ADOPTION OF GREEN SUPPLY CHAIN MANAGEMENT IN INDIAN LEATHER INDUSTRY

A thesis submitted to the
UPES

For the Award of
Doctor of Philosophy
in
Management

By
MANOJ KUMAR

Jul 2024

Supervisor
Dr. Ankur Mittal
External Supervisor
Dr. T Joji Rao

School of Business
UPES
Dehradun-248007: Uttarakhand

ADOPTION OF GREEN SUPPLY CHAIN MANAGEMENT IN INDIAN LEATHER INDUSTRY

A thesis submitted to the
UPES

For the Award of
Doctor of Philosophy
in
Management

BY
MANOJ KUMAR
SAP ID : 500078617

Jul 2024

Internal Superevisor
Dr. Ankur Mittal
Professor
School of Business
UPES

External Superevisor
Dr. T Joji Rao
Professor
Jindal Global Business School
O P Jindal University

School of Business
UPES
Dehradun-248007: Uttarakhand

Candidate Declaration

I hereby declare that the work which is being presented in the thesis entitled "ADOPTION OF GREEN SUPPLY CHAIN MANAGEMENT IN INDIAN LEATHER INDUSTRY" fulfilment the requirements for the award of the Degree of Doctor of Philosophy and submitted to the UPES is an authentic record of my work carried out during the period from July 2019 to Jul 2024 under the supervision of supervisor Dr Ankur Mittal, Professor (UPES) and Dr T Joji Rao, Professor (O.P Jindal Global University). The matter presented in the thesis has not been submitted by me for the award of any other degree or diploma of this or any other institution of higher learning, except where due acknowledgement has been made in the text.

Date:

(MANOJ KUMAR)
Candidate

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

(Dr. ANKUR MITTAL)

(Internal Supervisor)

T. Joji Rao

(External Supervisor)

The Ph.D. Viva-Voice examination of *Manoj Kumar*, Research Scholar has been held on _____.

(Supervisor) **(External Examiner)** **(Chairperson)**

UPES
UNIVERSITY OF TOMORROW

Great Place To Work. Certified FEB 2023 – FEB 2024 INDIA

16th August, 2024

CERTIFICATE OF INTERNAL SUPERVISOR

It is certified that Mr. MANOJ KUMAR has presented his thesis entitled "ADPOTION OF GREEN SUPPLY CHAIN MANAGEMENT IN INDIAN LEATHER INDUSTRY" for the award of Ph. D degree of the UPES under my guidance. He has carried out work in management at School of Business, UPES.

Signature of Internal Supervisor

Name: Dr. Ankur Mittal

O.P. JINDAL GLOBAL
INSTITUTION OF EMINENCE DEEMED TO BE
UNIVERSITY
A Private University Promoting Public Service

Sonipat Narela Road
Sonipat- 131 001, Haryana
NCR of Delhi, India

Tel: +91 130 4091800/801/802
Fax: +91 130 4091888
Email: info@jgu.edu.in

16th August, 2024

CERTIFICATE OF EXTERNAL SUPERVISOR

It is certified that **Mr. MANOJ KUMAR** has prepared his thesis entitled "ADOPTION OF GREEN SUPPLY CHAIN MANAGEMENT IN INDIAN LEATHER INDUSTRY" for the award of Ph.D degree of the UPES under my guidance. He has carried out work in management at the School of Business, UPES.

Signature of the Supervisor

Name: Prof. T. Joji Rao

Abstract

This research investigates the internal and external barriers to implementing Green Supply Chain Management (GSCM) in the Indian leather industry, specifically focusing on understanding the relationship between green supply practices and industry performance. The study employs a multi-method approach, integrating Interpretive Structural Modeling (ISM) to analyze barriers to GSCM adoption and cubic regression modelling to examine the association between green supply practices and performance metrics. Empirical data from five case studies within the Indian leather sector form the basis of analysis. Findings reveal inconsistent quality and inadequate regulatory frameworks as primary barriers to successful GSCM implementation in the Indian leather industry. Additionally, the study highlights the influence of human behaviour on GSCM adoption and presents a cubic regression model illustrating the relationship between green supply practices and industry performance indicators. This research contributes to the existing body of knowledge by providing insights into the complex dynamics of GSCM adoption in the context of the Indian leather industry. Integrating ISM and cubic regression modelling offers a comprehensive understanding of the barriers and opportunities associated with sustainable supply chain management practices. The findings offer practical implications for GSCM decision-makers in the Indian leather industry, guiding the development of effective strategies to address barriers and promote sustainable practices. Additionally, the study underscores the importance of regulatory interventions and quality assurance measures in facilitating GSCM implementation.

Keywords: *Green supply chain management, TISM,MICMAC, behavioural factors, Cubical regression, Case study approach.*

Acknowledgements

I sincerely thank my guides, Dr. Ankur Mittal and Dr. T. Joji Rao, for their invaluable guidance, support, and direction, which were instrumental to my research. Their expertise and knowledge were crucial in shaping my study. Their vision, sincerity, and motivation deeply inspired me, and it was a privilege to work under their guidance. I also appreciate the continuous encouragement and extensive time they devoted to ensuring the timely completion of my studies. I am deeply grateful to the entire faculty and staff of the School of Business, UPES, and especially to Dr. P.C. Bahuguna for his valuable support. I also thank the School Research Committee (SRC) members for their constant guidance and support. Thanks to the Library and Research team at UPES for providing a conducive learning environment. Additionally, I am thankful to Dr. Jagdish Chand Bansal, Dr. Nitika Sharma, and Dr. Himanshu Mittal for their immense help throughout this journey. The unwavering support of the Indian Air Force and the country, allowing me to work on my research as needed, was crucial to this endeavour. Behind this success, the steadfast support of my family was always there. I am deeply grateful to my parents, Urmila Devi and Diwan Singh; my wife, Reena Singh; my son, Adhrit Singh Chaudhary; and my brother, Papinder Singh, for their patience, support, and encouragement. Their belief in me and my work was a constant source of strength and motivation. Finally, I would also like to thank all those who have helped and assisted me in any small way in the successful completion of this thesis.

(Manoj Kumar)

Table of Contents

List of Figures

Title **Page No.**

List of Tables

Title **Page No.**

Chapter 1

Introduction

1.1 Introduction

India's leather industry has a rich history dating back to 3000 BC, evolving from traditional tanning methods to modern processes introduced during British colonial rule. Milestones such as establishing the first shoe factory in Kanpur in 1880 and founding the Central Leather Research Institute in 1948 highlight its strategic significance in India's economic development. Despite facing challenges and policy shifts, including restrictions on raw material exports, the industry has flourished, becoming a key contributor to India's economy. Today, it is a vital source of foreign exchange earnings and employment, particularly for low-income households. However, rapid growth has brought environmental concerns to the forefront, necessitating the adoption of sustainable practices. Embracing GSCM has become imperative, driven by evolving customer preferences and regulatory pressures. This chapter explores the equations of the green supply chain with industry performance of the IND leather sector. Through meticulously analysing internal and external barriers and applying advanced methodologies, the valuable insights are offered for practical recommendations to foster sustainable development within the industry. Moreover, the research endeavours to shed light on the various behavioural factors that may influence implementing GSCM practices in the IND leather industry. By examining the nuances of human behaviour and its impact on organisational decision-making processes, the study provides a comprehensive understanding of the challenges and opportunities associated with GSCM adoption. Through this dual focus on supply chain practices and behavioural dynamics, the study aims to contribute significantly to the ongoing discourse on sustainable development in the IND leather sector. Ultimately, the insights gleaned from this research endeavour have

the potential to inform strategic interventions and drive positive change towards a more environmentally responsible and socially conscious industry landscape.

1.2 Background

Leather is India's oldest industrial sector, dating back to 3000 BC. Regarding claims, leather was tanned using fat scrubbing, fumigation, and dyeing and utilised for garments, tents, footwear, and seats. In 1913, 24 tanneries were allowed to operate throughout India because of rising demand. The 1948 creation of the CLRI in independent India was essential for the leather industry. India purposefully bans the export of raw hides and skins, leaving leather and associated goods to the small-scale sector. 1972, Dr. A. Seetharamiah's group proposed restricting exports to finished leather and other value-added goods. Forex markets fully developed during trade liberalisation in the 1990s, dictating national and global activities. Committee (2012). Trade liberalisation was thought to benefit emerging economies with comparative advantages in natural resource extraction and labour-intensive products. This area has long been a priority for India. The Wrkg Gp Rpt GOI, 2011 have shown that our country's sector is the top job creator and foreign currency earner Bechtsis et al. (2018).

The IND economy relies on leather, leather goods, and footwear. The country's top 10 foreign currency earners include this industry, noted for its substantial export income. The sector has plentiful raw resources since India possesses 20 per cent of the world's cows and buffalo and 11 per cent of goats and sheep. Trained labour, modern technology, enhanced industrial conformity with international environmental standards, and allied industries' continuous support are further benefits. Over 4.42 million individuals, mostly from low-income households, work in the leather business. Women comprise up to 30 per cent of leather product workers. India is the world's second-biggest leather garment exporter, third-largest saddlery and harness exporter, and largest leather products exporter. Critical leather production stages include:

1. **Tanning**: Tanning is the first and most crucial step in leather manufacturing. This process involves treating hides or skins with tannins, minerals, and other materials to make them soft, flexible, and resistant to water and decay.

2. **Splitting**: Splitting is slicing the hide into thinner parts. This helps to ensure that the leather is of a consistent thickness and offers greater flexibility.

3. **Dyeing**: The dyeing technique involves colouring the leather. Numerous techniques, like painting, staining, and natural dyes, can achieve this.

4. **Finishing**: Finishing adds protective layers to the leather. This includes waxes, oils, and sprays that help to make the leather more resistant to water, stains, and scratches.

5. **Cutting**: Cutting involves forming the leather into the appropriate shape for the product. Several techniques can be used, including manual cutting and die-cutting machines.

6. **Stitching**: Stitching joins the leather pieces together. This is usually done with heavy-duty thread and specialised machines.

7. **Assembling**: Assembling combines all the pieces to create the finished product. This includes the use of adhesives, rivets, and others.

Recent production and consumption increases and supply chain activities have caused environmental damage. Many IND companies handle environmental challenges complicatedly governed by laws and regulations. In the 21st century, when customers shape the strategies of significant businesses and sectors, GSCM has become more critical. Customers drive green product awareness and force big companies to rethink their supply chain management methods. Environmental groups also move green products and supply chains. Additionally, many companies prioritise pollution avoidance over control Lu et al. (2007).

