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SUSTAINABLE ORGANISATION PERFORMANCE EVALUATION USING BALANCE SCORECARD AND ANALYTICAL HIERARCHICAL PROCESS

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Original Scientific Paper

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The present study uses the Analytic Hierarchy Process and Fuzzy Comprehensive method to evaluate the sustainable performance index with different sustainable dimensions on organisational performance measures. Limited integration methods available, inadequate exploration of sustainable dimensions, insufficient attention to key performance indicators, and lack of comparative studies have prompted the present study. This empirical study reveals that a balanced scorecard can be effectively applied to an aerospace organisation for sustainable performance evaluation. It is essential to select proper key performance indicators for a performance measuring system. This paper presents the study carried out on the sustainable performance evaluation in an aerospace organization in the Indian context and found the sustainability of the Organisation as moderate Level. The survey also identifies the Levels of different segments such as learning and growth, internal business, social and environmental dimensions, finance, customer dimension, etc. Suggestions are also included for the improvement of levels of various segments. The paper also covers the impact of locational differences or product segments on sustainable performance.

Keywords: Fuzzy Comprehensive Evaluations (FCE); Key performance indicators (KPI); Balanced Scorecard (BSC).

INTRODUCTION

Sustainable development at an organizational level is described as a triple bottom line that divides performance into economic, environmental, and social dimensions (Staniškis & Arbačiauskas, 2009). In this context, sustainable organizational development is a continuous improvement of environmental, economic, and social performance. Sustainable performance is taken because of the management of sustainable aspects in an Organisation (Marrewijk & Werre, 2003). Performance indicators facilitate establishing the opportunities for operation improvement, reveal the inefficiencies that might be removed by preventive measures, and improve internal and external communication. There are several compelling reasons to take up this problem such as holistic performance assessment, strategic alignment, comprehensive sustainability matrix, decision support for resource allocation, adaptability to organisation context, and alignment with continuous improvement culture. The main research question of this study is to give a clear direction for the study, guiding the exploration of the integrated use of BSC and AHP in the context of sustainable organizational performance evaluation. Subsequent sub-questions and hypotheses can be formulated to delve deeper into specific aspects and dimensions of the overarching research question. This overarching question encompasses several key elements such as the integration of methodologies that can be effectively combined to provide a cohesive

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framework for sustainable performance evaluation, comprehensive evaluation of diverse factors of sustainability, stakeholders' considerations that can be effectively combined to provide a cohesive framework for sustainable performance evaluation and the need for the evaluation process to align closely with organizational strategy, indicating an investigation into how BSC and AHP can be strategically applied to enhance sustainable practices. The main objective of this paper is to give an overview of sustainability performance evaluation and measure of performance indicators of an aerospace organization in the Indian context using the balanced scorecard approach and identify the dimensions to increase the effectiveness of decision-making. The impact of various sustainable dimensions will be measured using the Analytical Hierarchical Process (AHP) and FCE methods so that top management can focus on those areas for improvement. The impact of various dimensions on details that contribute sustainability of an organization has also been studied.

Concept of Balanced Score Card (BSC)

Corporate sustainability generally refers to an Organisation's activities - voluntary by definition - demonstrating the inclusion of social and environmental issues in business operations and interactions with the stakeholders (Lozano & Haartman, 2018). Their recent study has revealed the foremost vital drivers of organizational sustainability and highlighted the necessity for a holistic perspective. The trail toward organizational sustainability involves making environmental, social, and financially sustainable over the long term and covering sustainability-oriented ways, business models, investments, and management tools. Generally, sustainability awareness plays a vital role in implementing sustainable management tools (Talbot et al., 2021). Numerous researchers advocate for the acceptance of performance measures and management control systems that align with strategy implementation and drive organizations toward sustainable objectives (Baumgartner, 2014; Gond, et al, 2012; Lueg, & Radlach, 2016). This paper focuses on the sustainable balanced scorecard (SBSC), a multi-dimensional performance measuring and management control tool that may play a vital role in organizational sustainability, attracting growing analysis interest (Hansen & Schaltegger, 2018). The SBSC supplements traditional financial performance measures with four other non-financial perspectives, i.e., Customer, internal business, learning & growth, and social & environmental perspectives, supports cause-and-effect relationships, and propose the drivers for making long shareholder value (Kaplan, 2001; Kaplan, 2009). Combining the SBSC's five perspectives with the sustainable dimensions of environmental, social, or moral issues, the SBSC becomes a one-in-all principal methodology to measure organizational sustainability performance (Schaltegger & Wagner, 2006). Researchers have analysed the Balanced Scorecard (both BSC and SBSC), and the framework of four stages of design, implementation, use, and evolution has been structured (De Geuser et al., 2009; Hansen & Schaltegger, 2016).

