

Sustainability in Crisis: An Analysis of the Indian Leather Industry and Recommendations for Revitalization

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The present study endeavors to undertake a critical analysis of the Indian leather industry's current state, with a particular emphasis on the pressing sustainability challenges it confronts, and to advance strategies for its revitalization. The research method employs both primary and secondary data sources, encompassing industry reports, field-level observations and interviews with key stakeholders. The inquiry is organized into four discrete sections, each intended to offer a comprehensive comprehension of the industry and its current condition. The principal objective of this research is to provide valuable insights and recommendations for policymakers and industry practitioners to aid in the resurgence of the Indian leather industry. The findings of this study are expected to augment our understanding of the obstacles faced by the Indian leather industry and offer useful perspectives for decision-makers and industry leaders as they strive to revitalize the sector. Moreover, the study's ramifications are expected to have a significant impact on sustainable development, considering the leather industry's crucial role in supporting the livelihoods of many individuals and driving the country's economic progress. It is crucial to note that the study encountered two significant limitations. First, low participation from respondents due to their reluctance to engage in dialogue and their unwillingness to allow us to record conversations and take pictures. Second, the COVID-19 pandemic prevented us from visiting West Bengal, which would have added further strength to our findings.

INDIAN LEATHER INDUSTRY AND IT'S SUSTAINABLE SCENARIO

Globally, there is an increasing focus on implementing sustainable processes (A. Moktadir et al., 2018) and the concern has intensified in the last 30 years (Haque & Ntim, 2020). Sustainability is a crucial aspect to consider, especially in the context of the environment. It drives growth through ESG considerations (Margarida Rodrigues & Mário Franco, 2019) to benefit society and environment while creating long-term value for shareholders (Vivek et al., 2021). Sustainability, rooted in forestry, prioritizes regenerative utilization of natural resources, balancing growth and preservation (Kuhlman & Farrington, 2010). Adopting sustainable business models, which focus on long-term growth and profitability while considering societal and environmental impact (Xu & Wang, 2018), benefits not only the company but also its stakeholders, including employees, customers, shareholders, and society (O et al., 2020). Achieving sustainability requires multi-faceted strategies such as R&D to address societal needs, sustainable practices in the supply chain, stakeholder engagement, fostering innovation, and incorporating corporate social responsibility into overall strategy. This is evident from the study of (Cucchiella et al., 2017), which highlight the need for incorporating sustainability practices in a broader set of countries. The Indian leather industry is no exception, facing a range of sustainability challenges (Gombault & Begeer, 2013). India is a leading global player in the leather market, ranking 2nd for leather garments, 3rd for saddlery and harness, and 4th for leather goods exports. The garments sector alone accounted for 7.03% of total leather exports. Footwear dominates exports, with April-August 2022 exports valued at **US\$1,077.80 million**. Total leather and leather product exports reached **US\$4.87 billion** in 2021-2022, a 32% increase YoY. August 2022 saw a record-high of **US\$473.87 million** in total

leather exports (IBEF, 2022). It's evident that the Indian leather industry holds significant economic importance and has been a traditional source of livelihood for many individuals, particularly in certain regions. However, despite its historical and cultural significance, the industry has faced numerous sustainability challenges (S. K. Gupta et al., 2019) in recent years, leading to closures and widespread unemployment. The Indian Leather industry is a complex web of interdependent sectors that relies heavily on cattle breeding and slaughtering for raw materials, the chemical industry for tanning processes and the textile and rubber industries for finished products (Alaoui et al., 2012). However, this intricate production process has a significant environmental impact, with toxic chemicals (S. C. Singh & Gupta, 2013) contributing to environmental pollution (Pacheco et al., 2019), degradation of natural food chains, contamination, and waste of water resources (Hu et al., 2011). With an annual discharge level of 40,000 tonnes of Basic Chromium Sulphate (BSC), reducing waste through a transparent process is imperative for compliance with sustainable standards (Liu et al., 2016). The industry is predominantly small-scale and sustainable strategies and technology are not prioritized (Beltrán-Prieto et al., 2012). The production process of leather products is water-intensive (Sathya et al., 2022) and involves various chemical reactions, with the release of highly toxic and carcinogenic chemicals posing a severe threat to human and animal life, removed as solids and wastewater effluent (Sivaram & Barik, 2019a). The compliance with environmental regulations has proven to be a major obstacle for the growth and development of the industry (S. Gupta et al., 2007).

Environmental Challenges in Leather industry

Main waste	Sub-category	Quantity	Region	Source
Waste water		30 m ³ /one ton of raw hide & skin	-	(Arimam et al., 2022)
		15–50 m ³ / metric ton of raw animal hides	-	(Muralidharan et al., 2022)
		100 million tons wastewater annually	China	(Deng et al., 2015)
Solid Waste		4 million tons	Global	(Kantarli & Yanik, 2010)
	Collagen waste	450 kg/ 1000 kg of raw skin/hide	-	(Kanagaraj et al., 2015)
	Fleshing wastes	400 kg/ 1000 kg of raw skin/hide	-	
	Non-tanned solid waste	250 kg / metric ton	-	
	Tanned waste including 3 kg Cr	200 kg/ metric ton	-	{Formatting Citation}
	Raw trimmings	50 kg/ ton of material	-	(Masilamani et al., 2016)
	Chromium-containing solid waste	250 kg/metric ton of wet salted hides & skins	-	
	Chromium-free waste	350 kg/ metric ton of wet salted hides & skins	-	
	Matter lost in waste water	100 kg/ metric ton of wet salted hides & skins	-	
	Chrome-tanned leather solid waste	400 kg/ 1-ton wet salted hides	-	
	Chromium-tanned leather waste (CTLW)	250 kg/ one metric ton of wet hide	-	(L. Wang et al., 2019)
	Chromium-containing solid waste	100,000 ton/ year	Brazil	(L. Wang et al., 2020)
				(Oliveira et al., 2008)

	Finished leather waste	150,000 metric tonnes/ year	EU	(Ferreira et al., 2010)
Liquid Waste	Liquid waste	22000 m ³ (180 mg/L Cr)	Hazaribagh, Dhaka, Bangladesh	(Chowdhury et al., 2013)
	Wastewater effluent including 5 kg Cr	50000 kg/ metric ton	-	(Sivaram & Barik, 2019b)
Gaseous Waste	Ammonium Nitrogen (NH ₃ -N)	6 kg/ ton of raw hide	-	(Deng et al., 2015)
Dust	Buffing dust	2–6 kg/ ton	-	(Milu et al., 2022)
	Buffing dust	1.18 × 10 ⁴ – 3.54 × 10 ⁴ ton	Bangladesh	(Milu et al., 2022)
Chemicals	Chromium tanned shavings	0.8 million tons	Global	(Kantarli & Yanik, 2010)
Resources	Fresh Water	27410 kg/ (1000 kg of salty skins	India	(Yuvaraj et al., 2020)

There are many environmental challenges associated with the leather industry, as the industry produces a variety of wastes. Waste generated by the leather industry includes wastewater, solid waste, liquid waste, gaseous waste, dust, and chemicals. Developing effective waste management strategies is essential to ensure that these waste streams have a minimal impact on ecosystems and human health. Leather manufacturing generates significant amounts of **wastewater** due to its water-intensive process. According to studies, the production of one ton of raw hide and skin results in around 30 cubic meters of wastewater (Arimam et al., 2022). However, the amount of space required per metric ton of raw animal hides can range between 15 and 50 cubic meters (Muralidharan et al., 2022). Approximately 100 million tons of wastewater are produced each year in China alone (Deng et al., 2015). Leather production generates substantial amounts of **solid waste**, which contributes to environmental concerns. Its production globally amounts to approximately 4 million tons per year (Kantarli & Yanik, 2010). The types of solid waste include collagen wastes (450 kg per 1000 kg of raw skin/hide), fleshing wastes (400 kg per 1000 kg of raw skin/hide), non-tanned solid wastes (250 kg per metric ton), and tanned wastes (200 kg per metric ton) (Kanagaraj et al., 2015). Raw trimmings amount to 50 kg/ ton of material while Chromium-free waste is produced approximately 350 kg/ metric ton of wet salted hides & skins (Masilamani et al., 2016). Finished leather waste, another by-product amounts to approximately 150,000 metric tonnes/ year (Ferreira et al., 2010). Leather production disposes of significant amount of **liquid waste**. A metric ton of leather can produce wastewater effluent containing five kilograms of chromium (Sivaram & Barik, 2019b). According to Chowdhury et al. (2013), 22,000 cubic meters of liquid waste were generated in Hazaribagh, Dhaka, and the chrome concentration was 180 mg/l. Nutrient **gases** such as ammonium nitrogen (NH₃-N) are generated by the leather industry, with approximately 6 kg being released per ton of raw hide (Deng et al., 2015). **Dust** generation is a common problem in the leather processing industry. It is estimated that buffing dust, a by-product of the finishing process, ranges from 2 to 6 kg per ton. The amount of buffing dust generated solely in Bangladesh was estimated to be between 1.18 × 10⁴ and 3.54 × 10⁴ tons (Milu et al., 2022). Leather manufacturing utilizes a variety of chemicals, which generates **chemical waste**. Chromium-tanned (Kantarli & Yanik, 2010). Usually, Chrome-tanned leather solid waste amounts to 400 kg/ ton of wet salted hides (L. Wang et al., 2019), while Chromium-tanned leather waste (CTLW) amount to 250 kg/one metric ton (Masilamani et al., 2016), (L. Wang et al., 2020) of wet hide in production process. Brazil alone is reported to produce approximately 100,000 ton Chromium-containing solid waste annually (Oliveira et al., 2008). Leather production requires a