Leather production produces chromium, sulphates, and formaldehyde, which may pollute. The leather business pollutes air, water, and land with dyes and other chemicals. Leather manufacturers may minimise pollution by improving waste-water treatment, using more ecologically friendly chemicals and dyes, and using less hazardous ingredients. Businesses could also use more efficient ovens, decrease dust, and improve ventilation to reduce tanning air pollution. Due to ethical and environmental problems, the IND leather business needs help with its public image. The industry has been condemned for animal welfare, water and air pollution, and tanning chemicals. Due to these issues, some buyers see the IND leather industry adversely, putting social and environmental concerns above

price, quality, and safety. The IND leather industry has implemented sustainable practices and adopted ISO 14001 and Leather Working Group standards to improve its environmental and social performance. Modern organisations must adapt to rapid change. Networks of businesses are increasingly considered competitive Min and Zhou (2002).

Supply chains (SCs) are networks that provide products and services to customers at the proper time, place, and specifications. A supply chain may be Lambert et al. (1998) defined as a network of organisations that manage and improve the flow of resources, commodities, services, and information from origin to end-user to meet customer expectations at the lowest cost to all members.

Global SCs may also hold suppliers responsible for environmental and social performance Seuring and Müller (2008),Yang et al. (2009). Even if they become green to comply with laws, businesses may gain a competitive edge and boost long-term profits Paulraj (2009). Companies must understand how SCM and environmental issues influence their competitiveness. Research has not linked GSC practices to economic performance or competitiveness, according to Rao and Holt (2005). Hervani et al. suggest studying GSCM components and performance assessment.GSCM also promotes supply chain partner cooperation and environmental factors in decision-making. GSCM can save costs, enhance environmental performance and reputation, and boost firm innovation and competitiveness Mohanty and Prakash (2014).

The study statement tackles an essential issue in the IND leather industry and proposes a research problem. It emphasises the need to understand how obstacles, practises, and performances affect human behaviour and how this knowledge may encourage industry adoption of GSCM. However, additional context and facts are usually beneficial. Following are the brief of our work :

1.3 Research problem

The IND economy is where it is today with the contributions made by the leather industry. On the other hand, concerns about the long-term viability of the environment have given rise to an increased demand for implementing environmentally responsible supply chain management practices. Understanding

the challenges and opportunities faced by the IND leather industry in adopting green supply chain practices is imperative, even though there is a global shift toward sustainable and eco-friendly practices in various industries. This is especially important because there is a global shift toward sustainable and eco-friendly practices in various sectors. The research problem that pertains to the current topic can be found below:

"How differences in human behaviour, emotions, and past experiences affect individual behaviour through intentions"

1.4 Research Statement

The study will undertake a comprehensive analysis of the current state of the leather supply chain in India, identifying critical environmental hotspots, inefficiencies, and areas for improvement. Special attention will be given to the entire life cycle of leather products, from raw material extraction to manufacturing, transportation, and end-of-life disposal. By understanding the specific challenges and opportunities within the IND context, the research will develop tailored solutions to mitigate environmental degradation associated with leather production. Following is the research statement for our work :

"Investigating the relationship between various barriers, practices and performances with a better understanding of human behaviour can drive the adoption of GSCM in the IND Leather Industry".

1.5 Research Gaps

The identification of research gaps is essential for both the process of developing a comprehensive understanding of a topic and the process of directing the efforts of future researchers. The following are potential areas where more research is needed in the area of implementing GSCM in the IND leather industry:

1. **The relationship between internal and external barriers of GSCM in the IND Leather Industry is yet to be explored.**
2. **A detailed investigation of the relationship b/w various GSCM prac-**

tices against the IND leather industry's performance is yet to be studied.

3. **Lack of study on the role of various behavioural factors affecting GCSM implementation in the IND Leather Industry.**

In the IND leather industry, identifying and addressing the current research gaps is one way to contribute significantly to the knowledge base surrounding GSCM implementation. Researchers can use these gaps to design studies that will provide insights that can be implemented and contribute to more environmentally responsible practices within the industry.

1.6 Research Aim

To investigate the implementation of GSCM in the IND leather industry by exploring the relationship between internal and external barriers, assessing the influence of GSCM practices on performance parameters, and analysing the impact of behavioural factors on GSCM implementation.

1.7 Research Objectives (ROs)

To effectively implement GSCM in the IND leather industry, the research objectives may adhere to the accepted term, i.e. SMART framework: specific, measurable, achievable, relevant, and time-bound. The following are the proposed research objectives:

- **RO-01**- To establish a relationship between internal and external barriers in GSCM for IND Leather Industry. in adopting
- **RO-02**- To analyse the influence of GSCM practices on performance parameters for the IND leather industry.
- **RO-03**- To analyse the role of various behavioural factors affecting implementation in the IND leather industry

These research objectives aim to provide a comprehensive understanding of the challenges and opportunities associated with implementing GSCM in the IND leather industry, which will ultimately contribute to developing sustainable practices within the sector.

1.8 Motivation/need for the research

The different leather industry constraints constantly limit the positive use of GSCM in the IND leather sector. Multiple internal and external hurdles take hours of understanding. Knowing how internal and exterior walls relate can assist the IND leather sector in adopting GSCM Shao et al. (2016).

Srivastava (2007) claims that GSCM may minimise industrial operations' environmental impact while improving economic profit without sacrificing quality, cost, reliability, performance or energy efficiency. After adoption, green supply chain practices must be examined. Lambert et al. (1998) argue that without adequate Supply Chain metrics, customer happiness, corporate performance, and Supply Chain performance improvements may suffer. Performance evaluation is essential for SCM optimisation Wong et al. (2009).

The IND leather industry has implemented sustainable practices and adopted ISO 14001 and Leather Working Group standards to improve its environmental and social performance. This strategy has improved the sector's image and aligned its practices with consumer, regulator and stakeholder expectations. The IND leather industry also emphasises sustainable practises, supply chain transparency, and eco-friendly products to enhance its reputation.

Extensive literature was studied to identify GSCM barriers. Many variables hinder IND leather GSCM implementation. Internal and external barriers are crucial, but social, economic, and environmental variables may limit adoption. Despite this, the IND government collaborates with numerous agencies to execute GSCM for industry. From our understanding, IND peer-English-speaking GSCM has yet to explore the relationship between internal and external impediments.

1.9 Originality and Contribution of the Research

Our study embarks on a humble yet crucial mission, recognising the gravity of a pressing concern within the IND leather industry. With scholarly diligence, we initiate a groundbreaking effort to unravel the intricate dynamics between internal and external barriers and decipher behavioural nuances from a perspective deeply rooted in industry insights. Our endeavour is grounded in the sincere pursuit of discerning the pivotal practices that underpin firm performance, striving for a nuanced understanding of the industry's complexities. Moreover, the practical implications of our endeavour are profound. By providing a roadmap for researchers and industry practitioners alike, our work equips and empowers them to navigate the complex terrain of GSCM implementation with greater clarity and efficacy. Armed with a deeper understanding of the behavioural factors specific to our industry, stakeholders can devise targeted interventions to drive meaningful change and enhance operational efficiency, fostering a sense of empowerment and confidence in their ability to effect positive change. Ultimately, our research enriches scholarly discourse by comprehensively analysing the barriers and opportunities within the IND leather industry. It provides a tangible pathway towards a more sustainable and resilient sector, fostering collaboration, innovation, and informed decision-making. In doing so, we hope to contribute to the academic understanding of industrial dynamics, sustainability practices, and the collective efforts towards a brighter, more sustainable future for all stakeholders involved.

1.10 Chapter overview

In this chapter, we journeyed through the rich history of India's leather industry, tracing its origins to 3000 BC. We explore the traditional methods of tanning and processing leather alongside the introduction of modern techniques, such as chrome tanning during British colonial rule. We established the Central Leather Research Institute in 1948, marking a significant industry turning point. Today, the sector is a cornerstone of India's economy, providing employment to millions and yielding substantial export revenues. However, amidst its achievements, the industry grapples with specific environmental concerns. For instance, pollution from chemicals like chromium and waste materials such as sludge and trimmings has prompted worries about its detrimental ecological effects, including air, wa-

ter, and land pollution. Despite criticism, the industry strives for sustainability by embracing standards and practices prioritising environmental stewardship. GSCM is a pivotal initiative in this pursuit, integrating environmental considerations into every facet of the production process. GSCM offers advantages such as cost savings and heightened competitiveness and presents challenges, including internal barriers and the necessity to address human behaviour. In conclusion, the chapter underscores the imperative of adopting sustainable practices within the IND leather industry and outlines the path towards a more environmentally responsible future. Furthermore, the chapter introduces the IND leather industry, highlighting its historical significance and contemporary challenges. It underscores the importance of GSCM as a solution to address environmental issues within the sector. Additionally, it outlines the research methodology, encompassing data collection methodologies such as surveys, questionnaires, interviews, and document analysis. Data analysis techniques encompass quantitative and qualitative methods, including case studies of selected IND leather companies.

In summary, Chapter 1 introduces the IND leather industry and articulates the necessity for GSCM. It articulates the research problem, questions, and objectives, outlining the research methodology employed to address these issues in subsequent chapters.

Chapter 2

Review of Literature

2.1 Introduction

The IND leather industry, a testament to resilience, has a rich history dating back to 3000 BC. From its modest beginnings with traditional tanning methods to the adoption of modern techniques during British colonial rule, the industry has weathered significant changes over the centuries. Today, it is a robust pillar of India's economy, employing millions and making substantial contributions to export earnings. However, this success has come with its challenges. The industry grapples with environmental concerns, notably pollution caused by chemicals and waste materials. Despite commendable efforts to address these issues, there is an urgent need for sustainable practices within the sector. GSCM integrates environmental considerations into every stage of the supply chain, from sourcing raw materials to end-of-life disposal. While offering benefits such as cost savings and enhanced competitiveness, adopting GSCM also presents challenges. These include internal barriers such as resistance to change, lack of awareness, inadequate resources, and the need to address human behaviour, such as the reluctance to adopt new practices and the lack of environmental consciousness.

Building upon the foundation laid in the previous chapter, which outlined the historical evolution and current state of the IND leather industry, this chapter delves deeper into implementing GSCM within the sector. Through an extensive review of global literature and discussions with industry experts, this chapter aims to identify specific barriers such as the high cost of implementing sustainable practices, practices such as the use of eco-friendly dyes, performances such as the reduction of water and energy consumption, and behavioural factors such as the role of leadership in driving sustainability initiatives, influencing the adoption of GSCM in the IND leather industry. Furthermore, by drawing

insights from studies across various industries worldwide, including the automotive, textile, and electronics sectors, this chapter provides a comprehensive understanding of the challenges and opportunities associated with implementing sustainable practices in the IND leather industry. Through this exploration, we aim to lay the groundwork for developing tailored solutions to promote environmental responsibility and foster a greener future for the industry.