The design stage is significant because the SBSC architecture is an important internal communication device and enabler within the strategy-making process and encourages a discussion shift from design to implementation, use, and evolution despite the particular SBSC design (Schaltegger et al., 2016; Tranfield et al., 2003). Therefore, future analysis has to focus on sustainable performance measurement and control to examine existing frameworks and their connected strengths and weaknesses more broadly. Thus, in line with the work by Hansen and Schaltegger (2016), the SBSC may be a promising framework for integration strategy and sustainability in businesses and responsive to additional inquiry. The study aims to systemize and provide a summary of the general information on SBSC use based on a scientific literature review (Tranfield, Denyer & Smart, 2003). Specifically, to fill this gap and deepen the understanding of the SBSC, the study focuses on the determinants, applications, and outcomes associated with the use stage.

Characteristics of an Aerospace Organisation in Sustainable Performance

The aerospace sector finds itself at a pivotal juncture, grappling with existential concerns centred on environmental impact and guided by the overarching goal of sustainability. This industry is undergoing a profound evolution, transcending the singular focus on reducing aircraft emissions to encompass a comprehensive commitment to mitigating environmental effects throughout the entire value chain (Falcão, 2022; Li et al., 2021). Recognizing the imperative to transform product design, manufacturing processes, and servicing

practices, aerospace companies are undertaking strategic steps to champion sustainability across intricate value chains. A notable 63% of executives anticipate that up to one-third of their revenues in the next five years will be derived from more sustainable products or services, driven by efficient design and innovative sourcing.

Transforming anticipation into tangible action requires the adoption of diverse strategies. Enhancing connectivity within manufacturing facilities and supply chains significantly optimizes resource and energy management, with Internet of Things (IoT)-)-enabled smart meters demonstrating the potential to reduce energy consumption in aircraft production by a noteworthy 20%. Furthermore, the adoption of renewable energy in manufacturing facilities contributes to a reduction in the environmental impact of production operations. The aerospace sector's ecosystem provides a conducive environment for the rapid and extensive scaling of sustainability-based business models. A compelling 98% of aerospace and defence executives concur that engaging with and scaling sustainability ecosystem partnerships is indispensable in the next three years.

To ensure sustainability across sourcing and procurement, aerospace and defence companies must assess their methods and processes for extracting and transporting materials. Sustainability considerations permeate every facet of the supply chain, with the digitization of this chain emerging as a critical priority for aerospace and defence companies. This strategic emphasis aims to extract greater efficiencies, reduce risks, enhance visibility, and seamlessly integrate business processes. The benefits derived from these changes are anticipated to translate into higher profits and a reduction in waste during production.

Looking ahead, a substantial portion of the global fleet is set to reach the end of its operational life in the next two decades. Consequently, the imperative to dismantle products for maximum reuse and recycling becomes vital for sustainable end-of-life aircraft management. The establishment of a framework for sustainability Key Performance Indicators (KPIs) is crucial to measure environmental gains across the value chain, complementing efficiency and revenue gains. An overwhelming 49% of aerospace and defence executives believe that measuring, incentivizing, and communicating sustainability performance will be imperative for their companies three years from now, compared to the current figure of just 22%. This signals an anticipated near-term shift in what is measured and communicated for sustainability, with a focus on integrating sustainability alongside financial and customer performance elements. Sustainability-related goals, embedded in the organizational strategy and the ongoing monitoring of progress, are expected to be pivotal criteria shaping the future trajectory of the aerospace and defence industry.

Characteristic Aerospace Organisation in the Indian Context

Ever increasing demand for air services in India is the reason for the deregulation of the airline industry and the growth in India's air traffic. Post-COVID-19 global recovery in air travel, the domestic aviation market in India is expected to grow to $30 billion, making it the third largest globally. According to the International Air Transport Association (IATA), India's domestic revenue passenger kilometres rose 32.3% year-on-year in March 2022. The Indian Government has set a target of increasing the number of airports across the country from 140 to 220 by 2025. Boeing estimates that India requires an additional 2500 passenger aircraft to meet this rapidly growing demand. Similarly, India's Vision 2040 strategy document outlines development needs for the sector, including a five-fold increase in the number of airports needed to handle over a billion passenger trips a year (International Trade Administration, 2022).

As commercial aviation accounted for about 2.5% of global greenhouse gas emissions in 2020, and future projections will rise to as much as 25% by 2050, the aerospace industry across the world and in India needs greater thrust in this direction (Mishra, 2021). This industry has set long-term decarbonisation targets, including a 50% reduction in net emissions by 2050 compared with 2005 (Ahmad, 2016; Green & Jupp, 2016). The aerospace industry needs to take more transformational measures, with airframe and engine OEMs, suppliers, and other companies throughout the value chain stepping in to coordinate the sustainability agenda (Mishra, 2022). Considering the expected growth in domestic travel, decarbonizing the aviation sector is essential for India to remain committed to its Nationally Determined Contributions (NDC). Sustainability not only improves the Quality of our

lives but also protects our ecosystem and preserves natural resources for future generations. Sustainable fuels and sustainable products have great potential for securing sustainable growth in the industry as they could reduce CO_2 emissions by around 80% compared with fossil fuels. India has already started using Jet A fuel blended with Sustainable Aviation Fuel (SAF) made from waste and agricultural by-products to address sustainability issues as India's aerospace and defence sector continues to step in the greener direction. The Government has hinted at having over 90 carbon-neutral airports by 2024 and in less than two years the industries to face massive transformation. India's participation and dialogues in UN Climate Change Conferences show dedication and commitment. In line with government requirements, it is expected that India's progression towards becoming a sustainable aerospace leader will catch up and eventually be on par with its race to become one of the biggest aerospace industries worldwide.