considerable number of resources, including water. Approximately 27,410 kilograms of freshwater are consumed in India per 1000 kilograms of salty skins processed (Yuvaraj et al., 2020).

Social Challenges in Leather industry

Main problem	Sub-problem	Source
Working conditions	Poor working conditions	(Md. A. Moktadir, Ahmadi, Sultana, Zohra, et al., 2020)
	Poor lighting	(Yogaraj G. & Ravi, 2017)
	Sweatshop	(Brun & Ciccullo, 2022)
Lack of employer proactivity	Negligence towards the safety of workers	(Karuppiah et al., 2021)
	Hesitant in strengthening maintenance department	
	Unawareness towards maintenance importance	
	Care for health and life of staff and the general public	(Śmiechowski & Lament, 2017)
Working safety	Physical injuries	(Yogaraj G. & Ravi, 2017)
	Inhalation of raw dust	
Perks	Long-term impoverishment	
	Lack of access to government schemes	
Discrimination	Child labour	(Brun & Ciccullo, 2022)
	Forced labour	(Gojowczyk & Ravi, 2022)
Economy	High unemployment	(Md. A. Moktadir, Ahmadi, Sultana, Zohra, et al., 2020)
	Negative social image	
	Poverty	

Leather workers face a number of challenges that directly affect their well-being and livelihoods despite its significant economic contribution. The industry often struggles with **poor working conditions**, which harm employee well-being. Moktadir et al. (2020) emphasize the adverse effects of inadequate working conditions on leather industry workers' health and safety. Specific concerns include **poor lighting**, as highlighted by Yogaraj G. & Ravi (2017), which can lead to eye strain and decreased productivity. Moreover, sweatshops, as discussed by Brun & Ciccullo (2022), represent an alarming aspect of the leather industry, characterized by long working hours, low wages, and harsh treatment. The **lack of proactivity** among employers in ensuring leather industry workers' safety and welfare is a significant challenge. Karuppiah et al. (2021) shed light on employers' negligence toward worker safety, resulting in accidents and injuries. Furthermore, employers' hesitancy in strengthening their maintenance departments, can lead to equipment failures and compromised safety measures. Unawareness of the importance of maintenance practices also contributes to this problem. However, employers who prioritize the health and well-being of their staff and the general public contribute to a safer and more supportive work environment (Śmiechowski & Lament, 2017). Working safety is a paramount concern in the leather industry. Yogaraj G. & Ravi (2017) describe the risks of **physical injuries** resulting from hazardous working conditions and lack of proper safety protocols. Additionally, **raw dust inhalation**, a common occurrence in the leather industry, poses a significant health risk to workers. This can lead to respiratory problems and long-term health issues. **Inadequate perks** provided to leather industry employees present another challenge. Workers often lack access to government

schemes, exacerbating long-term unemployment (Yogaraj G. & Ravi, 2017). This lack of support perpetuates financial instability and hinders upward mobility for leather industry workers. Discrimination remains a pressing issue within the leather industry. Brun & Ciccullo (2022) highlight the prevalence of **child labor**, which deprives children of their childhood but also exposes them to hazardous working conditions, compromising their education and well-being. **Forced labor**, as identified by Yogaraj G. & Ravi (2017), represents a severe violation of human rights, subjecting individuals to exploitative and dangerous work environments. Leather industry workers face profound challenges for the economy. **High unemployment rates** persist due to various factors, including poor working conditions and limited opportunities (Md. A. Moktadir, Ahmadi, Sultana, Zohra, et al., 2020). This affects individuals' livelihoods but also hampers economic growth. A negative social image and poverty, also contribute to poverty. Further compounding the economic challenges faced by leather industry workers and communities. The **negative social image** associated with the industry's poor working conditions and unethical practices can impact consumer perceptions and lead to reduced demand for leather products. This can affect industry profitability and sustainability.

The adoption of eco-friendly procedures, closed-loop production, and improved skin-collection practices (Md. A. Moktadir, Ahmadi, Sultana, Fatema-Tuj-Zohra, et al., 2020) can reduce the negative impact of the industry. However, a lack of waste management, trust in the administration, executive support, and sustainable awareness within the industry make it challenging to implement cleaner technologies (Li et al., 2019). The lack of clear guidelines, economic incentives, trust, and infrastructure support from the government only exacerbates the issue. Additionally, the lack of research and development from academia hinders technology transfer from the lab to the factory (Ramjeawon, 2004). The outdated processes and a lack of innovation hinder competitiveness (Rapitsenyane et al., 2014). To tackle this issue, the industry can turn to frameworks such as the sustainable global sourcing benchmark in IKEA (Jiang et al., 2018) and the circular economy framework (Md. A. Moktadir, Ahmadi, Sultana, Fatema-Tuj-Zohra, et al., 2020). Managers can use KPIs and relational frameworks (Dwivedi et al., 2019) to make data-driven decisions and improve sustainability. The impact of ISO certification (S. Gupta & Racherla, 2016) and sustainability strategies (S. Gupta et al., 2018) have been explored, but recent political changes in India call for further investigation. To ensure growth and development, the industry must also analyze productivity (Pacheco et al., 2019); (S. K. Gupta et al., 2019).

Despite criticism for its negative environmental impact and social discomfort due to a lack of compliance with sustainable standards, the Indian Leather industry remains a major contributor to the country's economy (Muthusamy & Ganesh, 2019), (Dwivedi et al., 2019) providing employment to rural populations, especially women in the footwear sector (Sivaram & Barik, 2019a) and has ample opportunities for growth through modernization, skilled labor, and new market development. The leather sector also contributes significantly to the country's exports, bringing in substantial foreign exchange. The rich heritage and skilled workforce of the Indian leather industry presents a significant opportunity for resurgence and continued growth. The issue of balancing economic and environmental objectives has necessitated a crucial trade-off in the context of sustainability. While economic growth is essential for the development of society, the negative impact on the environment that arises from unchecked economic activities cannot be ignored. Therefore, a critical question that arises is how to strike a balance between economic prosperity and environmental sustainability (Castonguay et al., 2023). Besides, social sustainability is a crucial and under-researched pillar of sustainability that requires more attention.

Therefore, it is imperative to prioritize research efforts towards understanding and improving social sustainability (Omoloso et al., 2021).