2.2 Literature Review Approach

When it comes to a literature review on GSCM implementation in IND leather manufacturing firms, selecting themes is crucial. These themes, which we will now delve into, are critical areas of focus that will enable us to explore the topic at hand comprehensively.

Understanding Internal and External Barriers: This theme delves into the challenges and obstacles that hinder implementing GSCM within organisations. Internal barriers may include needing more top management support, resistance to change among employees, insufficient resources, or inadequate training. External barriers could involve regulatory constraints, market dynamics, supplier limitations, or customer demands. By examining these barriers, researchers aim to understand the complexities of adopting sustainable practices in SCM and strategise ways to overcome them.

Understanding Behavioral Factors Affecting GSCM Implementation: This theme explores the human aspects of GSCM adoption. It involves analysing the attitudes, beliefs, perceptions, and behaviours of individuals within organisations that influence green practices in the SCM. Behavioural factors may include employee commitment, motivation, awareness, communication, and organisational culture. By understanding these behavioural dynamics, researchers can identify interventions and strategies to promote a culture of sustainability and facilitate the successful integration of green practices into SCOs.

Understanding Various GSCM Practices and Their Role in Performance: This theme examines the green SCM practices adopted by IND leather manufacturing firms and their impact on organisational performance. It involves identifying specific strategies and initiatives these firms undertake to enhance environmental sustainability throughout the SC, such as eco-design,

green procurement, reverse logistics, and waste management. Researchers aim to assess the effectiveness of these practices in improving performance metrics such as cost reduction, operational efficiency, product quality, customer satisfaction, and environmental impact. By evaluating the relationship between GSCM practices and performance outcomes, insights can be gained into the business case for sustainable SCM and the factors driving competitive advantage in the IND leather manufacturing industry.

The three themes mentioned provide a structured framework for reviewing relevant literature, synthesising existing knowledge, identifying research gaps, and generating insights to inform future studies and practical implications for GSCM implementation in IND leather manufacturing firms.

An extensive review of global peer-reviewed Green SCM (GSCM) journals was conducted to identify the research gap better. This was a crucial step in our research, allowing us to pinpoint internal and external barriers. The bibliographic databases searched included popular publications like Scopus, Web of Science, Springer, Science Direct, and similar. Keywords such as 'GSCM', 'barriers', 'GSCM practices', 'GSCM performance', and 'behavioural factors' were used to retrieve relevant papers based on their titles, keywords, or abstracts, focusing on the operational components of environmental SCM. Given the breadth of GSCM as a topic, ample literature was available. However, the focus was explicitly on identifying various barriers, analysing the practices of GSCM and performance, and examining behavioural factors within the context of GSCM. Approximately 1,500 papers related to these topics were reviewed, with around 500 articles deemed relevant to the study. Ultimately, 107 articles were selected for in-depth analysis concerning barriers, practices, performances, and human behavioural factors, ensuring the utmost relevance to our research objectives.

This comprehensive review process provided a thorough understanding of the current research landscape. It helped identify critical areas for further exploration and analysis regarding GSCM implementation within IND leather manufacturing firms.

A comprehensive review was conducted on 800 papers regarding the theory of planned behaviour, with approximately 200 found relevant to our research. From these, we meticulously selected 115 articles to study intentional behaviour, ensuring that each chosen article added significant value to our research. Bu et al. (2020) contrasts, assesses, and discusses green SCM strategies for branded

and non-branded goods and services. Wu et al. (2012) analysed the environmental practices within Taiwan's electrical and electronic industry in response to the EU's Restriction of Hazardous Substances and Waste Electrical and Electronic Equipment directives. Zhu et al. (2007) presented the study of GSCM on 89 automotive firms in China, revealing significant regulatory and market constraints and solid internal motivations for adopting GSCM practices. Amjadian and Gharaei (2022) elucidated the closed-loop supply chain. Lu et al. (2007) employed factor analysis to identify the factors influencing GSCM adoption in the Taiwanese electronics industry. Piyathanavong et al. (2019) undertook a comprehensive investigation of green practices in the Thai electronics industry, studying 11 computer component manufacturers. The study focused on various factors, including recycling, transportation, marketing, production, and purchasing. Srivastava (2007) delved into implementing GSCM in India's sugar industry by surveying 30 sugar mills in Uttar Pradesh. Gharaei et al. (2021) examined the environmental impact of leather sourcing, focusing on achieving optimal economic growth while considering carbon emissions. Their research on GSCM techniques in the IND manufacturing industry, which included 59 survey items, concluded that GSCM adoption in India is still at an early stage.

This study, 45 factors are presented based on their understanding and similarities by consulting industry experts and detailed literature. 2.1 highlights various factors of GSCM with categories and sources. For this study, industry experts with more than ten years of environmental experience are considered.

Srivastava (2007) asserts that GSCM may reduce the ecological effect of industrial activities while increasing overall economic profit without compromising quality, cost, reliability, performance, or energy efficiency and analysing how GSCM practices impact supply chain performance after implementation is essential. The satisfaction of customers may be in jeopardy, the company may operate below par, and possibilities to enhance Supply Chain performance may be noticed if there are no acceptable Supply Chain measures, claim Lambert et al. (1998). The performance assessment is crucial to optimise the supply chain measure, as stated by Wong et al. (2009).

After going through the detailed literature review amounting to 1500 plus papers under four areas of the study in the subject, the following 2.1 were highlighted against each theme, i.e., the role of various stakeholders, barriers against green SCM, advancement in green SCM and practices followed by different

Barriers	Description	Sources
Outsourcing		
1. Problem in maintaining environmental suppliers	Due to traditional mindsets, suppliers' interests are different from others in the total supply chain network	Sarkar and Mohapatra (2006), Mudgal et al. (2010), Ninlawan et al. (2010)
2. Complexity in measuring and monitoring suppliers' environmental practices.	Metrics misalignment is thought to be the primary source of inefficiency and disruption in supply chain interactions.	Healy and Perry (2000), Mudgal et al. (2010), Hervani et al. (2005) and Björklund et al. (2012)
3. Lack of an environmental partnership with suppliers 4. Products potentially conflict with laws,	With environmental consciousness, industries find it difficult to maintain partnerships with suppliers. Most industries' products fail to conform to environmental laws.	Hamner et al. (2006) and Seuring and Müller (2008). Zhu et al. (2007a)
5. Lack of government support to adopt Environmentally friendly policies	Government regulations need to be stronger to force industries to adopt environmentally friendly policies.	AlKhidir and Zailani (2009) and Zhu et al. (2012)
6. No proper training/reward system for suppliers	Industries neither train/reward suppliers for adopting environment-friendly concepts	Massoud et al. (2010)
7. Fear of failure	Fear of failure in adopting a green supply chain; that firms could suffer monetary losses/product failure, leading to loss of competitive advantage.	Rao and Holt (2005), Peano et al. (2017) and Golafshani (2003)
8. Lack of effective environmental measures 9. Lack of human resources Lack of enough labourers in the organisation and their quality.	Industries reluctant to implement effective environmental measures. Basically, the fundamental obstacle to improving the environmental performance of SMEs is the need for more human resources.	Rao and Holt (2005) Hillary (2004)
10. Difficulty in transforming positive environmental attitudes into action 11. Lack of technical expertise	Though industries have positive environmental attitudes, they find it difficult to put them into action. Inability to find an alternative to design a pollution-free product to fulfill environmental requirements	Revell and Rutherfoord (2003), Hillary (2004) Revell and Rutherfoord (2003)
12. The complexity of design to reuse/recycle used products	Design of recycling used products difficult	Beamon (1999)
13. The complexity of design to reduce consumption of resource/energy	Inability of design technology to reduce the usage of resource/ energy. Present industrial practices incapable of switching to new systems.	Perry (1998) Revell and Rutherfoord (2003)

Table 2.1: Various barriers for GSCM with categories

Barriers	Description	Sources
Technology		
14. Lack of new technology, materials and processes	Non-availability of appropriate technology/process within organisations to adopt green supply chain. All materials are not eco-friendly.	Perry (1998)
15. Lack of awareness about reverse logistics adoption	Industries generally unaware of reverse logistics practices	Rao and Holt (2005), Mudgal et al. (2010)
16. Disbelief about environmental benefits	Industries lack belief in environmental benefits for implementing the green concept.	Revell and Rutherfoord (2003)
17. Perception of "out-of-responsibility" zone	Perception of organisations that are taking steps for environmental good-will is not their responsibility.	Shen and Tam (2002)
18. Difficulty in identifying environmental opportunities	Industries inefficient to identify environmental opportunities	Healy and Perry (2000)
19. Lack of Eco-literacy amongst supply chain members	Supply chain members lack knowledge about Eco-literacy.	Sarkar and Mohapatra (2006), Mudgal et al. (2010) and Revell and Rutherfoord (2003)
20. Lack of Environmental Knowledge	Lack of awareness of environmental legislations and ignorant of environmental impact on the organisation's activities and benefits of adopting green supply chain	Shen and Tam (2002)
21. Lack of green system exposure to professionals	SMEs is known to lack human resources both in quantity and quality to pursue environmental management.	Lin et al. (2020)
22. Complexity in identifying third parties to recollect used products	Identifying third parties to recollect used products is challenging for industries.	Our contributed barrier
23. No specific environmental goals	Industries lack well-set environmental goals	Healy and Perry (2000)
24. Difficulty in obtaining information on potential environmental improvements	Industries struggle to get information on potential environmental improvements/inability to get correct feedback	Perron and Zhu (2005)
25. Hesitation/fear to convert to new systems	Industries fear adopting new systems	Revell and Rutherfoord (2003)
26. High investments and less return-on-Investments	High investment-low returns in implementing green concept	Our contributed barrier
27. Expenditure in collecting used products	Collection of used products expensive.	Our contributed barrier
28. Cost of environment friendly packaging	High cost of eco-friendly packaging	Walker and Devine-Wright (2008)
29. Non-availability of bank loans to encourage green products/ processes	Industries struggle to get loans for environment-related initiatives.	Our contributed barrier
30. Risk in hazardous material inventory	Maintaining hazardous materials inventory involves high probability of financial loss	Our contributed barrier