RESEARCH METHODOLOGY

This part of the paper covers the methodology, data source and industry participation, data collection tool, and sampling technique employed to correlate the strategic management system and sustainability. The study features a rational and impartial nature and a quantitative technique that considers the most straightforward approach to achieving the objectives. The deductive approach is the best-suited approach to realize the target of generalization. Therefore, the present analysis justifies the methodology to carry on the further process of data acquisition and sampling.

Data Source and Participants

A set of well-planned questions was used for the basic data collection in an aerospace organization in India, spreading across various geographical locations and engaging in various product platforms. The survey covered different functional areas of the organization, such as production, supply chain, logistics, Human Resources, Corporate management, Information technology, Quality, etc., to better represent the subject. The response was received from about 450 participants, details are in Table 1.

Statistics show that 86% of the participants were male, and 14% were female. The participants also worked in different locations of the Organisation and working in different product segments. The final scores of experts were evaluated by taking the geometric mean. In addition, a weighted geometric mean score was taken in cases where the experience and expertise vary between experts' opinions.

Table 1: Basic Demographic Characteristics of Participants

Charac.	Item	Total Responses		Location-A		Location-B		Location-C		Aircraft	Helicopter	Accessories	Design
	Characteristic	Frequ.	%	Frequ.	%	Frequ.	%	Frequ.	%				
Gender	Male	387	86	232	89	82	81	73	81	115	101	65	92
	Female	65	14	29	11	19	19	17	19	28	17	14	20
	Total	452	100	261	100	101	100	90	100	143	118	79	112
Age Group	25-35(Jr. Mgmt.)	356	79	183	70	85	84	68	76	87	65	52	35
	36-45 Mid Mgmt.)	40	9	40	15	12	12	8	9	35	28	15	45
	46-55 (Sr. Mgmt.)	38	8	25	10	3	3	10	11	14	15	10	27
	55-65 (Top Mgmt.)	18	4	13	5	1	1	4	4	7	10	2	5
	66 + (Corp. Mgmt.)	0	0	0	0	0	0	0	0	0	0	0	0
	Total	452		261		101		90		143	118	79	112

Questionnaires

The questionnaires were designed on a 5-point Likert's Scale (1= strongly disagree, 2=Disagree, 3=neither agree nor disagree, 4= Agree, 5= strongly agree) to determine the comparative importance of each perspective to suit the various perspective evaluations of sustainable balance scorecard measure [29, 30]. The first Level of perspectives is the Finance Perspective (B1), Customer Perspectives (B2), Internal Business Perspectives (B3), Learning and Growth Perspectives (B4), and Social & environmental Perspectives (B5). Each first Level of perspectives also depends upon the evaluation of second-level perspectives like B1: C1-C5, B2= C6-C10, B3= C11-C15, B4= C16-C20, B5= C21-C25). The present study identified a few KPIs (Key Performance Indicator) that affects the first Level of perspectives of organizational performance

measure (Croasmun & Ostrom, 2011; Joshi et al., 2015). The present study has taken five essential questionnaires for each type of first-level perspective that must be evaluated for sustainable development. The Organisation can choose as many perspectives or as many levels of evaluation. As the Level and number of perspectives go up, evaluation becomes more complex. The details of the questionnaires are presented in Table 2.

Sampling Approach

Considering the employee population of about 0.3 million, a sampling approach was adopted to succeed in a relevant sample of the population of the aerospace industry in India. The following equations are used:

$$x = Z\left(\frac{c}{100}\right) 2r\ (100 - r)$$

$$n = \frac{Nx}{(N-1)\ E2 + x}$$

$$E = \sqrt{\frac{(N-n)x}{n\ (N-1)}}$$

where E= Margin of Error. The margin of error that can be tolerated, is taken as 10% of the population size. 'r' is the fraction of responses interested, and if it is not known, then 50% is used, which gives the largest sample size. C is the confidence level needed (90% considered in the present study). Z(c/100) is the critical value of confidence limit C.

Model Specification

The fuzzy comprehensive evaluation (FCE) method is used to evaluate the fuzzy evaluation result through a fuzzy mapping matrix and fuzzy weights vector (Simon et al., 2020). This approach involves the following six steps:

Table 2: Questionnaires for Sustainable Development Measures in Aerospace Organisation