THE STUDY PURPOSE

To fully understand these challenges, more research is required in the field (S. C. Singh & Gupta, 2013). The industry needs to be analyzed in terms of productivity and sustainable (S. K. Gupta et al., 2019). In-depth research is needed to delve into key areas such as market trends, effluent discharge (Devikavathi & Muralidharan, 2014), working environment, production efficiency, and employee productivity (M et al., 2013), (Beltrán-Prieto et al., 2012), (Garai, 2014a), (Jaegler, 2016), and (Pacheco et al., 2019). The study thus aims to critically analyze the present scenario of Indian Leather Industry, focusing on the pressing challenges it faces and proposing strategies for its revival. The research draws upon both primary and secondary data sources, including industry reports and government statistics, as well as field-level observations and interviews with key stakeholders. The research delves into both macro and micro perspectives. The macro analysis covers the industry's sustainable growth and development, building on previous research by (S. K. Gupta et al., 2019) and (S. Gupta et al., 2018). They have analyzed the industry's economic, social and environmental strategies from 1998 to 2013 and found a consistent performance in Uttar Pradesh. Another study by (Ch. Suresh & Padmavathi, 2016) to evaluated the performance of the Indian Leather Industry from 2000-01 to 2013-14 and found the growth to be satisfactory, However, post-2014 the leather industry has faced challenges, including allegations of non-compliance and mass unemployment (S. Singh, 2018), leading to the closure of many business units (K. Sharma & Singh, 2021). This study aims to include results post-2014 and a few additional variables. For the micro analysis, the study employs qualitative methods and in-depth interviews with industry experts. Dwivedi et al. (2019) established a relational framework of sustainable KPIs through TISM, but the study aims to extend their work by identifying additional variables from interviews with industry personnel. The final list of variables includes those from the review and content analysis of cases, ensuring the inclusion of variables prevalent at the ground level. The study combines TISM-AHP to better understand the importance of variables and their relationships. To achieve this goal, the research is divided into four distinct parts, each designed to provide a comprehensive understanding of the industry and its current state.

THE STUDY SECTIONS AND REVELATIONS

Part 1

In the first part, the study focused on macro analysis by computing secondary data obtained from Annual Survey of Industries in India, similar to analysis performed by (S. Gupta et al., 2018) and (S. K. Gupta et al., 2019). This section provides a comprehensive overview of the current state of the Indian leather industry. By analyzing data from industry statistics and sustainability indicators, researchers have gained a deeper understanding of the industry's current performance and identify areas of concern. Below are the aggregate results obtained from the analysis. The three major states including Uttar Pradesh, West Bengal, Tamil Nadu and the entire India. have been compared in terms of 15 sustainability parameters. A similar comparison is made different sectors including tanneries, footwear, overall leather industry and overall manufacturing industry in India.

Table 1: Sustainability Parameters

	Parameter	Formula
Economic	Percentage Operational Factories (POI)	Operation factories/total factories * 100
	Return on Investment (ROI)	Return/capital invested * 100
	Fixed Assets Turnover (FAT)	Turnover/Fixed Assets
	Turnover per Manday (TPM)	Turnover/Total No of Mandays
	Total productivity (TP)	Total output/Total input
	Labour productivity (LP)	Turnover/People employed
Environmental	Material Intensity (MI)	Material consumed/Turnover
	Electricity Intensity (EI)	Electricity consumed/Turnover
	Fuel Intensity (FI)	Fuel consumed/Turnover
	Coal Intensity (CI)	Coal consumed/turnover
	Petroleum Intensity (PI)	Petroleum consumed/turnover
Social	Gender Ratio (GR)	No Female Workers/No Male Workers
	Percentage Salary Wage Expense (PSWE)	Total Salary Paid/Turnover*100
	Percentage Bonus Expense (PBE)	Bonus Paid/Turnover* 100
	Percentage Employer's Contribution (PEC)	Employer's contribution/Total salary*100

Adapted From: (S. K. Gupta et al., 2019)

Table 2: Macro level analysis of Indian Leather Industry – State-wise

	Uttar Pradesh				West Bengal				Tamil Nadu				All States			
	T	F	L	All	T	F	L	All	T	F	L	All	T	F	L	All
POF	89.56	84.02	86.29	85.20	90.69	84.23	89.89	89.73	81.03	76.08	78.58	80.99	84.07	80.16	81.97	84.39
ROI	8.88	14.17	11.98	13.32	7.31	11.46	7.97	5.24	0.16	-0.86	-0.39	10.61	4.98	11.33	9.00	14.26
FAT	5.27	5.06	5.14	3.67	5.35	4.53	5.00	3.04	5.84	5.67	5.72	3.08	5.37	5.09	5.18	2.71
TPM	74.70	40.48	50.08	140.99	48.92	81.59	54.61	126.23	42.48	28.79	32.83	96.66	51.77	42.44	45.37	146.95
TP	1.14	1.27	1.21	1.18	1.19	1.25	1.20	1.14	1.21	1.23	1.22	1.21	1.19	1.25	1.23	1.21
LP	22.26	12.15	15.01	42.11	14.57	22.70	16.06	39.21	12.64	8.66	9.84	29.35	15.43	12.73	13.58	44.53
MI	0.75	0.59	0.65	0.65	0.69	0.42	0.62	0.65	0.66	0.64	0.65	0.63	0.68	0.60	0.63	0.64
EI	1.78	1.47	1.58	2.01	1.35	2.39	1.59	3.20	1.39	1.23	1.29	2.21	1.49	1.73	1.64	2.15
FI	0.03	0.02	0.03	0.05	0.02	0.03	0.02	0.05	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.04
CI	0.29	0.02	0.13	0.38	0.00	0.00	0.00	0.38	0.04	0.01	0.02	0.26	0.11	0.03	0.06	0.78
PI	0.99	0.69	0.81	0.83	0.26	0.68	0.37	0.58	0.68	0.57	0.61	0.96	0.60	0.61	0.60	0.68
GR	0.04	0.01	0.02	0.04	0.12	0.01	0.10	0.03	0.79	2.92	1.94	0.67	0.38	0.70	0.60	0.25
PSWE	5.68	11.18	8.82	5.00	9.25	9.92	9.34	4.98	11.06	15.08	13.45	6.83	9.23	10.99	10.33	5.07
PBE	0.24	0.30	0.27	0.16	0.32	0.40	0.34	0.19	0.90	1.31	1.15	0.35	0.48	0.59	0.55	0.19
PEC	8.31	6.66	7.09	13.15	6.16	13.47	8.17	14.45	14.97	16.12	15.78	15.01	10.88	12.22	11.80	13.25

Source: Compiled by the authors

Table 3: Macro level analysis of Indian Leather Industry- Sector-wise

	Tanneries				Footwear				Leather				All industries			
	UP	WB	TN	AS	UP	WB	TN	AS	UP	WB	TN	AS	UP	WB	TN	AS
POF	89.56	90.69	81.03	84.07	84.02	84.23	76.08	80.16	86.29	89.89	78.58	81.97	85.20	89.73	80.99	84.39
ROI	8.88	7.31	0.16	4.98	14.17	11.46	-0.86	11.33	11.98	7.97	-0.39	9.00	13.32	5.24	10.61	14.26
FAT	5.27	5.35	5.84	5.37	5.06	4.53	5.67	5.09	5.14	5.00	5.72	5.18	3.67	3.04	3.08	2.71
TPM	74.70	48.92	42.48	51.77	40.48	81.59	28.79	42.44	50.08	54.61	32.83	45.37	140.99	126.23	96.66	146.95
TP	1.14	1.19	1.21	1.19	1.27	1.25	1.23	1.25	1.21	1.20	1.22	1.23	1.18	1.14	1.21	1.21
LP	22.26	14.57	12.64	15.43	12.15	22.70	8.66	12.73	15.01	16.06	9.84	13.58	42.11	39.21	29.35	44.53
MI	0.75	0.69	0.66	0.68	0.59	0.42	0.64	0.60	0.65	0.62	0.65	0.63	0.65	0.65	0.63	0.64
EI	1.78	1.35	1.39	1.49	1.47	2.39	1.23	1.73	1.58	1.59	1.29	1.64	2.01	3.20	2.21	2.15
FI	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.05	0.05	0.04	0.04
CI	0.29	0.00	0.04	0.11	0.02	0.00	0.01	0.03	0.13	0.00	0.02	0.06	0.38	0.38	0.26	0.78
PI	0.99	0.26	0.68	0.60	0.69	0.68	0.57	0.61	0.81	0.37	0.61	0.60	0.83	0.58	0.96	0.68
GR	0.04	0.12	0.79	0.38	0.01	0.01	2.92	0.70	0.02	0.10	1.94	0.60	0.04	0.03	0.67	0.25
PSWE	5.68	9.25	11.06	9.23	11.18	9.92	15.08	10.99	8.82	9.34	13.45	10.33	5.00	4.98	6.83	5.07
PBE	0.24	0.32	0.90	0.48	0.30	0.40	1.31	0.59	0.27	0.34	1.15	0.55	0.16	0.19	0.35	0.19
PEC	8.31	6.16	14.97	10.88	6.66	13.47	16.12	12.22	7.09	8.17	15.78	11.80	13.15	14.45	15.01	13.25

Source: Compiled by the authors

Legend: The visual representation in the heat map displays a gradient of colors ranging from red to green, reflecting the performance of specific parameters. Regions saturated with hues closer to red signal a deficiency in performance, while those suffused with hues closer to green signal an optimal level of performance

Notes: The above tables show that Uttar Pradesh and West Bengal have a good economic sustainability performance, while Tamil Nadu excels in environmental and social sustainability. The data analysis within Tamil Nadu highlights the superior performance of the footwear sector in environmental and social aspects and the tanning sector in economic aspects. Overall, the leather industry performs better in environmental and social sustainability compared to the industrial average, but its economic performance requires attention. Despite criticism for environmental non-compliance, the results of this study present a positive outlook for the leather industry in terms of environmental and social sustainability.