Table 2.1: Various barriers for GSCM with categories

Barriers	Description	Sources
Involvement and support		
31. Financial constraints	Finance plays a major role in green supply chain management implementation; it has many constraints.	Sarkar and Mohapatra (2006), Hervani et al. (2005) and AlKhidir and Zailani (2009)
32. Need for extra human resources	More human resources needed to adopt/maintain GSCM in environmental systems.	Our contributed barrier
33. High cost of hazardous waste disposal	Disposal of hazardous waste due to threats involved.	Our contributed barrier
34. The cost of switching to a new system	Adoption of the new system is costly.	Mudgal et al. (2010)
35. Lack of training courses/ consultancy/institutions to train, monitor/mentor progress specific to each industry	Industry professionals need training to adopt GSCM in their units and to monitor progress from consultancy or institutions	Carter and Liane Easton (2011)
36. Lack of customer awareness and pressure about GSCM	Low demand from customers for eco-friendly products due to lack of GSCM awareness.	Chen and Paulraj (2004) and Mudgal et al. (2010)
37. Lack of Corporate Social Responsibility	Corporate social responsibility suggests firms are willing to go beyond simple compliance. Willing to consider public consequences of organisational actions but industries fail to adopt it	Mudgal et al. (2010)
38. Not much involvement in environmental-related programs/meetings	Lack of participation in conferences/seminars on green supply chain conducted by government/organisations which successfully adopted this concept. Hence, less exposure to top management.	Perron and Zhu (2005)
39. Restrictive company policies towards product/process stewardship	Lack of importance attached to product and process stewardship and management's inattention detrimental to GSCM.	Beamon (1999), Revell and Rutherfoord (2003) and AlKhidir and Zailani (2009)
40. Poor supplier commitment/ unwilling to exchange information	Suppliers unwilling to exchange environment-related information with industries, fearing end product being affected	Sarkar and Mohapatra (2006), Wong et al. (2009)
41. Lack of Inter-departmental cooperation in communication	Restriction in information flow across organisation hierarchy makes GSCM implementation unfeasible.	Sarkar and Mohapatra (2006)
42. The Lack of top management's involvement in adopting green supply chain management	Resistance of top management to change existing investments, information systems, and habits make a new supply chain system challenging.	Ghobadian et al. (1998), Hillary (2004), Lin et al. (2020), Sarkar and Mohapatra (2006), Zhu et al. (2007b)
43. Lack of awareness of the environmental impacts on business	Top management lacks awareness of environmental impacts on their business	Mudgal et al. (2010)
44. Inadequate management capacity	Management capacity is poor/unstable	Beamon (1999)

Table 2.1: Various barriers for GSCM with categories

western countries.

Li et al. (2009) gave metrics to examine the RFID deployment factors for Supply Chain performance. Furthermore, Chan and Qi (2003) evaluates the supply chain's performance by combining quantitative and qualitative measures in terms of, for instance, efficient risk management, flexibility, strategic planning, information and material flow integration. Green practices in the supply chain context are enumerated in 2.2.

At this stage, the appropriate literature on GSCM in the IND leather industry and various behavioural factors are explained below: -

2.3 GSCM

This includes reducing the environmental impact of supply chain activities, such as transportation, production, and waste management, while improving efficiency and reducing costs. Over the last ten years, it has become the most focused area among the formerly related aspects of SCM. There are two primary sources of GSCM. First, green management frequently uses a life cycle assessment (LCA) technique to analyse a product's environmental influence. As a second approach, integrated environmental issues with supply chain practices can help improve and optimise the process. Green SCM contributes to meeting and maintaining minimal legal and regulatory limits for permissible pollution levels by minimising inefficient use of energy resources.

GSCM has been explored across various industries, including automotive, computer hardware, mobile phones, textiles and apparel, nuclear power, bottling, and packaging. These studies aim to understand barriers and key drivers for GSCM adoption and identify opportunities and challenges for sustainable practices of supply chain.

2.4 GSCM in IND Leather Industry

Several players in the IND leather industry have adopted clean production methods and environmental management systems (EMS). According to a comprehensive study of the literature, these practices are deemed to align with the

SNO	THEME	NO OF DOC. REFERRED	REFERENCES
1	**ROLE OF VARIOUS STAKEHOLDERS IN GSCM**	27	HASSAN YOUNIS, BALAN SUNDARAKANI AND PRAKASH VEL(2015) , MOCHAMAD AGUNG WIBOWO1 , NANIEK UTAMI HANDAYANI , ANITA MUSTIKASARI (2018), SIMONE SEHNEM GEAN PACHECO DE OLIVEIRA(2016), KAMALAKANTA MUDULIA, KANNAN GOVINDANB (2013), LEI XUA, K. MATHIYAZHAGANC, KANNAN GOVINDANB(2013), JEFFREY S. HARRISON (2009) , DOUGLAS A. BOSSE(2008), AIHUA WU TIANFU LI (2019), XIANGMENG HUANG , SHUAI YANG (2021), QI GUOYOU,1 ZENG SAIXING (2011) ETC.
2	**BARRIER AGAINST GSCM**	26	VIRENDRA BALON A. K. SHARMA(2016), GUOHONG WANGA,YUNXIA WANGB , TAO ZHAOA(2008) , GIUNIPERO,L.C., HOOKER, R.E., & DENSLOW (2012) , FU JIA, PHD, SHIYUAN YIN, LUJIE CHEN , XIAOWEI CHEN(2020), KAMALAKANTA MUDULI,KANNAN GOVINDAN , AKHILESH BARVE ,YONG GENG(2012), KES MCCORMICK, TOMAS KABERGER(2007) , QINGHUA ZHU, YONG GENG(2010) , VICHATHORN PIYATHANAVONG A , JOSE ARTURO GARZA-REYES B (2019) , OLGA CHKANIKOVA AND OKSANA MONT(2015), G. HILSON(2010) ETC.
3	**ADVANCEMENT IN GREEN SUPPLY CHAIN MANAGEMENT**	29	CRISTIANA PEANO, VINCENZO GIRGENTI, CLAUDIO BAUDINO AND NICOLE ROBERTA GIUGGIOLI (2017), UMAR RUHI OFIR TUREL(2015), WENFEI XIA, BAIZHOU LI 1,SHI YIN(2020) , CHUAN ZHAOA , YAN SONGA , MIN ZUOA , AND HONGJI YANGB (2021) , ANDR□ES VILLA-HENRIKSEN GARETH T.C. EDWARDS B , LIISA A. PESONEN, OLE GREEN (2020), JIAN WANG A , HUIJUAN JIANG A , MINGZHU YU(2019), MARJANEH JAHANGIRI LAHKANI ,SHOUYANG WANG, MARIUSZ URBANSKI, MARIYA EGOROVA(2020) ETC.
4	**PRACTICES FOLLOWED BY VARIOUS WESTERN COUNTRIES**	24	SIMONOV KUSI-SARPONG JOSEPH SARKIS(2016), JOS ARTS , PAULA CALDWELL & ANGUS MORRISON-SAUNDERS(2001), ADAM BARKER UNIVERSITY OF ABERDEEN CHRISTOPHER WOOD EIA CENTRE, UNIVERSITY OF MANCHESTER(1999), DANIEL P. CLAYCOMB(1993) , RASHID SAEED · AYESHA SATTAR · ZAFAR IQBAL · MUHAMMAD IMRAN RAZIYA NADEEM (2010) , ELIZABETH M. DE SANTO(2013), ROBERT DAVIDSON(2020)

Figure 2.1: LR summary for the study

	Greening the supply process practices	Advanced green practices	Product-based green practices	Greening the delivery process practices
First-tier supplier <->focal company				
Environmental collaboration with suppliers(E1)				
Providing design specifications to suppliers that include environmental requirements for the purchased item			Zhu et al. (2008)	
Communicating to suppliers environmental and ethical criteria for goods and services	Wang et al. (2006), Zhu et al. (2008), and Ghobadian et al. (1998)			
Working with product designers and suppliers to reduce and eliminate product environmental impacts	Zhu et al. (2007a), Ghobadian et al. (1998), and Paulraj (2009)			
Working with industry peers to standardise requirements for suppliers and purchasing items			Zhu et al. (2007a)	
Encouraging suppliers to take back packaging	Rao and Holt (2005) and Ghobadian et al. (1998)			
Greening procurement/ sourcing	Ghobadian et al. (1998) and Routroy (2009)			
Using green purchasing or logistics guidelines	Wang et al. (2006) and Ghobadian et al. (1998)			
Using recyclable pallets to deliver materials				Ghobadian et al. (1998)
Promoting ISO 14000 certification of suppliers	Zhu et al. (2008)			
Designing products to avoid or reduce the use of hazardous products and their manufacturing process			Zhu et al. (2008)	

Table 2.2: Green practices in the supply chain context

	Greening the supply process practices	Advanced green practices	Product-based green practices	Greening the delivery process practices
Working with designers and suppliers to reduce and eliminate product environmental impact				
Using environmentally friendly raw materials	Rao and Holt (2005), Seuring and Müller (2008), and Ghobadian et al. (1998)			
Reduction in raw material (i.e., the use of recycled material) for product manufacturing			Seuring and Müller (2008)	
Designing products for disassembly	Zhu et al. (2008), and Ghobadian et al. (1998)			
Implementing internal environmentally friendly operations				
Minimising waste		Rao and Holt (2005) and Paulraj (2009)		
Decreasing the consumption of hazardous and toxic materials		Zhu et al. (2007a) and Vachon and Klassen (2008)		
Using filters and controls for emissions and discharges		Vachon and Klassen (2008)		
Selling scrap and used materials		Zhu et al. (2008)		
Reducing energy consumption		Rao and Holt (2005), Ghobadian et al. (1998), and Paulraj (2009)		
Reusing/recycling materials and packaging		Rao and Holt (2005), Vachon and Klassen (2008), Ghobadian et al. (1998), and Paulraj (2009)		
Using standardized components to facilitate their reuse		Gonzalez et al. (2008)		
Green design (ecodesign)			Wang et al. (2006), Zhu et al. (2007a), Zhu et al. (2008), and Routroy (2009)	

Table 2.2: Green practices in the supply chain context

	Greening the supply process practices	Advanced green practices	Product-based green practices	Greening the delivery process practices
Risk-prevention systems to cover possible environmental accidents and emergencies		Wang et al. (2006) and Gonzalez et al. (2008)		
Obtaining ISO 14001 certification		Rao and Holt (2005), Wang et al. (2006), Zhu et al. (2007a), Vachon and Klassen (2008), Zhu et al. (2008), and Ghobadian et al. (1998)		
Integrating total quality environmental management (TQEM) into planning and operation processes		Rao and Holt (2005), Zhu et al. (2007a), and Zhu et al. (2008)		
Implementing environmental management system (EMS)		Zhu et al. (2008) and Routroy (2009)		
Green innovation		Routroy (2009)		
Focal company <->first-tier customer				
Environmental collaboration with customers(E2)				
Cooperation with customers for eco-design and cleaner production			Zhu et al. (2008)	
Working with customers to change product specifications(WCC)				Lin et al. (2020)
To use environmentally friendly practices with customers				
Planning vehicle routes for reduced environmental impacts	Zhu et al. (2008)			
Customers return original packaging or pallet systems.				Gonzalez et al. (2008), and Ghobadian et al. (1998)
Environmentally friendly packaging(E3) (green packaging)				Rao and Holt (2005), Zhu et al. (2008), and Routroy (2009)
A formal policy on green logistics/transport				Ghobadian et al. (1998)
RLgs				Rao and Holt (2005), Wang et al. (2006), and Routroy (2009)
Eco-labelling				Rao and Holt (2005)

Table 2.2: Green practices in the supply chain context

objectives of Green SCM. These CP and EMS techniques were implemented for various purposes, including compliance with government rules, obtaining human rights to work, attracting economic investors, and improving environmental effectiveness.