First Level Indicator		Second Level Indicator C	Strongly disagree	Disagree	Nor disagree nor agree	Agree	Strongly Agree
	Code	**Questionnaires**	1	2	3	4	5
Financial Perspective B1	**C1**	In your opinion, are the gross sales increasing?					
	C2	How do you rate your net profit margin growth rate?					
	C3	How does your organisation maintain an Asset Liability ratio?					
	C4	Do you feel your company's ROA is always better than the industry average?					
	C5	The income level of Employees is on par with the industry average.					
Customer Perspective B2	**C6**	How do your services help to improve customer's profitability?					
	C7	How well has your organisation acquired New Customers?					
	C8	Do you feel your customers are satisfied with your product/ services?					
	C9	What is your perception of customer relationships?					
	C10	How do you rate your organisation's Image to attract customers?					
Internal Business Perspective B3	**C11**	Your company's effort on integrated processes across an organization.					
	C12	Focus on cross-organizational processes that are valued by customers.					
	C13	Is your operation process integrated with the delivery schedule?					
	C14	Does your company follow the required quality initiatives?					
	C15	Level of effort put in by organizations to have a competitive advantage.					
Learning & Growth Perspective B4	**C16**	Does your company invest in capabilities, productivity investments?					
	C17	Does your employee's innovation link to organizational objectives?					
	C18	Does your company invest in improving its information system?					
	C19	Does the company align individuals' and teams' strategies with long-term objectives?					
	C20	Does the company emphasize and introduce managerial innovations?					
Social & Environment. Perspective B5	**C21**	Does the company follow any model leading to environmental improvements?					
	C22	How do you rate the company in achieving social, and environmental challenges?					
	C23	Does the company follow statutory audits to Ensure Regulatory Compliance?					
	C24	How do you rate your company in meeting the Society's needs?					
	C25	How company with social and environmental complaints.					

Step 1: Determine a set of indicators. Define and evaluate the first- and second-level indicators set B = {B1, B2 B3, B4, B5}, and set C = {C1, C2, C3…C25} respectively. B i represents the first-level indicator, and C i represents the second-level indicator. There are five first-level indicators and 25 second-level indicators in total. Each first-level perspective depends upon the five second-level indicators.

Step 2: Determine a set of appraisal grades. In this paper, a set of 5 grades has been considered which can be seen as a vector V = {inferior, poor, moderate, sound, and excellent}.

Step 3: A fuzzy mapping matrix is to be established in this step. Then, determine the membership degree of each evaluation indicator ci to the appraisal vector V. As a result, the fuzzy mapping matrix is obtained as follows:

$$R = \begin{bmatrix} r11 & r12 \dots & r1n \\ r21 & r22 \dots & r2n \\ rm1 & rm2 \dots & rmn \end{bmatrix},$$

$$r = [r_{i1}\ r_{i2}\ r_{i3} \dots \dots r_{in}],$$

$$after\ normalization \sum_{j=n}^{i=m} r_{ij} = 1$$

Where rij represents the membership degree of an evaluation indicator ci to the subsets V i in the appraisal grade vector set V. The ‘n’ indicates the number of levels in the appraisal vector.

Step 4: The weightage of each indicator for ‘m’ evaluation can be shown in a vector form such as W = (Wc1, Wc2... W cm), Wci indicates the weightage of each second-level indicator, Wci >0, i=m Pj = ∑ W cij = 1.
Weights obtained after the comparison matrix (using the AHP application) against each Level of perspective significantly impact the final evaluation.

Step 5: The fuzzy comprehensive evaluation results fuzzy weights vector W. Vector W combined with matrix R to get fuzzy evaluation result U for each indicator. The resultant becomes the fuzzy evaluation model which is expressed as:

$$U = Wx = \\ = [w_{c1}\ w_{c2} \dots \dots w_{cm}]x \begin{bmatrix} r11 & r12 \dots & r1n \\ r21 & r22 \dots & r2n \\ rm1 & rm2 \dots & rmn \end{bmatrix} = \\ = [u_1\ u_2\ u_3 \dots \dots u_n]$$

The Maximum Membership Principle is the most commonly used method to quantify evaluation results in practice.

Step 6: While determining system scores, The Maximum Membership Principle can only utilize some of the information of the fuzzy grades vector, which may lead to a significant deviation. The system score can be calculated for comparison using the formula.

$$N = U\ x\ ST$$

Where N is the total score of the system and the grade score of corresponding factors in the appraisal grades set V is S.

Description of Indicator

The present study considers 5 SBSC dimensions in the first-level indicators and 25 representative and operable second-level indicators, considering the finance, customer, internal business, learning & growth environmental characteristics of the aerospace organization. Twenty-five questionnaires were designed and circulated among the respondents to measure the dimensions (Davis, 2015; Hristov et al., 2019; Noell & Lund, 2002; Zadeh, 2015).

Financial Performance

The goal of an organization is to ensure that it earns a return on the investments made and manages key risks involved in running the business. These financial goals may be achieved by satisfying the needs of all stakeholders associated with the business, such as the shareholders, customers, and suppliers. The various initiatives taken to achieve these goals include introducing new products and services, improving the company's value proposition, and cutting down on business costs.

Customer Performance

Customer satisfaction is an essential indicator of the Organisation's success and reflects how well an organization is dealing. The BSC considers the Organisation's reputation versus its competitors and how customers see the industry or organization

vis-à-vis their competitors. Customer performance of the organization helps to step out of its comfort zone to view itself from the Customer's point of view rather than just from an internal perspective.

Internal Business Performance

The organization's internal processes determine how well the entity runs. BSC scorecard puts the perspective of the measures and objectives that will help the business to run more effectively. Also, the scorecard helps evaluate the company's products or services and determine whether they conform to the standards that Customers desire. Internal business perspectives can help the Organisation formulate marketing strategies and pursue innovations that will lead to improved ways of meeting customers' needs.