Part 2

For the second part, the study focused on developing a case through field notes and observations helped researchers to gain a deeper understanding of the issues faced by the industry and the impact they have on the lives of those who depend on it for their livelihoods. The case study method is helpful when you want to deeply understand a particular problem, event, or situation in its natural setting (Crowe et al., 2011). The researchers traveled to Jajmau region in the city of Kanpur near the banks of river Ganges, and interviewed industry personnel and visited the nearby locality. Below are pictures clicked by the researchers:

	
Fig 1: Cattle drinking water from the tanneries	Fig 2: Water from tanneries flowing into the fields
	
Fig 3: Sludge produced in tanneries	Fig 4: Sludge treatment plant (Small tannery)

Source: Compiled by the authors

Notes: The leather industry in Kanpur has faced closures due to allegations of tanneries discharging their effluent into the river. This has resulted in the decline of prices for hides and threatened the livelihoods of tanneries and allied businesses, including meat sellers. Tanneries are accused of causing pollution through improper effluent treatment, but they argue that the installed CETPs are insufficient and they lack support from government authorities. Research has revealed that the water released by the tanneries is not toxic and that the fields, cattle and crops are thriving (**refer to fig 1 and fig 2**). There are also allegations of tanneries dumping their sludge in water and nearby land, but researchers have found that tanneries have built-in sludge treatment plants (**refer to fig 3 and fig 4**).

Understanding the case of Jajmau

The tannery owners are only responsible for the primary treatment of their effluent and the government needs to step in for secondary and tertiary treatment processes. The government has announced schemes for the sustainable development of the leather industry ([DPIIT, 2022](#)), but the tanners face difficulties in accessing and implementing them. The situation in the Kanpur leather industry is cause for concern, and immediate action must be taken to address the issue of environmental pollution. Although the tanneries have implemented their own treatment methods, the problem lies with the inefficiency of the government-run treatment plants. It is imperative that the authorities take corrective measures to improve the management of effluent treatment. Corruption within the governing bodies has resulted in improper management of effluent treatment, leading to untreated effluent entering the river stream. This untreated effluent still requires further treatment, which is not implemented correctly. The government must prioritize this issue and take swift action to address it. The use of Nano-materials in the effluent treatment

process can prove to be an effective solution. However, it requires significant investment and research to develop cost-effective methods. The government must allocate adequate funds and promote research in this area. Moreover, the tanners must be educated, aware, and trained to implement these new technologies successfully. The implementation of government policies must be reviewed, and bureaucratic procedures must be minimized to enable tanners to access guidelines quickly. Additionally, the government must monitor other industries that contribute to water pollution and not solely target the leather industry. To support the tannery exporters, the government must relieve them from the high surcharge on export development. This high tax has decreased the demand for Indian Leather to **40%**, which is beneficial to the Bangladesh leather industry. The government must also take responsibility for the setting and maintenance of effluent treatment plants and charge the tannery owners for their operational maintenance. The government should initiate skill development programs to train small tanneries in the latest machinery and processes. The unavailability of raw materials has negatively impacted the leather production process, resulting in a decline in demand for Indian leather goods in the foreign market. As a result, the demand is shifting toward Indian counterparts such as Pakistan, Bangladesh, and China. In conclusion, the government must improve the implementation of its policies, monitor the working of local bodies, and take responsibility for the disposal of tannery waste. With corrective action, the Indian leather industry can revive its position as a leading global player in the leather market.

Part 3

The third part includes identifying challenges and possible strategies by formulating themes through content analysis of transcripts generated in text from the audio files ([Vaismoradi et al., 2013](#)). Qualitative content analysis is among the most prevalent techniques for scrutinizing qualitative data ([Burnard et al., 2008](#)) and is notable for its emphasis on the subject and context, foregrounding divergences and convergences within codes and categories ([Graneheim & Lundman, 2004](#)). This has been done through in-depth interviews with key stakeholders in the industry, including industry leaders, policymakers, and workers. The data collection was administered in Kanpur in Uttar Pradesh and in Chennai, Ranipet and Ambur in Tamil Nadu. The interviews were obtained in audio format which were transcribed in English language. The content analysis process starts with performing research on lower levels of abstraction, including text and manifest content. It ends with crystallizing the transcript to higher levels of abstraction, which consists of the reflection of interpretation and latent understanding of the text. The analysis starts with developing meaning units which are then shortened into condensed meaning units. These condensing units are then transformed into relevant codes, then segregated under meaningful categories. These categories are then explored to form underlying themes that come under the research's overarching theme ([Erlingsson & Brysiewicz, 2017](#)).

Table 4: An illustration showing how the interview transcript has been condensed into themes

Higher levels of abstractions represent interpreted and latent meaning of the interview text	Overarching theme	Problems faced by the Tamil Nadu leather industry
	Theme	The decline in demand for leather products
	Category	Competitive synthetic material
	Code	Synthetic material
	Condensed meaning units	Stiff competition from cheaper and attractive synthetic materials in China
	Meaning unit	The whole Indian leather industry is facing stiff competition from synthetic leather produced by China, which is cheaper and more attractive
Lower levels of abstractions that are close to the original interview manuscript		

Source: Concept adapted from (Erlingsson & Brysiewicz, 2017)

The content analysis of the transcripts revealed following variables to be considered for further qualitative investigations

Table 5: Variables - Challenges for the industry

S.No.	Main challenges	Sub-variables		
C1	The decline in the global leather trade	Decline in demand	High duties	Leather substitutes
C2	Ineffective monitoring of government agencies	Lack of accountability of NGOs	Corruption within agencies	Lack of industry support
C3	Troubled industrial scenario	Domination of large firms	Lack of finance for small firms	Shifting of tanneries
C4	Lack of skill and awareness	Lack of technical training	Top executives lack negotiation skills	Lack of awareness regarding sustainability
C5	The negative perception among customers	Tanners are unethical	Tanners are downgraded	Tanners are irresponsible
C6	Social discrimination	Unprofessional attitude	Discrimination of tanners	Violence against transporters
C7	Political instability	Shifting of production units	Closure of units	Banning slaughtering
C8	Fluctuating consumer market	Changing fashion trends	Opting for synthetic material	PETA campaigns
C9	Lack of modern technology	High production costs	Low environmental compliance	Low quality of production
C10	Environmental degradation	Pollution from effluent	Black-listing from the global market	Closure of tanneries

Source: Compiled by the authors

S.No.	Main challenges	Sub-variables			
S1	Monitoring government agencies and treatment units	Monitoring government agencies and NGOs	Financial support for machinery and schemes	Ensuring political stability	
S2	Technological upgradation	Researching low-cost technology	Treatment technologies	Production upgradation	
S3	Infrastructure development	Design centers	Factories relocation	Warehouse facilities	
S4	Implementing employee training	Technology training	Provision of facilities	Health and wages schemes	
S5	Spreading awareness	Educating employees in the workplace	Publishing articles	Attention is driven by government	
S6	Fostering a favorable working environment	Mitigating discrimination	Unity among businesses	Safety provisions	
S7	Treatment of effluent	Secondary and tertiary treatment from the Government	Recycling and ZLD	Reduction of chemical usage	
S8	Facility provisions for workers	Housing facilities	Transport facilities	On-job amenities	
S9	Providing financial support to the industry	Empowering small units	Providing access to loans	Relaxing taxes	
S10	Protection of industry workers from violence and harassment	Fast redressals	Educating against violent actions	Strong surveillance	

Part 4

Table 7: Reachability Matrix - Challenges

[illegible]