2.5 Behavioral factors

In human behaviour, motivation, passion, and enthusiasm are significant drivers of individual performance and success within job roles or processes. While possessing requisite knowledge, skills, and experience is undeniably valuable, the intrinsic desire to fulfil a job or task is even more pivotal. This innate drive serves as a potent catalyst, often transcending mere ability to shape one's capability to excel in one's professional endeavours.

Furthermore, human behaviour, particularly the inclination to engage in work-related activities, remains susceptible to change and influence from various factors. The dynamics of behavioural change play a pivotal role in shaping individuals' attitudes and actions towards achieving specific goals or objectives. Hence, comprehending and effectively managing human behaviour is imperative for implementing and enhancing any management program or system. Moreover, success in job roles or processes hinges greatly on motivation, passion, and enthusiasm in today's fast-paced world. While skills and experience hold significance, the inherent drive to accomplish tasks or roles emerges as paramount. This internal impetus is a potent motivator, often overshadowing one's ability to perform tasks proficiently. In essence, understanding the intricacies of human behaviour is crucial, considering its fluid and adaptable nature. Behavioural events exhibit dynamism and flexibility and are responsive to environmental stimuli and situational contexts.

Consequently, when devising management systems or interventions geared towards augmenting organisational performance, it becomes imperative to comprehend and address the multifaceted aspects of human behaviour. This entails acknowledging the pivotal role of motivation, providing avenues for skill enhancement, fostering conducive work environments, and deploying strategies to instigate positive behavioural shifts among employees. By doing so, organisations can foster a culture of excellence that propels success and growth. A lot of evidence from previous research about these behavioural activities also shows

better results Chen and Hu (2018).

2.6 Behavioral factors in GSCM

Behavioural factors in green SCM refer to the actions and attitudes of individuals and organisations that can positively or negatively impact the implementation and success of sustainable practices in the supply chain. Positive behavioural factors include a commitment to sustainability by top management, open communication and collaboration among supply chain partners and employee engagement in green initiatives. Negative behavioural factors may include a lack of employee understanding or buy-in, resistance to change, and a lack of accountability for sustainable performance. Addressing these behavioural factors is essential for green SCM efforts Muduli et al. (2013).

Top management support

Top administration commitment is frequently used to gauge an organisation's efforts and plans for tackling anti-environmental activities in its supply network. Previous studies have shown that the support and involvement of top management have contributed to the success of GSCM practices. Top managers in environmental businesses play a crucial role in creating a culture that supports sustainable practices. They can do this by setting clear and measurable sustainability goals, providing the necessary resources for employees to implement green initiatives, and creating an open and transparent communication system where employees feel comfortable sharing their ideas and concerns. They can also provide training and education opportunities to help employees understand the importance of sustainability and the specific actions they can take to support it. Additionally, by involving employees in decision-making processes and empowering them to take ownership of environmental management decisions, top managers can foster a sense of commitment and accountability among the workforce. This can help ensure that sustainable practices are integrated throughout the organisation and that the company is better equipped to identify and manage environmental risks.

Appraisal of performance and reward

Performance evaluation is a strategic procedure that links human resources operations with organisational policies. It is also a common term used by companies to evaluate the performance of employees, develop their skills, improve their performance, and distribute rewards. Many companies have begun to set environmental objectives for their workers, whose results are compared as part of the individual corporate performance assessment programme. For example, Xerox's research and reward system has significantly contributed to employee innovation in surplus reduction and recycling zones. Companies working to accomplish their long-term sustainability goals must ensure that their compensation and reinforcement systems reflect the industry's commitment to green performance to encourage and promote the behaviours sought by their workers Harrison and Freeman (1999).

Communication

Regular communication between management and employees is essential. A recent study shows that workers often complain that they do not know enough about environmental problems. Regular communication is critical to an organisation's environmental strategy, programs, and goals and must be transferred to the employee to achieve long-term success. Workers will be more involved in the effort if management communicates effectively about the relevance of the sustainability organisation programme, its purpose, and its participation in recognising and controlling ecological issues. Unofficial communication helps workers propose innovative approaches to reduce the organisation's impact. A feedback system built on efficient communication must inspire, guide, and allow productive conduct while discouraging poor behaviour. Because the excitement and passion connected with the early phases of environmental initiatives might fade, inadequate feedback and communication can lead to insufficient worker efforts to enhance the environment Hayes et al. (2018).

Green training

An effective training program is a systematic process that guides an organisation's or employee's behaviours toward achieving specific objectives. Because of the

cultural character of GSCM, workers require proper environmental training since poor training may result in incompetent staff who will not engage in GSCM's environmentally friendly initiatives. Workers are becoming more conscious of quality and environmental problems due to adequate education and training, and they become more responsive to change and engaged in their approach to it.

Employee empowerment

Worker empowerment to solve environmental challenges is described as a method by which an institution's management distributes power to its workers. Employee participation initiatives can achieve the best outcomes by empowering workers and recognising them as critical partners in a business. It is, therefore, beneficial and essential for the organisation to empower its employees to achieve its environmental objectives. Unlike the usual top-down organisational structure, which often limits employee empowerment, a simpler, more horizontal organisational structure is necessary for appointment.

Employee empowerment can produce various benefits for businesses, including increased job satisfaction, improved decision-making, and increased employee commitment. Another essential achievement element of viable GSCM is representative inclusion. Employees who are empowered have more freedom and authority to make decisions, which leads to a more significant percentage of employee satisfaction in environmental development activitiesAziz et al. (2021).

Team Work

"Teamwork" refers to a small group of people with equally skilled, mutual interests and views dedicated to accomplishing shared or shared targets to secure the collective's incorporation. By utilising the collective knowledge of individuals, teamwork aids the organisation in solving complex problems, preventing duplication of effort, and completing numerous tasks simultaneously. According to previous research in environmental management, effective collaboration significantly enhances ecological performance.

Work culture

Work culture can be defined as a set of core values that a group establishes, develops, or discovers as it grows to address internal integration and external adaptation challenges. An organisation's culture can foster or hinder employees' interest in environmental management. A green work culture reflects a company's commitment to environmentally responsible actions, which tends to attract motivated and capable employees. This underscores the importance of corporate culture. Consequently, organisational culture can either support or undermine environmental improvement efforts. A company culture that encourages employee involvement and fosters trust between management and staff enhances responsiveness to creativity and risktaking Reader and O'Connor (2014).

Mutual trust and respect

Mutual trust and respect are essential in creating a positive and productive work environment in a factory setting. When employees trust and respect their managers and colleagues, they are more likely to feel engaged and motivated. This can lead to increased productivity, improved quality of work, and a reduction in turnover and absenteeism.

Respect can be fostered by treating employees with dignity and fairness. Managers should avoid discrimination and favouritism and be willing to listen to and consider the perspectives of all employees. They should also acknowledge and reward good work and provide opportunities for employees to develop their skills and advance in their careers.

Minimizing resistance to change

Humans are incredibly resistant to change, and this propensity is not any different when change is required in the workplace. Minimising resistance to change is essential to implementing changes in any organisation. Resistance to change can come from employees, managers, or other stakeholders and can slow down or even derail the implementation of new processes or systems. Implementing changes can be difficult, but the right strategies and approach can minimise resistance and ensure the change initiative's success.

Green innovation

Green innovation refers to developing and implementing new products, services, and environmentally friendly and sustainable processes. It encompasses various activities, including research and development, design, marketing, and commercialising eco-friendly products and services. Green innovation can be applied to multiple industries, such as energy, transportation, construction, and agricultureJuntunen et al. (2019).

Employee participation in ongoing innovation is encouraged through employee incentive programs and environmental training, and these inventions lead to increases in the organisation's ecological efficiency. The financial stability of a company might be another factor supporting its innovative culture. According to Beard and Hartmann (1997), employee invention or creativity is a valuable resource for businesses looking to solve environmental issues and helps them achieve their goals of making significant, ongoing changesPeano et al. (2017).

Green motivation

The need to inspire employees to the strategy's success stems from their being directly responsible for its implementation. As a result, supervisors and executives continuously seek new ways to motivate their employees to implement GSCM. A group motivating notion, morale is typically an automatic result of management's encouraging and supportive approach to employees' demandsFryxell et al. (2004).

In a GSCM setting, a succession of equally essential human needs is identified by Maslow's hierarchy of needs. More impactful than any slogans, banners, or lectures is the fundamental salary of every employee, set at a level that can meet his necessities. Employee motivation is primarily decided by other factors such as worker safety, job stability, and a free and impartial work environment.

Strategic planning

It involves setting goals and objectives, developing strategies and tactics, and creating action plans to achieve them. Preparation may help with both the

formulation of long-term approaches required to attain GSCM goals and the selection of GSCM goals. The present market climate, which includes rapid technical breakthroughs, client and industrial behavioural shifts, and demand from diverse communities and governments, needs good strategic planning for the success of greening projects in the supply chainCronin et al. (2011).

2.7 Research Gaps

A comprehensive review of the relevant literature revealed some research gaps across all four themes. However, to keep our study focused on implementing environmentally responsible SCM, we have limited our consideration to just three gaps. The following gaps 2.2 were found following an extensive review of the relevant literature, and the gaps highlighted in orange were those considered applicable to this study.