Learning and Growth Potential

The employees in the organizations are required to demonstrate high performance in terms of leadership, culture, application of knowledge, and skill. Suitable infrastructure is required for the organization to deliver according to management's expectations. In addition, the organization needs to use the latest technology to automate activities and ensure a smooth flow.

Social and Environmental Performance

The social dimension of sustainable development refers to the impact an organizational activity has on the social systems within it. Organizations are gradually becoming aware of the value of getting involved in sustainable development, which would lead to economic & market growth ensuring environmental protection and promoting social responsibility. The responses of BSC Key performance indicators of the Organisation are presented in Table. 3.

Method for Weight Determination

Weight determination of indicators is an integral part of the performance evaluation. The effect of each indicator can be seen in the overall performance. In this study, decision-making for obtaining resulting priorities among various perspectives was obtained using AHP throughout and at each Level to determine indicator weights (Saaty, 2008). Analytical Hierarchical Process (AHP) is a theory of measurement primarily based on the expert's judgment. Therefore, the opinion of experts plays a vital role in evaluating pairwise comparisons between criteria. The steps involved in weight determination are as follows:

Step 1: Hierarchical structure is decided per the BSC performance measurement and overall objective. Key performance indicators about each perspective were decided. The list of factors that affect the overall objective for the problem is selected by consulting the expert and experienced people working in the field. In this research, the sustainable performance of the Indian Aerospace organization is the target level A, which follows the first-level indicators layer B and second-level indicators layer C.

Step 2: A pair-wise comparison matrix "A" is constructed for the estimation of the weights of the indicators. The experts then rate the relative importance of each factor to fit the pair-wise comparison matrix. The relative importance of each indicator varies from 1 to 9. Reciprocal of the relative importance indicates the relative degree of unimportance. After the evaluation of AHP, the judgment matrix consistency is obtained.

Step 3: The average of the Normal Column method is used to calculate the priority vectors and weight vectors.

$$wi = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}\,(i,j = 1,2,\ldots.,n)$$

The weight vectors can be obtained by normalising the vectors in each column and averaging over the rows of the resulting matrices.

Step 4: Consistency of the judgment is checked. The confidence ratio is found in the equation.

$$CR = \frac{CI}{RI} \text{ where } CI = \frac{\lambda \max - n}{n-1}$$

RI is the average random consistency indicator of the judgment matrix. The judgment matrix is satisfactory when the confidence ratio (CR) ≤ 0.1.

Table 3: BSC Responses of Key Performance Indicators of Surveyed Organisation

Level of Perspectives		1 point	2 point	3 point	4 point	5 point	Fuzzy Matrix				
First Level Indicators							R b				
First Level Perspectives	B1	20.22%	21.42%	22.83%	21.59%	13.94%	0.2022	0.2142	0.2283	0.2159	0.1394
	B2	16.73%	27.21%	24.20%	20.66%	11.19%	0.1673	0.2721	0.2410	0.2066	0.1119
	B3	9.12%	16.02%	18.76%	24.91%	31.19%	0.0912	0.1602	0.1876	0.2491	0.3119
	B4	3.19%	7.92%	19.78%	37.96%	31.15%	0.0319	0.0792	0.1978	0.3796	0.3115
	B5	9.60%	17.57%	24.51%	29.12%	19.20%	0.0960	0.1757	0.2451	0.2912	0.1920
Second Level Indicators							R b1				
Financial Perspective	C1	23.45%	22.79%	27.88%	18.36%	7.52%	0.2345	0.2279	0.2788	0.1836	0.0752
	C2	6.86%	11.95%	22.57%	33.19%	25.44%	0.0686	0.1195	0.2257	0.3319	0.2544
	C3	19.91%	21.46%	22.57%	18.36%	17.70%	0.1991	0.2146	0.2257	0.1836	0.1770
	C4	19.03%	26.55%	20.13%	24.12%	10.18%	0.1903	0.2655	0.2013	0.2412	0.1018
	C5	31.86%	24.34%	21.02%	13.94%	8.85%	0.3186	0.2434	0.2102	0.1394	0.0885
							R b2				
Customer Perspective	C6	18.58%	27.88%	21.90%	19.91%	11.73%	0.1858	0.2788	0.2190	0.1991	0.1173
	C7	6.64%	19.91%	28.76%	27.21%	17.48%	0.0664	0.1991	0.2876	0.2721	0.1748
	C8	31.42%	37.83%	14.82%	11.73%	4.20%	0.3142	0.3783	0.1482	0.1173	0.0420
	C9	14.82%	26.77%	30.75%	17.92%	9.73%	0.1482	0.2677	0.3075	0.1792	0.0973
	C10	12.17%	23.67%	24.78%	26.55%	12.83%	0.1217	0.2367	0.2478	0.2655	0.1283
							R b3				
Internal Business Perspective	C11	8.41%	15.04%	13.72%	24.34%	38.50%	0.0841	0.1504	0.1372	0.2434	0.3850
	C12	12.61%	19.03%	23.23%	23.45%	21.68%	0.1261	0.1903	0.2323	0.2345	0.2168
	C13	11.06%	19.69%	26.99%	23.89%	18.36%	0.1106	0.1969	0.2699	0.2389	0.1836
	C14	9.96%	13.50%	14.82%	25.44%	36.28%	0.0996	0.1350	0.1482	0.2544	0.2628
	C15	3.54%	12.83%	15.04%	27.43%	41.15%	0.0354	0.1283	0.1504	0.2743	0.4115
							R b4				
Learning & Growth Perspective	C16	3.10%	6.86%	18.14%	29.42%	42.48%	0.0310	0.0686	0.1814	0.2942	0.4248
	C17	5.75%	8.63%	16.15%	37.83%	31.64%	0.0575	0.0863	0.1615	0.3783	0.3164
	C18	1.33%	9.07%	22.12%	43.36%	24.12%	0.0133	0.0907	0.2212	0.4336	0.2412
	C19	2.88%	7.30%	13.94%	40.27%	35.62%	0.0288	0.0730	0.1394	0.4027	0.3562
	C20	2.88%	7.74%	28.54%	38.94%	21.90%	0.0288	0.0774	0.2854	0.3894	0.2190
							R b5				
Social & Environmental Perspective	C21	5.09%	14.82%	29.20%	36.73%	14.16%	0.0509	0.1482	0.2920	0.3673	0.1416
	C22	14.16%	23.89%	20.35%	24.34%	17.26%	0.1416	0.2389	0.2035	0.2434	0.1726
	C23	1.99%	8.19%	19.47%	38.05%	32.30%	0.0199	0.0819	0.1947	0.3805	0.3230
	C24	7.74%	16.81%	24.78%	27.65%	23.01%	0.0774	0.1681	0.2478	0.2765	0.2301
	C25	19.03%	24.12%	28.76%	18.81%	9.29%	0.1903	0.2421	0.2876	0.1881	0.0929