Table 7: Final Reachability Matrix - Challenges

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	DRP
C1	1	0*	1	0*	0*	0*	0*	1	0*	0*	10
C2	1	1	1	1	1	1	0*	1	1	1	10
C3	1	1	1	1	1	1	1	1	1	1	10
C4	1	0*	1	1	1	0*	0*	0*	0*	1	10
C5	1	0	0*	1	1	1	0	1	0*	0*	8
C6	1	0	0*	1	0*	1	0	1	1	0*	8
C7	1	1	1	1	1	1	1	1	1	1	10
C8	1	0	0*	1	0*	0	0	1	0	0*	6
C9	1	0	0*	1	1	0*	0	1	1	1	8
C10	1	0	0*	0*	1	1	0	1	0*	1	8
DPP	10	5	10	10	10	9	5	10	9	10	88

(0* denotes transitivity)

Table 8: Level Partitioning - Challenges

	Reachability Set	Antecedent Set	Intersection	
C1	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1
C2	1,2,3,4,5,6,7,8,9,10	1,2,3,4,7	1,2,3,4,7	
C3	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1
C4	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,8,9,10	1
C5	1,3,4,5,6,8,9,10	1,2,3,4,5,6,7,8,9,10	1,3,4,5,6,8,9,10	1
C6	1,3,4,5,6,8,9,10	1,2,3,4,5,6,7,9,10	1,3,4,5,6,9,10	
C7	1,2,3,4,5,6,7,8,9,10	1,2,3,4,7	1,2,3,4,7	
C8	1,3,4,5,8,10	1,2,3,4,5,6,7,8,9,10	1,3,4,5,8,10	1
C9	1,3,4,5,6,8,9,10	1,2,3,4,5,6,7,9,10	1,3,4,5,6,9,10	
C10	1,3,4,5,6,8,9,10	1,2,3,4,5,6,7,8,9,10	1,3,4,5,6,8,9,10	1
	Reachability Set	Antecedent Set	Intersection	
C2	2,6,7,9	2,7	2,7	
C6	6,9	2,6,7,9	6,9	2
C7	2,6,7,9	2,7	2,7	
C9	6,9	2,6,7,9	6,9	2
	Reachability Set	Antecedent Set	Intersection	
C2	2,7	2,7	2,7	3
C7	2,7	2,7	2,7	3

Table 9: MICMAC Analysis (Challenges)

10					C2, C7					C1, C3, C4
9										
8		Driving Factors					Linkage Factors	C6, C9		C5, C10
7										
6										C8
5										
4										
3		Autonomous Factors					Dependent Factors			
2										
1										
	1	2	3	4	5	6	7	8	9	10

Table 10: AHP Results for Challenges sub-variables

	Criterion	Weights	+/-
1	C11	21.8%	4.9%
2	C12	10.0%	2.2%
3	C13	68.2%	15.3%

	Criterion	Weights	+/-
1	C41	22.2%	4.0%
2	C42	10.8%	1.9%
3	C43	67.0%	12.0%

	Criterion	Weights	+/-
1	C71	10.3%	1.8%
2	C72	59.0%	10.2%
3	C73	30.7%	5.3%

	Criterion	Weights	+/-
1	C21	26.0%	4.6%
2	C22	63.6%	11.3%
3	C23	10.4%	1.8%

	Criterion	Weights	+/-
1	C51	24.8%	3.4%
2	C52	9.9%	1.3%
3	C53	65.3%	8.9%

	Criterion	Weights	+/-
1	C81	27.6%	6.6%
2	C82	63.2%	15.2%
3	C83	9.2%	2.2%

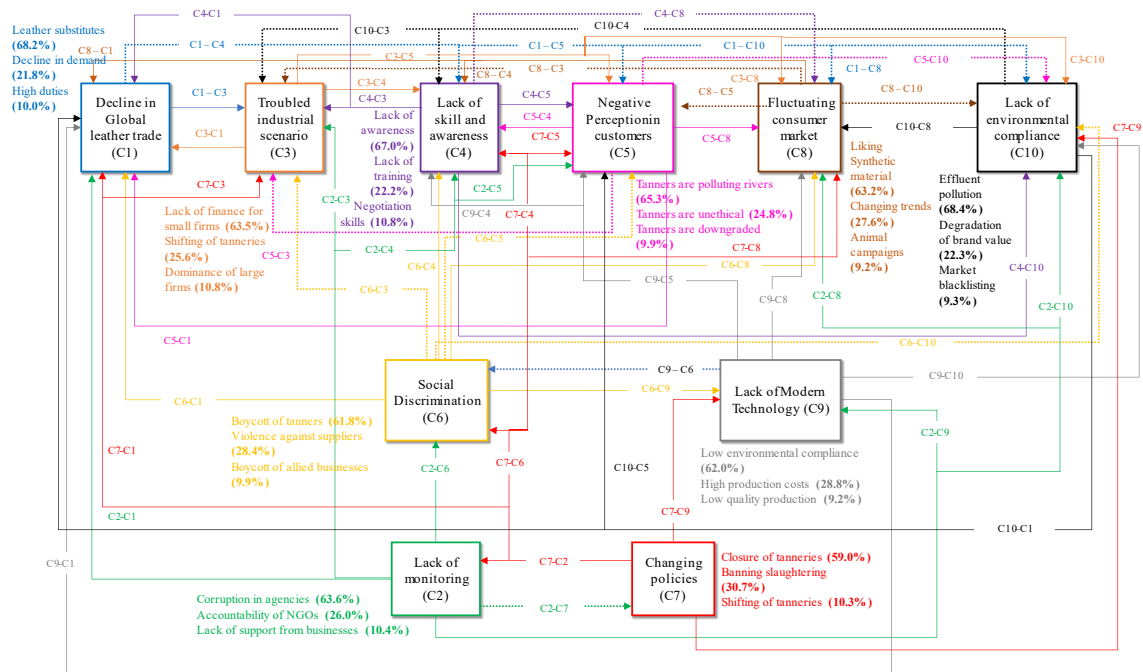
	Criterion	Weights	+/-
1	C101	22.3%	4.7%
2	C102	9.3%	2.0%
3	C103	68.4%	14.4%

	Criterion	Weights	+/-
1	C31	10.8%	2.0%
2	C32	63.5%	12.0%
3	C33	25.6%	4.8%

	Criterion	Weights	+/-
1	C61	9.9%	0.8%
2	C62	61.8%	5.1%
3	C63	28.4%	2.4%

	Criterion	Weights	+/-
1	C91	28.8%	5.3%
2	C92	62.0%	11.4%
3	C93	9.2%	1.7%

Fig 5: Challenges in Indian Leather Industry (TISM – AHP combined)



Source: Compiled by the authors

Findings

Challenges faced by Indian Leather Industry

Economic

The Indian leather industry faces several challenges in the present scenario, such as material intensity, electricity intensity, and petroleum intensity. The material intensity has declined in the footwear sector, but has increased in the manufacturing industries. On the other hand, the electricity intensity is a significant concern, particularly in the footwear sector in West Bengal, which has higher electricity consumption compared to the industrial average. Meanwhile, the petroleum intensity has shown a downward trend in the leather industry, but it still remains higher than the industrial average, with higher intensity in the tanning sector in Uttar Pradesh and in the

footwear sector in West Bengal. One of the major challenges faced by the industry is non-compliance (Roy, 2012) with environmental standards. The government must enforce the rules and regulations to ensure that the leather industry operates sustainably and does not harm the environment. The industry must work towards reducing its carbon footprint (Acquaye et al., 2017) and adopt eco-friendly practices (Kafa et al., 2013). Additionally, the industry must strive to upgrade its technology and improve its processes to ensure efficient resource utilization and reduce waste. By addressing these challenges, the leather industry can play a key role in promoting sustainable and responsible production in India. The Indian leather industry faces a multitude of challenges, both internally and externally. One of the main hindrances is the rampant corruption (S. Gupta et al., 2007) within the government agencies responsible for monitoring and implementing policies set forth by the government. The lack of accountability among NGOs working towards the upliftment of the leather sector also exacerbates the situation. Additionally, a lack of support from the business community in reporting issues to the government further complicates the situation. Changing government policies and a lack of clarity in these policies result in uncertainty for the leather industry. Another challenge faced by the leather industry is the outdated technology (Garai, 2014b). Due to a lack of attention and support from the government, the sector has not been able to advance in terms of technology and production methods. This has resulted in higher production costs, lower quality products, and a decline in the competitiveness of the Indian leather industry in the global market. The absence of modern treatment methods and inefficient management of effluent have also led to environmental pollution, further damaging the reputation of the industry. The leather sector is also facing stiff competition from alternative materials such as synthetic materials, which have been able to capture a large portion of the market share. This can be attributed to the lack of modern technology and production techniques in the leather industry, which hampers the quality of leather and impacts its demand. The decline in demand for leather globally, along with the prevalence of synthetic materials, has resulted in a decline in the Indian leather industry's performance and market share. In conclusion, the Indian leather industry needs the support and attention of policymakers and the government to address the challenges faced by the sector and regain its competitiveness in the global market.