2.8 The Theory of Planned Behavior

The TPB details the behaviour in a multitude domains, from recycling to choice of travel mode, from technology adoption to protection of privacy, from safer sex to consumer behaviour, from physical activity to drug use. To predict and understand the behaviours, TPB immediately determines by perceiving behavioural control and behavioural intentions under certain circumstances.

TPB is a well-known and significant psychological theory that is applied to comprehending and forecasting human behaviour in various circumstances. The fundamental tenet of TPB is that people's behavioural intentions are excellent indicators of their actual behaviour. According to the Theory, there are three major influences on a person's intention to engage in a particular behaviour:

Attitude toward the Behavior (AB)

A person's subjective judgement of whether engaging in the behaviour is positive or negative. It considers the individual's views and a broader assessment of the behaviour's repercussions.

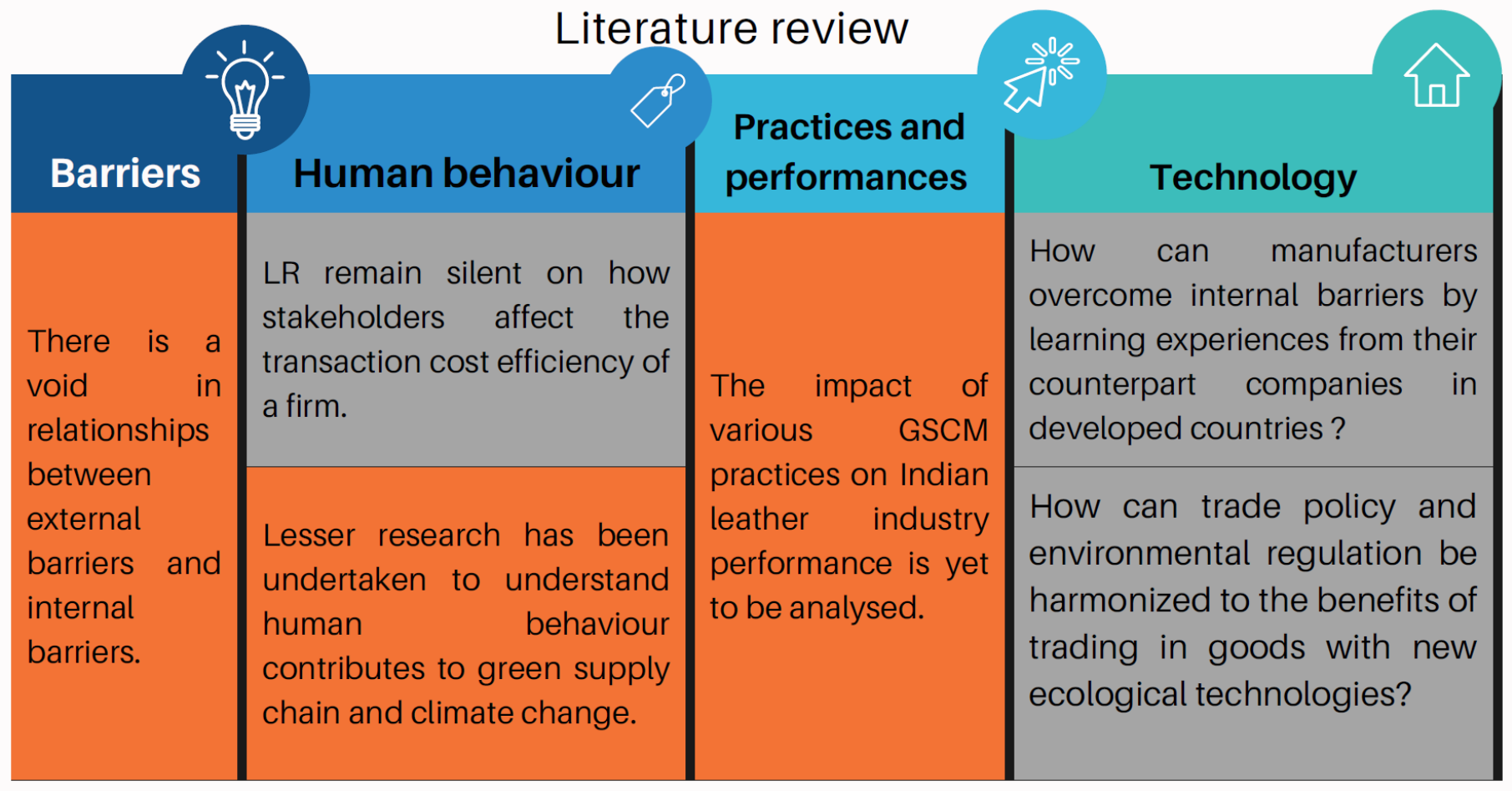

Figure 2.2: GAPS for the study

Subjective Norms (SN)

Subjective norms, like invisible forces, exert a powerful influence on our actions. They represent our perceptions of the social pressure or influence significant people or groups exert. These could be our close friends, family members, coworkers, or societal expectations. In essence, subjective norms reflect whether others consider a particular action acceptable and our inclination to conform to these perceived norms. For instance, an individual may feel compelled to recycle regularly because their friends and family members actively engage in environmentally friendly practices, creating a social norm around recycling. In this scenario, the individual's subjective norm is influenced by the perceived expectations of their social circle. However, not just our immediate social circles shape our subjective norms. Societal attitudes and cultural norms also play a significant role, as individuals may feel motivated to conform to broader societal expectations regarding environmental stewardship. Ultimately, subjective norms significantly shape individuals' behaviours and decision-making processes, providing insights into the social context and pressures influencing their actions. By understanding these subjective norms, researchers and policymakers can design interventions and initiatives that leverage social influence to promote positive behaviours and drive societal change towards sustainability. This understanding offers hope, showing us how to harness subjective norms' power for the greater good.

Perceived Behavioral Control (PBC)

PBC can be understood through examples. For instance, if you believe you have the skills and resources to cook a meal, you have a high PBC for cooking. On the other hand, if you feel you need more skills or ingredients, your PBC for cooking is low. PBC encompasses a range of factors that influence an individual's confidence in their capability to execute the desired action successfully. These factors include self-efficacy, available resources, and external limitations that may facilitate or impede the behaviour. At the heart of PBC is self-efficacy, an ability to achieve desired outcomes by accomplishing the assigned tasks. This belief is a crucial determinant of PBC. High levels of self-efficacy not only indicate a strong sense of confidence but also lead to increased perceived control over behaviour. In other words, the more confident you are in your abilities, the more power you perceive over your behaviour, paving the way for positive change. The

perception of control is also influenced by the availability of resources necessary to perform the behaviour. These resources may include tangible assets such as time, money, and equipment and intangible resources like knowledge, skills, and social support networks. When individuals have access to adequate resources, they are more likely to perceive more significant control over their ability to engage in the desired behaviour. Conversely, limited resources may diminish perceived control and inhibit behaviour change efforts. External limitations refer to factors outside the individual's control that may affect their ability to perform the behaviour. These limitations could include environmental constraints, such as living in a noisy neighbourhood that hampers your ability to concentrate on studying. They could also be societal norms, like cultural expectations, that discourage women from pursuing specific careers. Institutional policies, such as strict dress codes that limit personal expression, can also be external limitations. Finally, another external limitation is situational barriers, like a lack of transportation that prevents you from attending a job interview. These factors play a crucial role in shaping PBC as they can either facilitate or impede behaviour change. For instance, if an individual faces time constraints, financial limitations, or logistical challenges that hinder their ability to adopt sustainable practices, their perceived control over the behaviour may decrease. When individuals are confident in overcoming obstacles and successfully perform the desired action, they are more likely to develop strong intentions to enact that behaviour. Thus, interventions aimed at enhancing perceived behavioural control, such as providing resources, building self-efficacy, and addressing external limitations, can effectively promote behaviour change and facilitate the adoption of sustainable practices.

2.9 TPB for industry

The TPB states, in brief, that a person's intention to engage in a specific action is influenced by their attitudes about that behaviour, which is associated with a greater intention to engage in the behaviour but also empowers individuals. When individuals feel confident in their ability to overcome obstacles and successfully perform the desired action, they are more likely to develop strong intentions to enact that behaviour. Thus, interventions aimed at enhancing perceived behavioural control, such as providing resources, building self-efficacy, and addressing external limitations, can effectively promote behaviour change and facilitate the adoption of sustainable practices, which are actions that can be

maintained or continued over a long period without causing harm to the environment or depleting resources. This empowerment is crucial to our work, as it shows the potential for positive change and the importance of our research and interventions, the subjective norms that impact them, and their assessment of their level of control over the behaviour. The TPB also admits that other factors may moderate or mediate the relationship between these three criteria and actual conduct. These are examples of individual differences, outside conditions, and other contextual factors. The TPB has been used in various domains, including business, social psychology, environmental psychology, health psychology, and consumer decision-making, to explain and predict multiple behaviours. It provides a valuable foundation for developing treatments and tactics to encourage desired behaviours and comprehend why people behave in particular ways.

Since our work is to understand human behaviour at the industrial level, going through TPB with industrial implications is essential. An effective paradigm for comprehending and forecasting human behaviour at the industrial level is the TPB. It offers perceptions of the choices and steps people inside organisations make concerning their work. The TPB can be used in an industrial setting, as shown here:

Understanding Employee Behavior

The TPB can examine and forecast various work-related behaviours, including adherence to organisational policies, job performance, and safety compliance. Organisations can learn more about why employees act a specific way by looking at their attitudes, subjective norms, and perceived behavioural control.

Improving Safety and Compliance

The TPB can assist in determining the variables influencing employees' safety-related behaviours in businesses where safety is a top priority. Companies can build interventions and training programs to improve safety compliance by targeting attitudes, norms, and perceived control.

Innovation Adoption

Comprehending employees' goals while introducing new technology or procedures in an industrial context is essential. The TPB can assist in identifying the factors that promote and impede the adoption of innovations, enabling businesses to modify their implementation methods accordingly.

Environmental Sustainability

The TPB can evaluate employees' intentions and behaviours linked to sustainable practices in industries with environmental sustainability goals. This knowledge can assist with sustainability efforts and promote eco-friendly behaviour.

Change Management

The TPB can assess employees' attitudes and perceived control over the change process during organisational change projects. The results of change management can be improved by recognising and eliminating impediments.

Team dynamics

In an industrial setting, collaboration is frequently crucial. The TPB can assist in evaluating team members' attitudes and norms toward cooperation and collaboration, which may affect the team's effectiveness and productivity.