RESULT AND DISCUSSION

The author surveyed India's aerospace industry for this study on sustainable development. Response data on KPIs based on BSC requirements was collected from the employees and executives in this Organisation. The data collected was also segregated, considering the different geographical locations of the organization and the product segment involved. Accordingly, the operating units are categorized among production complexes at different locations, and each complex is named as per the product segments like Aircraft Business, Helicopter Business, and Accessory Business. However, data from a similar sector is not available in the open domain for comparison. AHP calculator was extensively used to find out the priority matrix of each category, and fuzzy analysis was done for sustainable development evaluation. The details of BSC responses and KPIs are presented in Table 4.

Weights of First-Level Indicators

The author used the AHP calculator (Goepel, 2018) and matrix multiplication using emathhelp.net online matrix multiplication tool (www.emathhelp.net) for calculating the priority matrix. Fuzzy comprehensive evaluated performance parameters are affecting sustainable developments of various Levels of indicators as required by the BSC approach. To calculate the Principal Eigenvalue of this comparative judgment matrix λ (1) max = 5.211. The corresponding weight vector of the five first-level indicators B1, B2, B3, B4, and B5 is Wbi = (0.464, 0.31, 0.122, 0.071, 0.033), and the consistency of first-level indicators to the target layer ratio CR (1) = 0.047 < 0.05

Table 4: BSC responses and KPIs

BSC Responses							FCE of KPIs					
Level of Perspectives		**Fuzzy Matrix**					**Fuzzy Calculation**					
1st Level		**Rb**					**AHP Ranking Matrix (Wb)**					
First Level Perspectives	B1	0.2022	0.2142	0.2283	0.2159	0.1394	Wb	0.464	0.31	0.122	0.071	0.033
	B2	0.1673	0.2721	0.2410	0.2066	0.1119	Wb1	0.436	0.245	0.171	0.092	0.056
	B3	0.0912	0.1602	0.1876	0.2491	0.3119	Wb2	0.41	0.293	0.153	0.089	0.055
	B4	0.0319	0.0792	0.1978	0.3796	0.3115	Wb3	0.411	0.24	0.152	0.122	0.075
	B5	0.0960	0.1757	0.2451	0.2912	0.1920	Wb4	0.396	0.213	0.211	0.126	0.054
2nd Level		**Rb1**					Wb5	0.437	0.27	0.157	0.087	0.049
Financial Perspective	C1	0.2345	0.2279	0.2788	0.1836	0.0752	**Ub = Wb x Rb (Matrix Multiplication)**					
	C2	0.0686	0.1195	0.2257	0.3319	0.2544	Ub	0.162	0.215	0.226	0.231	0.168
	C3	0.1991	0.2146	0.2257	0.1836	0.1770	Ub1	0.182	0.245	0.234	0.211	0.129
	C4	0.1903	0.2655	0.2013	0.2412	0.1018	Ub2	0.164	0.267	0.238	0.21	0.124
	C5	0.3186	0.2434	0.2102	0.1394	0.0885	Ub3	0.096	0.164	0.182	0.244	0.313
		Rb2					Ub4	0.033	0.078	0.186	0.36	0.343
Customer Perspective	C6	0.1858	0.2788	0.2190	0.1991	0.1173	Ub5	0.08	0.169	0.249	0.319	0.184
	C7	0.0664	0.1991	0.2876	0.2721	0.1748	ST	1	2	3	4	5
	C8	0.3142	0.3783	0.1482	0.1173	0.0420	**Nb = Ub x ST (Matrix Multiplication)**					
	C9	0.1482	0.2677	0.3075	0.1792	0.0973	Nb	3.0346				
	C10	0.1217	0.2367	0.2478	0.2655	0.1283	Nb1	2.8601				
		Rb3					Nb2	2.8581				
Internal Business Perspective	C11	0.0841	0.1504	0.1372	0.2434	0.3850	Nb3	3.513				
	C12	0.1261	0.1903	0.2323	0.2345	0.2168	Nb4	3.9036				
	C13	0.1106	0.1969	0.2699	0.2389	0.1836	Nb5	3.2593				
	C14	0.0996	0.1350	0.1482	0.2544	0.2628						
	C15	0.0354	0.1283	0.1504	0.2743	0.4115						
		Rb4										
Learning & Growth Perspective	C16	0.0310	0.0686	0.1814	0.2942	0.4248	– W bi is obtained by using the AHP calculator (www.bpmsg.com) considering the pair-wise comparisons among BSC perspectives by taking the opinions of experts of surveyed aerospace organisations in India. – Analysis of first-level KPIs indicates that the Financial and Customer perspective of a surveyed organisation is below moderate and needs further improvement. However, Internal Business, Learning & Growth, and Social and environmental perspectives at the organisation level are above moderate. Overall surveyed organisation's sustainable performance index is moderate.					