Environmental

The footwear sector in West Bengal is making great strides in sustainability with a decrease in material intensity. However, the high electricity intensity remains a concern for the industry. The leather sector in particular, and West Bengal's manufacturing industry as a whole, struggle with electricity consumption. The good news is that the petroleum intensity in the leather industry has shown a downward trend, but it still exceeds the industrial average. In the tanning sector, Uttar Pradesh has a higher petroleum intensity, but in the footwear sector, West Bengal takes the lead. The biggest challenge to the industry is non-compliance with environmental standards. It's crucial for the sector to prioritize sustainability and implement eco-friendly practices (Sathya et al., 2022) to reduce its impact on the environment. The pollution caused by tanneries is a severe issue that has far-reaching consequences for human, animal, and aquatic life. The absence of modern technology in the industry is a significant contributor to the problem, with many businesses lacking eco-friendly production facilities and effective methods for treating or reusing their effluent. This results in toxic effluent being discharged into rivers and lands (Srinivas & Singh, 2018), rendering the water unsafe for drinking and causing harm to the environment. Unfortunately, the lack of compliance in northern states such as Uttar Pradesh and West Bengal exacerbates the problem, with the effluent discharge often exceeding the capacity of treatment plants. Small businesses within the industry, who are already considered a degraded community, are further disadvantaged by a lack of access to technological upgrades and development aids offered by the government.

Their sole focus becomes production and profit, with little regard for sustainable manufacturing. The negative perception of the tanners by customers only exacerbates their image, ultimately affecting the way they conduct their operations.

In the Indian leather industry, particularly in the states of Uttar Pradesh and West Bengal, the gender ratio is alarmingly skewed towards men. In Uttar Pradesh, only 24 women are employed in the footwear sector for every 1000 male workers, while the number is slightly higher at 41 women in West Bengal. Despite global efforts to promote women's empowerment, this disparity highlights the lack of progress made in these two states. Not only does the gender ratio raise concern, but the trend in the footwear sector is also concerning. The percentage of bonus expenses has remained stagnant and has even declined since 2016. This highlights a lack of progress in the tanning sector, and the footwear sector in general. Uttar Pradesh and West Bengal are lagging behind in terms of social sustainability parameters, particularly in terms of gender balance. In terms of environmental parameters, Uttar Pradesh has performed poorly, with tanneries showing a lack of attention to both environmental and social factors. To improve the overall state of the footwear sector in Uttar Pradesh, there needs to be an increase in the gender ratio and in the employer's contribution. Small tanners face a double-edged sword in their industry. On one hand, they find themselves socially isolated from their peers, especially those who run small businesses. The lack of support from government authorities is a major contributing factor to this issue, as large businesses have strong networks and can secure a larger share of government provisions and financial aid. On the other hand, the lack of modern technology and a shortage of financial resources to purchase advanced machinery further exacerbates their isolation. This creates a vicious cycle, where small businesses are considered outdated and traditional (Garai, 2014b), making it difficult for them to attract customers and invest in their employees' skill development. Moreover, the shifting demand globally makes the industry less attractive, which causes the government and private firms to focus their investments on more promising industries. The lack of investment in technology and skill development reinforces the negative perception of customers, who view the industry personnel as not competent enough and environmentally damaging. All these factors contribute to the social isolation faced by small tanners, creating a need for proper monitoring and support from the authorities to help revive the industry and bring it back to its former glory.

[illegible]

Table 12: Final Reachability Matrix

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Driving Power
S1	1	1	1	1	1	1	1	1	1	1	10
S2	0*	1	1	1	1	1	1	1	0	0*	9
S3	0*	1	1	1	1	1	1	1	0	1	9
S4	0*	1	0*	1	1	1	1	0*	0	0*	9
S5	1	0*	0*	0*	1	1	1	0*	0*	1	10
S6	0	0*	0	1	1	1	1	1	0	1	7
S7	0	0	0	0	0	0	1	0	0	0	1
S8	0	0*	0	1	0*	1	0*	1	0	1	7
S9	0*	1	1	1	1	1	1	1	1	1	10
S10	0	0	0	0	0	0	0	0	0	1	1
Dependence Power	6	8	6	8	8	8	9	8	3	9	73

(0* denotes transitivity)

Table 13: Level Partitioning

	Reachability Set	Antecedent Set	Intersection	
S1	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,9	1,2,3,4,5,9	
S2	1,2,3,4,5,6,7,8,10	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8	
S3	1,2,3,4,5,6,7,8,10	1,2,3,4,5,9	1,2,3,4,5	
S4	1,2,3,4,5,6,7,8,10	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8	
S5	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8,9	
S6	2,4,5,6,7,8,10	1,2,3,4,5,6,8,9	2,4,5,6,8	
S7	7	1,2,3,4,5,6,7,8,9	7	1
S8	2,4,5,6,7,8,10	1,2,3,4,5,6,8,9	2,4,5,6,8	
S9	1,2,3,4,5,6,7,8,9,10	1,5,9	1,5,9	
S10	10	1,2,3,4,5,6,8,9,10	10	1
	Reachability Set	Antecedent Set	Intersection	
S1	1,2,3,4,5,6,8,9	1,2,3,4,5,9	1,2,3,4,5,9	
S2	1,2,3,4,5,6,8	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8	2
S3	1,2,3,4,5,6,8	1,2,3,4,5,9	1,2,3,4,5	
S4	1,2,3,4,5,6,8	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8	2
S5	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8,9	2
S6	2,4,5,6,8	1,2,3,4,5,6,8,9	2,4,5,6,8	2
S8	2,4,5,6,8	1,2,3,4,5,6,8,9	2,4,5,6,8	2
S9	1,2,3,4,5,6,8,9	1,5,9	1,5,9	
	Reachability Set	Antecedent Set	Intersection	
S1	1,3,9	1,3,9	1,3,9	3
S3	1,3	1,3,9	1,3	3
S9	1,3,9	1,9	1,9	
	Reachability Set	Antecedent Set	Intersection	
S9	9	9	9	4

Table 14: MICMAC Analysis (Strategies)

10	S9			S1			S5			
9										
8	Driving Factors			S6, S8			S2, S4			
7				Linkage Factors						
6							S3			
5										
4										
3	Autonomous Factors			Dependent Factors						
2										
1							S7, S10			
	1	2	3	4	5	6	7	8	9	10

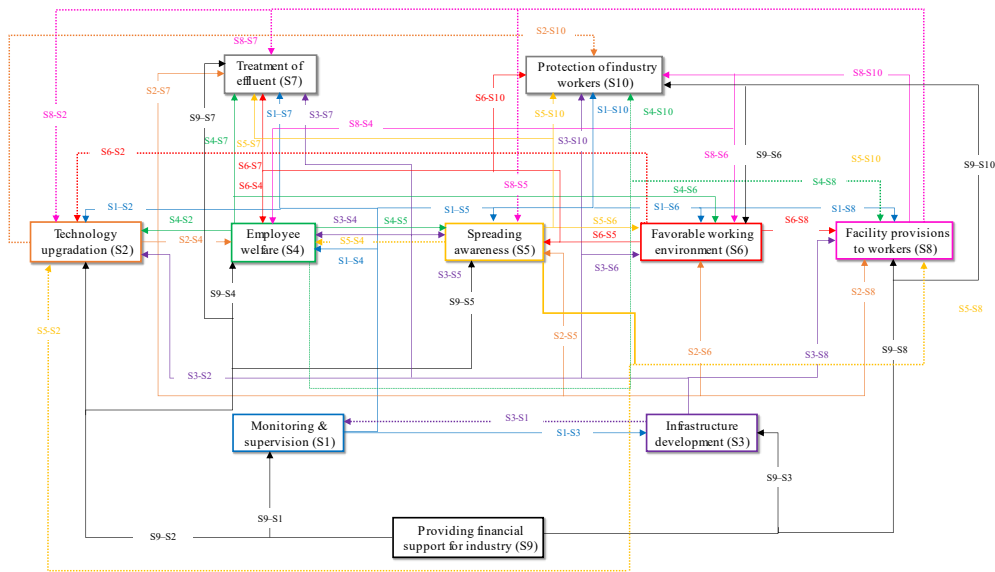
Table 15: AHP Results for Strategies sub-variables