SCM

The TPB can be used to comprehend and forecast behaviours involved in SCM, including decisions regarding supplier choice, logistics, and quality control procedures. It may improve the effectiveness and efficiency of SCM.

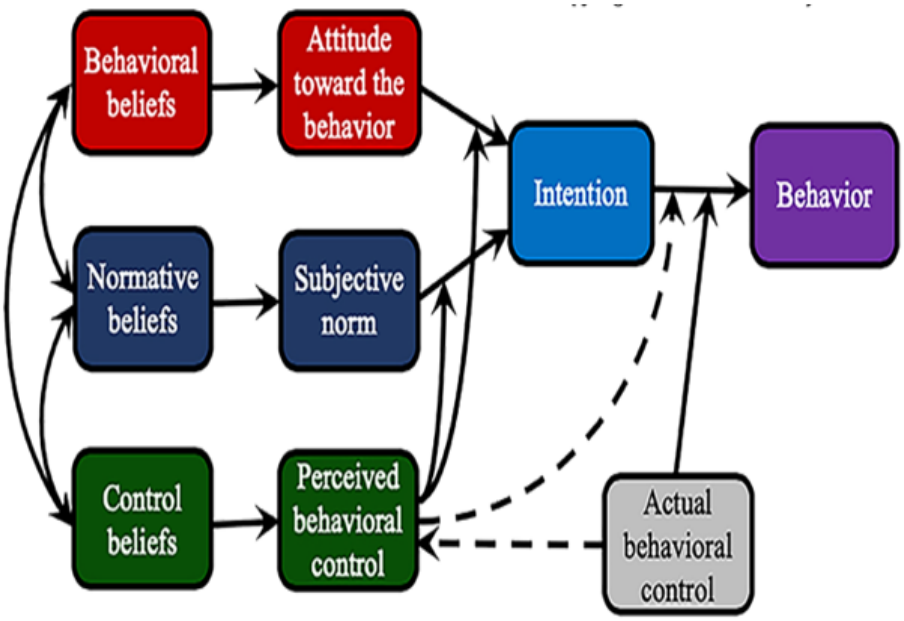

Figure 2.3: Theory of Planned Behaviour

Employee Engagement

The TPB can look into job happiness, loyalty to the company, and willingness to go above and beyond in their responsibilities, which may affect employee engagement. Then, businesses can create plans to raise employee engagement.

In conclusion, the Theory of Planned Behavior 2.3 is a flexible framework used in various industrial scenarios to understand how people behave and make decisions. Organisations can create focused interventions and tactics to encourage desired behaviours, improve performance, and accomplish corporate goals by considering attitudes, subjective norms, and perceived behavioural control. It is an essential resource for comprehending and controlling behaviour at the industrial level.

2.10 Literature review for Theory of Planned Behavior(TPB)

The Theory of Planned Behavior is widely used in behavioural research but has limitations. This study aims to address these limitations and further refine the theory by including additional factors. By doing so, we hope to expand its

SN	Title (Year) Author	Key Findings	Gaps
1.	Research on Developers' Green Procurement Behavior Based on the Theory of Planned Behavior(2019) Yang et al. (2009)	"The results showed that subjective norms and perceived behaviour control factors significantly influenced developers' green procurement (GP) behaviour attitude". • "The results help promote developers' GP behaviour and green building planning development". • "Finds out the key factors that influence the behaviour of GP from the developers' point of view, enriches the Theory and method of GP research, and complements the related literature on GP research."	• "Conversely, the government should reinforce public environmental knowledge education and concepts through media promotion, network education, community activity and many different forms, and improve public green consumption awareness". • "Future studies should continually deepen the research from the perspective of other stakeholders and developers with varying qualifications".
2.	Applying an Extended Theory of Planned Behavior to Sustainable Food Consumption(2020) Alam, SS (Alam, Syed Shah)	• Results show that social norms, perceived value, perceived consumer effectiveness, and attitude significantly impact the intention to consume sustainable food. • Perceived availability, perceived consumer effectiveness and intention also significantly impact actual behaviour. • "The findings of this study can provide specific grounds for understanding sustainable food consumption intention and behaviour". • In a global context, the findings of this study are important, as consumption patterns need to be changed to meet the climate challenge.	• "The study was limited to only a particular area in Malaysia. Further study can be conducted in other countries". • Further studies may use structural equation modelling to test more comprehensive relationships regarding the relationship between these variables. • Further study may use other theories, such as a "value-belief-norm (VBN) model" or an "attitude-behaviour-context (ABC) model" to examine sustainable food consumption behaviour among Malaysians.

Table 2.3: TPB Literature review

SN	Title (Year) Author	Key Findings	Gaps
3.	Modeling Acceptance of Electric Vehicle Sharing Based on Theory of Planned Behavior (2018) Zhang, K (Zhang, Kai)	• "The results indicate that perceived behavioural control is the primary factor positively contributing to EV-sharing acceptance". •"The results also reveal an insignificant relationship between attitude towards behaviour and sharing acceptance, consistent with relevant research".	• "Hence, future studies should include more demographic information, such as gender, age, income, daily travel mode, and number of household vehicles, in the SEM to simultaneously analyse several groups".
4.	Influence of Altruistic Motives on Organic Food Purchase: Theory of Planned Behavior(2021) Boobalan, K (Boobalan, Kirubaharan).	• "This study examines the model for the Indian and the USA samples. It is thus integrated using three theories: the Theory of Planned Behavior (TPB), the Pro-Social Behavior (PSB) Theory and the interaction of Consumer Culture Theory". • "Moreover, the study found that attitude towards organic food is a significant element for US subsamples, whereas subjective norm plays a vital role in Indian samples adopting organic food".	• "Therefore, the researchers are also advised to show concern about other untested effects of cultural values, such as universalism versus particularism, specific versus diffuse, and neutral versus emotional". • Future cross-cultural studies may help generalise the results, which could help evolve strategies for organic food companies.
5.	Effects of Emotions and Ethics on Pro-Environmental Behavior of University Employees: A Model Based on the Theory of Planned Behavior(2021) Aziz, F (Aziz, Faiq).	• Thus, this study extended the TPB to explain PEB among university employees. • "The findings revealed that environmental ethics significantly affected attitudes, perceived behavioural control, and subjective norms".	• As a result, future studies should determine if there is a connection between individual HRM activities and the degree to which university staff participate in PEB. • "Future studies should look into this relationship because it will help universities choose where to focus their efforts to maximise their positive impacts on the environment".

Table 2.3: TPB Literature review

SN	Title (Year) Author	Key Findings	Gaps
6.	Using the Theory of Planned Behavior to Predict the Adoption of Heat and Flood Adaptation Behaviors by Municipal Authorities in the Province of Quebec, Canada(2021) Jacob, Johann.	• "This study aims to identify which psychosocial factors better predict and explain the adoption of heat and flood adaptation behaviours by municipal authorities in the Province of Quebec, Canada, and to explore the cognitive structures motivating municipal officers to adopt adaptation behaviours".	• "In this study, municipalities were used as the unit of analysis. At the same time, our respondents were municipal officers who may not have been aware of all their municipalities' actions to adapt to heat waves or flooding".
7.	Exploring the Sustainability Concepts Regarding Leather Apparel in China and South Korea(2019) Jung, Hye Jung.	• "Consumption in the clothing and textiles industry causes a significant impact on the environment and utilises unsustainable practices, from clothing production to use and disposal". • "With shifts toward a more sustainable future within the government, businesses, and society, the apparel industry and consumers must prepare for a sustainable future".	• "Due to growing interest in North Korea worldwide, a sample from North Korea, whose database has been minimal previously, will hopefully be collected in future research". • "Second, there might be differences in sustainable consumption behaviours based on demographic factors, including age, gender, occupation, and marital status".
8.	Knowledge Management And Leather Technology Quality Assurance In Research And Technical Activities (2009) Grasso, G	• "Knowledge Management is a systematic practice which is quickly expanding in such application fields as production engineering and the planning business, that aims to define methods and procedures for giving a concrete direction to the organisation of the competences, the multidisciplinary nature of information and lifelong learning".	• "The study mainly focuses on aspects such as identifying, classifying, representing, codifying, creating, capturing, organising/structuring data, distributing and finally enabling the adoption of the technical knowledge of tanning processes".

Table 2.3: TPB Literature review

SN	Title (Year) Author	Key Findings	Gaps
9.	Application of Theory of Planned Behavior in the motor vehicle repair and service industry (2017) Abu Bakar, Elistina.	• "This paper aims to examine the determinant factors of consumer safety behaviour." • "Results show that all factors can explain 39.7 variance in the safety behaviour of consumers, and safety priorities become the main determinant factor".	• "This research holds significant implications for government, industries and, most importantly, consumers so that policy and educational programs can be proposed to teach good behaviour among consumers, especially on safety matters".
10.	Study on safety behaviour planning theory and control strategies for coal chemical workers Min et al. (2020).	• "This paper explores the mechanism among many factors, collects index data through a safety perception questionnaire, and uses the DEMATEL-SIM system analysis method to analyse the system structure model of the influencing factors of field safety".	• The model in this paper specifies the mechanism of human safety behaviour more precisely and can better answer the diversity and uncertainty of human behaviour.
11.	Predictors of Respiratory Protective Equipment Use in the Norwegian Smelter Industry: The Role of the TPB etc in Understanding Protective Behavior Robertsen et al. (2018)	• "Previous research has revealed a higher prevalence of respiratory symptoms in Norwegian smelter workers compared to average population controls. Nevertheless, respiratory protective equipment (RPE) is not always used, even in situations with high exposure risk".	• In future research, investigating any interaction, mediation, or moderation effects between the independent variables on behavioural intention should be of interest.
12.	Understanding consumer behaviour regarding luxury fashion goods in India based on the TPBSushil (2017).	• "Even though the Indian luxury market is predicted to grow as much as the Chinese one over the coming years, limited research has been conducted on luxury consumer behaviour. This study uses the TPB framework to examine purchasing behaviour for luxury fashion goods".	• This study provides new theoretical insights regarding luxury consumer behaviour in India. • The study's findings will significantly help global luxury companies formulate their penetration and expansion strategies in the Indian market.

Table 2.3: TPB Literature review

applicability and provide a more comprehensive understanding of human action determinants. Our next step is to conduct a detailed literature review of TPB and identify any potential gaps related to our work.

A total of 800 papers were reviewed for the theory of planned behaviour, which is the underpinning theory, and around 200 were found to be relevant to our work. Still, 115 articles were considered for the study on intentional behaviour. A detailed literature review was undertaken for the TPB and following the significant work against their respective gaps in the 2.4 shown below:-

The TPB has identified crucial aspects that require further research, as shown in the 2.4. This overview of research gaps and the related articles is engaging and of significant interest.