Fuzzy Evaluation Scores: First-Level Indicators

According to the Maximum Membership Principle, the maximum membership degree of financial performance is "good" (MAX (Ub1) = 0.2451) (Parekh et al., 2015).

The quantitative set for the appraisal comment set V is S = {1 2 3 4 5}., then the calculated financial performance score

Nb1 = Ub1 x ST = (0.1857, 0.2451, 0.2336, 0.2106, 0.1290) x (1, 2, 3, 4, 5)T =2.8601.

The financial performance score of the investigated Organisation is "below moderate" as shown in Table 5. Therefore, the same method was used for the other three BSC dimensions.

Table 5: Financial Performance Score

		Performance Score
Nb1	Ub1 x ST	2.8601
Nb2	Ub2 x ST	2.8581
Nb3	Ub3 x ST	3.513
Nb4	Ub4 x ST	3.9036
Nb5	Ub5 x ST	3.3593
Nb	Ub x ST	3.0346

Evaluation of score: Second-Level Indicators

Fuzzy Evaluation Scores for 25 second-level indicators were evaluated by the aerospace organization. The number and proportion of each choice for each second-level indicator are listed in Table 6. The proportions are taken as the evaluation of vectors done similarly to first-level indicators (Civanlar et al., 1986).

The result shows that the second-level dimensions C1, C3, C4, and C5 are below moderate and are responsible for the below-moderate performance of the financial perspective. The Organisation can focus on improving performance in these dimensions. Similarly, second-level dimensions C6, C8, C9, and C10 are below moderate and responsible for low scores of first-level perspectives. The Organisation may focus on improving the performance in these dimensions. Similarly, second-level dimensions C12 and C13 are below moderate and need improvement. The second-level dimensions C22, C24, and C25 are below moderate and need improvement in social and environmental scores.

Effect of Regional Operation

Sustainability development performance is presented in Table 6. There is a significant difference in the overall sustainable performance of various complexes of the Organisation spreading over different geographical locations in India. The sustainable performance index is found to be 3.9411 (Location-C), 3.037 (Location-A), and 2.7128 (Location-B), respectively. The calculation results of the one-way ANOVA (analysis of variance) show that there is a significant difference in terms of financial performance, Customer, learning and growth performance, etc. (p-values < 0.05) over the locations. W bi is obtained using the AHP calculator, considering the pairwise comparisons among BSC perspectives by taking the opinions of experts of surveyed aerospace organizations in India.

Analysis of the first-level KPIs indicates that the Financial and Customer perspective of the surveyed Organisation could be more moderate and needs further improvement. However, Internal Business, Learning & Growth, and Social & environmental perspectives are above moderate at the organizational Level. Therefore, the overall surveyed organization's sustainable performance index is moderate.

