, no. 1, 109–127, 2004.