	Criterion	Weights	+/-
1	S11	24.3%	4.9%
2	S12	9.5%	1.9%
3	S13	66.2%	13.5%
	Criterion	Weights	+/-
1	S41	9.7%	2.2%
2	S42	65.5%	15.0%
3	S43	24.7%	5.7%
	Criterion	Weights	+/-
1	S71	61.5%	14.0%
2	S72	28.6%	6.5%
3	S73	9.9%	2.2%

	Criterion	Weights	+/-
1	S21	28.3%	6.2%
2	S22	62.2%	13.6%
3	S23	9.5%	2.1%
	Criterion	Weights	+/-
1	S51	67.0%	14.0%
2	S52	10.7%	2.2%
3	S53	22.4%	4.7%
	Criterion	Weights	+/-
1	S81	20.9%	5.2%
2	S82	10.1%	2.5%
3	S83	69.0%	17.1%
	Criterion	Weights	+/-
1	S101	26.0%	2.8%
2	S102	10.8%	1.2%
3	S103	63.2%	6.8%

	Criterion	Weights	+/-
1	S31	10.2%	2.0%
2	S32	60.2%	11.6%
3	S33	29.6%	5.7%
	Criterion	Weights	+/-
1	S61	21.5%	4.0%
2	S62	10.4%	1.9%
3	S63	68.1%	12.7%
	Criterion	Weights	+/-
1	S91	21.7%	4.5%
2	S92	10.5%	2.2%
3	S93	67.8%	14.0%

Fig 6: Strategies for Indian Leather Industry (TISM – AHP combined)



Source: Compiled by the authors



Fig 7: A worker transporting leather hides in TN



Fig 8: Advance Machinery for Spraying in TN



Fig 9: Mechanized Tanning Drums in TN



Fig 10: Environmental Awareness Banners in TN



Fig 11: Modified Pre-Treatment Unit in TN



Fig 12: Clean roads and transportation in TN



Fig 13: Women working along with Men in TN



Fig 14: Woman doing manual labour in TN



Fig 15: Women working in Tanneries in TN



Fig 16: No Child Labour board in TN

Source: Clicked by researchers

Sustainable opportunities & strategies

Economic

The leather industry in India has significant growth opportunities, as demonstrated by its **favorable fixed assets turnover**. The industry is performing well, particularly in West Bengal, which has a higher turnover rate than the national average. The tanning sector in Tamil Nadu and West Bengal has also shown promising total productivity, with an increase in their productivity ratios, despite the national average dipping. While Uttar Pradesh lags behind the other states, it is catching up and offers potential for further growth in the industry. These trends indicate that there is potential for continued growth in the Indian leather industry and present opportunities for investment and expansion. Additionally, the government can provide tax incentives (Kamau & Kinoti, 2021) to firms that adopt sustainable practices such as recovering chromium from the tannery effluent (A. Singh & Gundimeda, 2020). This not only helps in reducing the cost of production but also helps in creating a cleaner and greener environment. The government can also provide training programs to help workers acquire new skills and improve their overall efficiency. Moreover, by investing in R&D, the government can encourage innovation and the development of new technologies (refer to fig 8 and 9) that are more sustainable. Finally, the government can also play a role in creating a market for sustainable products by promoting eco-friendly labeling (S. Gupta et al., 2007), educating consumers about the benefits of sustainable products, and supporting environmentally friendly production processes. In this way, the government can help create demand for sustainable products and encourage firms to adopt sustainable practices. In conclusion, the government plays a crucial role in promoting sustainability in the Indian Leather industry. By providing financial, technical, and regulatory support, the government can help firms adopt sustainable practices and contribute to the development of a more environmentally friendly and economically viable industry.

Environmental

The Indian leather industry has significant environmental growth opportunities, as demonstrated by its favorable electricity, fuel, and coal intensity levels. The tanneries have been performing well in all three states, compared to the national average, and the government should analyze the factors that contribute to high electricity intensity in the footwear sector. The success of the tanning sector in reducing electricity consumption should be further explored and applied to the rest of the

industry. The fuel and coal intensity for the leather industry is also much lower compared to the national average, indicating a positive trend in terms of sustainability. The industry can leverage this low carbon footprint as a competitive advantage. By addressing areas of high electricity consumption, the Indian leather industry can continue to improve its environmental performance and capitalize on growth opportunities. With the increasing number of units being shut down (S. Singh, 2018) due to non-compliance, it is imperative that the industry take measures to address this issue. The treatment of effluent involves multiple stages, and small units cannot carry out all these stages on their own. They require support from the government in the form of financial assistance and proper monitoring (Srinivas & Singh, 2018). The effluent must be treated in secondary and tertiary treatment plants maintained by government agencies. These plants must be monitored closely to ensure that the amount of effluent discharged is reduced. The goal should be to achieve zero liquid discharge, where the recycled water is used for other purposes. Technological upgradation (**refer to fig 11**) is also essential for the effective treatment of effluent. The capacity of the treatment plants needs to be increased, and workers must be trained to work on advanced machinery (S. K. Gupta et al., 2019). The spending on technological upgradation will only be justifiable if the workers have the necessary skills to implement it. Creating awareness (**refer to fig 10**) within the industry is crucial, and the cooperation of the workers is necessary for making a better working environment (**refer to fig 12**). The technological upgradation will largely depend on government assistance. Improving the infrastructure will pave the way for the effective implementation of technical advancements. Finally, the business units must meet safety and skill standards before being approved.

Social

The Indian leather industry has promising social growth opportunities, as indicated by its favorable gender ratio and expenses for salary wages and bonuses. Tamil Nadu is the only state where the number of women workers in the leather sector is higher than men, and this trend has been increasing over time. This is a positive sign and other states, including Uttar Pradesh and West Bengal, should learn from Tamil Nadu's best practices in providing equal opportunities for women (**refer to fig 13, 14 and 15**) in the leather sector. The leather industry is also performing well in terms of salary wages and bonus expenses, which is a positive sign compared to other industries. However, Uttar Pradesh and West Bengal still need improvement to be at par with Tamil Nadu. Focusing on enhancing the wage structure of workers and promoting education for all genders will significantly improve the social performance of the Indian leather industry. In order to improve the working conditions in the leather industry, particularly in the northern region, several measures need to be taken. Firstly, certifications such as ISO need to be made mandatory for all production centers. This will ensure that the workers are provided with necessary safety provisions and working in a safe environment (**refer to fig 7**). However, this requires financial assistance from the government. Secondly, it is important to raise awareness among employees about the safety provisions and importance of working in a safe environment (UNIDO, 2021). This will lead the employers to adopt preventive measures. In addition, creating a favorable working environment where every employee feels respected and valued is crucial. This will prevent any form of on-job harassment and violence (Jain, 2019). Production units in Tamil Nadu can serve as an example by promoting a healthy and safe working environment. It is important to put up No Child Labour boards (**refer to fig 16**) at the gates of the factories to promote ethical practices. By doing so, the workers will feel valued and motivated, making it easier for them to be trained in new skills. A trained workforce will be more cooperative and willing to adopt sustainable and ethical norms put

forward by the management. It is imperative for the management to prioritize the well-being of the workers as this will lead to a better and more sustainable business.

Suggestions

Role of administration and government agencies

Industry inspection is a critical aspect of ensuring the sustainability and compliance of industrial operations. The implementation of schemes from local bodies and monitoring of the work status of projects run by NGOs are essential steps in this process (A. Singh & Gundimeda, 2020). Additionally, identification of treatment capacity lags in water treatment and identification of water pollution by other industries is crucial in addressing environmental concerns. In order to support the leather industry, financial support measures should be put in place to streamline access to loans for production houses. Additionally, setting up housing facilities for workers in nearby areas of production houses and training industry personnel in advanced processes such as Zero Liquid Discharge (ZLD) (A. Sharma & Varma, 2012) and Nano-technology (Bora & Dutta, 2014; Lu et al., 2008; Nagar & Pradeep, 2020; Seggiani et al., 2014) can improve the efficiency and sustainability of operations. To further address environmental concerns, secondary and tertiary treatment of effluent through Common Effluent Treatment Plants (CETPs) can be implemented. Surveillance of the leather industry is also critical to ensure compliance with regulations and to prevent illegal activities (Srinivas & Singh, 2018). This includes ensuring safe transportation of leather hides from suppliers to production houses, ensuring the number of hides and water usage in production houses are within specified norms and regulations, and ensuring that there is no involvement of child or forced labour in the production houses. Overall, a comprehensive approach to industry inspection, financial support, and surveillance is necessary to ensure the sustainability and compliance of the leather industry.