Table 6: Sustainability Development Performance Second-Level Indicators

C1	0.2345	0.2279	0.2788	0.1836	0.0752	2.2563	Below Moderate
C2	0.0685	0.1195	0.2257	0.3319	0.2544	3.3585	Above Moderate
C3	0.1991	0.2146	0.2257	0.1836	0.177	2.5991	Below Moderate
C4	0.3185	0.2434	0.2102	0.1394	0.0885	2.2258	Below Moderate
C5	0.2022	0.2142	0.2283	0.2159	0.1394	2.6478	Below Moderate
Average						2.8601	Below Moderate
C6	0.1858	0.2788	0.219	0.1991	0.1173	2.5643	Below Moderate
C7	0.0664	0.1991	0.2876	0.2721	0.1748	3.0022	Above Moderate
C8	0.3142	0.3783	0.1482	0.1173	0.042	2.0064	Below Moderate
C9	0.1482	0.2677	0.3075	0.1792	0.0974	2.5024	Below Moderate
C10	0.1217	0.2367	0.2478	0.2655	0.1283	2.7942	Below Moderate
Average						2.8581	Below Moderate
C11	0.084	0.1504	0.1372	0.2434	0.385	3.695	Above Moderate
C12	0.1261	0.1903	0.2323	0.2345	0.2168	3.2256	Below Moderate
C13	0.1106	0.1969	0.2699	0.2389	0.1837	3.1882	Below Moderate
C14	0.0996	0.135	0.1482	0.2544	0.3628	3.6458	Above Moderate
C15	0.0354	0.1283	0.1504	0.2743	0.4116	3.8984	Above Moderate
Average						3.513	Above Moderate
C16	0.031	0.0686	0.1814	0.2942	0.4248	4.0132	Above Moderate
C17	0.0575	0.0863	0.1615	0.3783	0.3164	3.8098	Moderate
C18	0.0133	0.0807	0.2212	0.4336	0.2512	3.8287	Moderate
C19	0.0284	0.0733	0.1394	0.4027	0.3562	3.985	Above Moderate
C20	0.0288	0.0774	0.2854	0.3894	0.219	3.6924	Below Moderate
Average						3.9036	Above Moderate
C21	0.0509	0.1482	0.292	0.3673	0.1416	3.4005	Moderate
C22	0.1416	0.2389	0.2035	0.2434	0.1726	3.0665	Below Moderate
C23	0.0199	0.0819	0.1947	0.3805	0.323	3.9048	Above Moderate
C24	0.0774	0.1681	0.2478	0.2765	0.2302	3.414	Below Moderate
C25	0.1902	0.2412	0.2876	0.1881	0.0929	2.7523	Below Moderate
Average						3.5393	Above Moderate

Segment-wise Sustainability

Of the four types of business of the organization considered in this study, the Accessory business ranked first (3.366), followed by the aircraft Segment (3.312) and design (3.266), with the Helicopter segment lowest (3.146). The one-way ANOVA results in Table 6 show that the differences in terms of internal business process performance and overall performance are significant as $p<0.1$.

CONCLUSION

Sustainable performance indicators of an aerospace organization are evaluated using a fuzzy comprehensive evaluation model through Balance Scorecard and Analytical Hierarchical Process. Based on the current study, the following inferences can be drawn.

- The process is capable of evaluating the overall sustainable performance of an Organisation. In the present case, it is 3.0346 which is below the average value of 3.2788.
- It is found that the Organisation is performing better in outcome indicators (internal business, learning & growth, social & environmental dimension) than in driving indicators (financial & customer dimension).
- This empirical study validates the Balanced Scorecard (BSC) as a mature performance management tool for industrial enterprises, asserting its appropriateness for organizational and sustainable performance evaluation.
- The sustainable development of the organization relies on a balance across all BSC dimensions. Notably, in this study, the Learning and Growth dimension scored the highest among the five BSC dimensions, potentially attributed to the organization's open and innovative culture.
- Fuzzy results concerning the 25 second-level indicators unveil certain weak links in the sustainable development of the surveyed organization.
- The sustainable performance evaluation index system is a complex mechanism and more comprehensive and systematic indicators can improve the accuracy level of the evaluation.
- The data acquired for this study can be further generalized in the future incorporating market indicators, internal business processes, and learning and growth dimensions. The sustainable performance of surveyed organizations is to be reflected dynamically, which is a deficiency of the BSC and can be studied further.

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ODRŽIVA EVALUACIJA UČINKA ORGANIZACIJE KORIŠĆENJEM BALANSIRANIH KARTICA USPEHA I ANALITIČKOG HIJERARHIJSKOG PROCESA

Ova studija je koristila Analitički hijerarhijski proces (AHP) i Fuzzy Comprehensive metodu za procenu indeksa održivog učinka sa različitim održivim dimenzijama organizacionog učinka. Ograničene dostupne metode integracije, neadekvatno istraživanje održivih dimenzija, nedovoljna pažnja na ključne indikatore učinka i nedostatak komparativnih studija podstakli su ovu studiju. Ova empirijska studija otkriva da se izbalansirani rezultati mogu efikasno primeniti na vazduhoplovnu organizaciju za održivu evaluaciju učinka. Neophodno je odabrati odgovarajuće ključne indikatore učinka za sistem merenja performansi. Ovaj rad predstavlja studiju sprovedenu o evaluaciji održivog učinka u vazduhoplovnoj organizaciji u Indijskom kontekstu i utvrdio je da je održivost organizacije na srednjem nivou. Anketa takođe, identifikuje nivoe različitih segmenata kao što su učenje i rast, interno poslovanje, društvene i ekološke dimenzije, finansije i dimenzije potrošača, itd. Uključeni su i predlozi za poboljšanje nivoa različitih segmenata. Rad takođe obuhvata uticaj lokacijskih razlika, odnosno segmenata proizvoda na održive performanse.

Ključne reči: : Fuzzy Comprehensive Evaluations (FCE); Key performance indicators (KPI); Balanced Scorecard (BSC)