Role of owners and managers

Developing a favorable work environment for occupational safety is crucial for the success and sustainability of any industry. One of the key ways to do this is by avoiding discrimination based on age, gender, region, and religion. This can be achieved through the use of CCTV cameras (UNIDO, 2021) and fast redressals for any complaints that may arise. Additionally, providing health provisions and on-job amenities to employees, such as industry standard salaries and bonuses, can help to improve job satisfaction and retention. Compliance with ISO norms of production, such as safety equipment and material usage, is also important to ensure that the workplace is safe and efficient. Raising awareness through communication strategies like posters and guidelines is key to promoting sustainability in the workplace. Incentivizing employees with rewards and recognition for their eco-friendly practices can encourage a culture of sustainability, reducing waste and conserving resources. (Haque & Ntim, 2020). Additionally, educating employees about gender inclusion and providing opportunities for women to work in the industry can help to promote diversity and inclusion (UNIDO, 2019). Employee training is an important aspect of the industry, it can be done by encouraging employee participation in leather fairs and other national & international trade interactions, and encouraging employees to join training programs and providing them funds for paying the fees. Cooperation with officials and other stakeholders is also important. This includes reporting any unethical as well as promoting sustainability activities (Omolooso et al., 2020), such as discrimination or dumping of waste, to the local body administration, cooperating with researchers and sharing knowledge about problems within the industry, and refraining from any illegal production activity, such as exceeding the

permissible limit on the production of hides and shoes. Overall, developing a favorable work environment, creating awareness, employee training, sustainability reporting (Omoloso et al., 2020) and cooperation with officials are all essential steps in ensuring the sustainability and success of the leather industry.

Discussion

Important note:

Based on a thorough analysis, the initial understanding was that the most critical issue is the failure to comply with environmental regulations in the industry. This lack of compliance has resulted in negative public perception, leading to the closure of industries. As a consequence, a significant increase in unemployment has occurred, adversely affecting the economy. In essence, environmental problems are causing social and economic challenges. This forms our initial understanding of the situation. However, the outcomes of the research offer valuable insights, prompting a reassessment of our initial understanding that environmental problems directly cause social and economic challenges. The research findings reveal a different perspective, highlighting the influence of environmental compliance as influenced by various social and economic factors. The predominant underlying issue identified through the research is the absence of effective monitoring mechanisms and evolving government policies. Consequently, it becomes evident that the onus of initiating the revival process lies with the government, contrary to our initial understanding that the tanners themselves should take the first step towards environmental compliance. Notably, the case study conducted in the Jajmau region of Kanpur suggests that primary treatment practices are being implemented in the production units. However, the implementation of secondary and tertiary treatments necessitates government intervention, entailing investments in common effluent treatment plants and regular monitoring of their functioning.

The Indian leather industry faces multiple challenges, including economic, environmental, and social aspects. Several regions, including Uttar Pradesh and West Bengal, struggle with meeting international standards when it comes to sustainable compliance. While tanners in Uttar Pradesh may bear some responsibility for the issues they face, the issues go beyond that. Among the factors contributing to the lack of sustainable compliance are inadequate monitoring of non-governmental organizations, suboptimal policy implementation, and shortcomings in the secondary and tertiary treatment processes. This has implications for countries that import Indian leather products, as they must ensure that their supply chains meet international sustainability standards. As foreign countries recognize the challenges specific regions face and encourage sustainable practices, they can support the Indian leather industry's sustainable growth and promote responsible sourcing. Tamil Nadu, on the other hand, has taken commendable steps to improve sustainability in its industry and deal with compliance issues. This has had short-term economic repercussions, but in the long-term, it is expected to safeguard the industry's global competitiveness by enabling it to successfully navigate challenges such as closures and blacklistings. Among the most pressing concerns of the Indian leather industry are insufficient monitoring mechanisms and unstable government policies. There is a link between these issues and the economic performance of the industry, such as a decline in leather exports, noncompliance with environmental regulations, and a negative perception of the industry by global customers. In addition, social discrimination and the absence of modern technology make these challenges even more difficult, further weakening the position of the industry in the global economy. Our research shows addressing these issues for ensuring industry economic performance. In order to engage in trade with India's leather industry, foreign nations should advocate for transparent monitoring processes and consistent policy frameworks. While enhancing global competitiveness, this will help create a level playing field and ensure fair competition. In order to maintain strong trade relations with foreign countries that import Indian leather products, such as the United States, Germany, the United Kingdom, Italy, and France, it is essential to understand the challenges faced by the industry. In order to maintain

a reliable supply of high-quality leather products, foreign countries can support initiatives that address these challenges. Further, our research shows that proactive government intervention as well as industry-wide initiatives particularly in terms of the provision of financial support, the strengthening of monitoring mechanisms, and the investment in infrastructure development are necessary to revitalize the Indian leather industry. Additionally, safety and well-being of industrial workers should be ensured as well as effluent treatment facilities should be improved. Reviving the industry requires technology upgrading, ensuring employee welfare, creating a favorable working environment that is in compliance with international labor standards, and fostering awareness. The implementation of sustainable practices and technological advancements can be assisted by foreign countries through collaborations, sharing of best practices, and financial assistance. As a result, not only will the industry benefit, but also the relationship between nations will be strengthened and responsible trade will be promoted. Globally, it is imperative to highlight the economic significance of the Indian Leather Industry. Any decline in the industry's performance could negatively affect India's overall economy, since it contributes significantly to the country's export earnings. Hence, addressing the sector's challenges and promoting sustainable practices will not only benefit global stakeholders, but also enhance India's competitiveness in the market, thus ensuring the country's economic stability and growth.

Conclusion

The purpose of this research is to critically analyze the current state of the Indian leather industry, focusing on its pressing sustainability challenges and suggesting strategies for its revitalization. An integrated research approach, including the use of primary and secondary data sources, observations on the ground, and interviews with key stakeholders, provided valuable insights into the study. In addition to highlighting the industry's economic significance, the findings highlight its complex interdependencies. Environmental pollution, resource degradation, and non-compliance with regulations have plagued the Indian leather industry, renowned globally for its exports. In addition to being harmful to the environment, animal life, and human health, the cattle production process entails extensive chemical usage and water-intensive processes. In order for the industry to develop and grow, sustainable standards and environmental regulations must be met. This study has also shed light on the socio-economic impact of the industry, with its historical and cultural significance as a source of livelihood for many individuals, particularly in specific regions. Businesses closures and widespread unemployment in recent years necessitate urgent measures to address industry sustainability challenges. Policymakers and industry practitioners have been recommended recommendations to support the revitalization of Indian leather. The measures include improving industry inspections and monitoring, implementing financial support measures, improving occupational safety and work environments, raising sustainability awareness, and fostering collaboration among stakeholders. As the industry adopts sustainable business models, incorporates innovative technologies, and prioritizes compliance with environmental regulations, long-term growth, profitability, and societal benefits can be achieved. The overall objective of this study is to understand the obstacles confronting the Indian leather industry and provide valuable perspectives for decision-makers and industry leaders. In addition to resurging the industry in a sustainable way, it emphasizes supporting livelihoods, preserving the environment, and driving economic growth.

Implications and Future research directions

This study provides important information for policy development in the Indian leather industry, specifically in terms of investments, technology, and government regulations. The government can use the findings to determine where funding is needed and which business functions require the greatest investment, as well as what kind of technology is necessary for the industry's expansion. The study also sheds light on the government's role in the industry's decline and highlights the need for preservation of the sector for value addition, employment, and growth. Additionally, the study has academic implications, as the growth of the Indian leather industry has led to an increase in scholarly research on the sector and a deeper understanding of traditional and modern leather processing techniques and products. Further research, such as questionnaire-based surveys, can be conducted based on the study's findings. The study's findings also hold significant relevance as they provide a valuable reference for understanding sustainability challenges faced by industries in Europe, particularly in the United Kingdom (Dey et al., 2020).

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