2.11 Theoretical underpinning Gaps

The TPB was silent on aspects of Emotions, differences in human behaviour and Past Experience. The study suggests that if these factors are well handled, behaviour can be controlled easily. The individual's self-identity was kept out of the scope of the study. These factors are essential as they deal with fundamental human nature and must be accounted for when dealing with human behaviour. These factors are explained below for better understanding:-

1. **Emotions**: The TPB does not adequately address the role of emotions in influencing human behaviour. Emotions can significantly impact decision-making and actions, and their omission in the Theory may limit its explanatory power.
2. **Differences in Human Behavior**: The TPB may not account for individual differences in human behaviour. People vary in their personalities, attitudes, and preferences, and these differences can play a crucial role in shaping behaviour. The Theory may benefit from incorporating a more nuanced understanding of these variations.
3. **Past Experience**: The TPB may not consider the influence of past experiences on behaviour. Previous experiences and learned behaviours can shape an individual's decision-making and actions, and this aspect is not explicitly addressed in the Theory.

SN	PAPERS	AUTHOR	GAPS
1	**The extended theory of planned behavior in Turkish customers' intentions to visit green hotels**	**Emel Yarimoglu(2019)**	It was also suggested to **analyze direct or mediating effects of social influence, lifestyle, interpersonal relations, and anticipated emotions on pro-environmental behaviors and behavioral intentions** in the hotel sector
2	**Sustainable food consumption among young adults in Belgium: Theory of planned behaviour and the role of confidence and values**	**Iris Vermeir (2007)**	Future research could benefit **from incorporating perceived responsibility and self-identity.**
3	**Time to retire the theory of planned behavior**	**Falko F. Sniehotta(2014)**	The theory has been criticized for its exclusive focus on rational reasoning, excluding **unconscious influences on behavior and the role of emotions beyond anticipated affective Outcomes.**
4	**Exploring the Sustainability Concepts Regarding Leather Apparel in China and South Korea**	**Jung, Hye Jung(2019)**	Second, there might be some differences in sustainable consumption **behaviors based on demographic factors including age, gender, occupation, and marital status.**
5.	**Research on Developers' Green Procurement Behavior Based on the Theory of Planned Behavior**	**Yang, SJ (Yang, Shijing) (2019)**	On the other hand, the **government should reinforce public environmental knowledge education** and concept by media promotion, network education, community activity and many other forms, and improve public green consumption awareness.
6	**Modeling Acceptance of Electric Vehicle Sharing Based on Theory of Planned Behavior**	**Zhang, K (Zhang, Kai) (2018)**	Third, apart from behavioral intention, **the individual behavior is affected by opportunities and resources around them.**
7.	**Study on safety behavior planning theory and control strategies for coal chemical workers**	**Yao, M (Yao Min) (2020)**	Finally, polishing employees' skills can achieve behavioral safety. The model in this paper specifies the mechanism of human safety behavior more specifically, and can better answer the diversity and uncertainty of human behavior.

Figure 2.4: Final Theoretical Underpinning Gaps

4. **Self-Identity**: The Study suggests that the concept of self-identity was not included in the scope of the TPB. Self-identity is a fundamental aspect of human nature and can strongly influence behaviour. Incorporating self-identity into the theory may be valuable in providing a more comprehensive understanding of behaviour.

These gaps highlight the need for a more comprehensive and nuanced framework that considers the role of emotions, individual differences, past experiences, and self-identity in shaping human behaviour. Addressing these factors could lead to a more robust and accurate understanding of effectively controlling or influencing behaviour. The information below depicts all the knowledge in the block diagram 2.5.

2.12 Chapter Conclusion

In this chapter, we embarked on a journey into GSCM, laying the groundwork for our research study through a comprehensive literature review. Our exploration encompassed various databases, scouring through many articles to uncover insights into GSCM practices, barriers, performances, and the crucial role of behavioural factors. The literature review yielded a wealth of information, with around 500 relevant articles meticulously selected from an extensive pool. Focusing further, we honed in on 107 articles that provided valuable insights into GSCM's intricacies, shedding light on the challenges and opportunities within the industry. Much of our research delved into the Theory of Planned Behavior, underpinning our understanding of intentional behaviour in the context of GSCM. From the review of 800 papers, 115 articles emerged as pivotal in elucidating the complexities of intentional behaviour within the supply chain. Throughout the chapter, we cited studies that offered profound insights into the challenges and opportunities in GSCM implementation across various industries. We defined GSCM as integrating environmental considerations into SC practices, highlighting its multifaceted applications across different sectors. Crucially, we emphasised the pivotal role of behavioural factors in the success of sustainable practices within the supply chain. Recognising the influence of human behaviour on decision-making processes is paramount in devising effective strategies for GSCM adoption. While the chapter alludes to identifying research gaps based on the literature review, the specifics of these gaps are yet

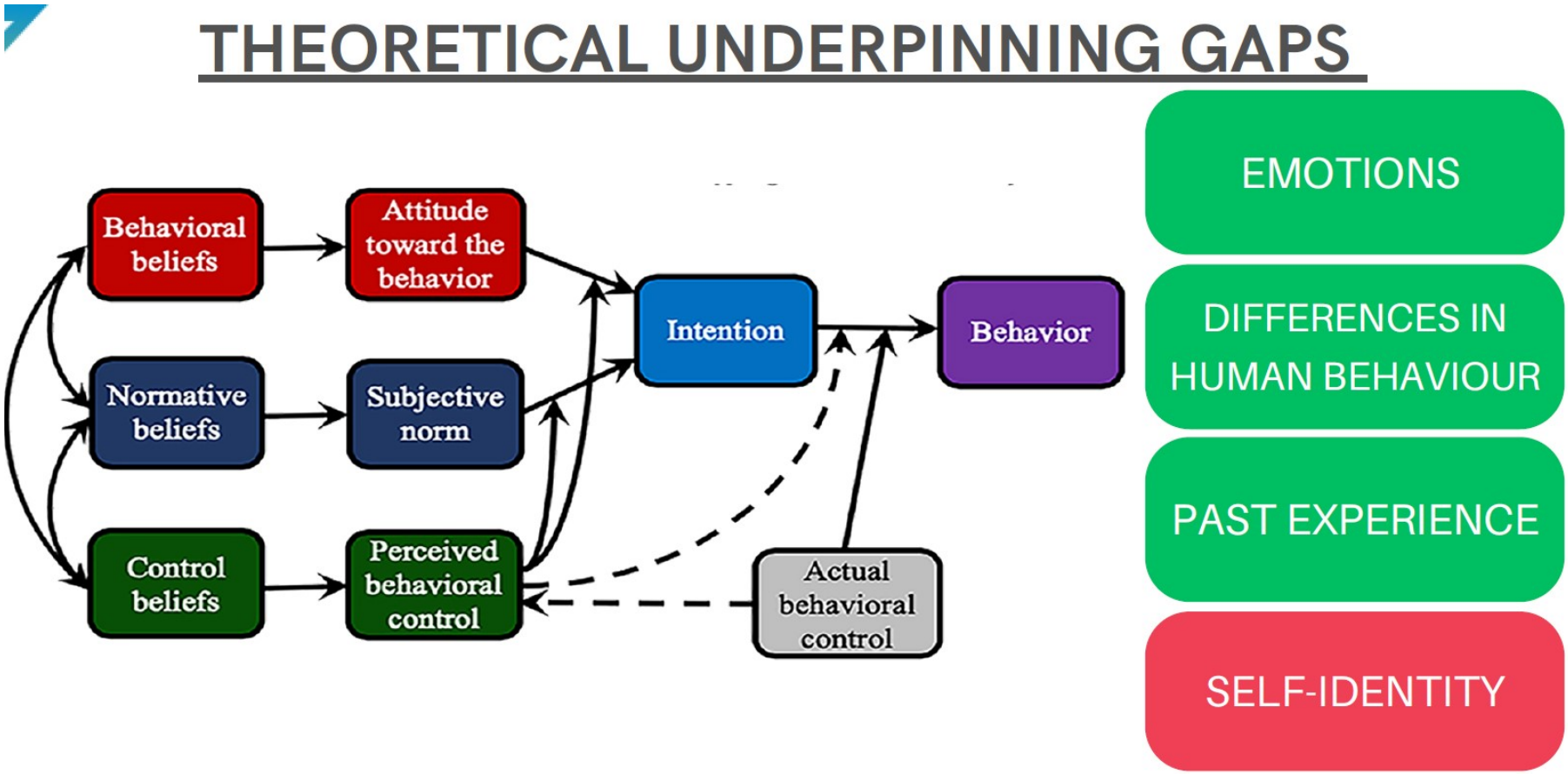

Figure 2.5: Theoretical Underpinning Gaps

to be elucidated. Nonetheless, this chapter serves as a foundational pillar for our research study, setting the stage for a deeper exploration into the intricacies of GSCM adoption and its implications for the IND leather industry.

Chapter 3

Research Design

3.1 Introduction

Building on the earlier chapter's literature review, this chapter outlines the research methodology, detailing the framework, paradigm, and strategy used. The chapter first describes the qualitative and descriptive nature of the study, which aims to explore the study in depth with a small number of respondents. It adopts the TPB to understand human behaviour in job roles, motivation, and performance related to GSCM in IND leather manufacturing firms. The research paradigm is subjective and interpretive, focusing on understanding diverse individual perspectives. This approach shapes the research methods and data analysis techniques. The study uses a qualitative expert opinion survey with semi-structured interviews, allowing for in-depth exploration of participant insights. The survey questions are based on literature and research objectives, and responses are analysed thematically to identify recurring patterns. Sampling involves selecting a homogeneous group of IND leather experts and a diverse group from within the industry, enhancing relevance and variety. Data collection through semi-structured interviews on Google Meet provides flexibility and depth. The chapter emphasises data saturation, ensuring an adequate sample size and comprehensive understanding. It also addresses reliability and validity in qualitative research, focusing on trustworthiness and credibility with techniques like triangulation. This chapter thoroughly overviews the research framework, paradigm, and strategy, ensuring rigorous and relevant findings.

3.2 Research Methodology

In this study, exploratory research is applied to carry out the qualitative study, which deals with data interpretation. In the qualitative study, semi structured

interviews are conducted to collect data and analysed using MICMAC, NVivo, and ISM software. The data organisation and elicitation of the semi-structured interview are conducted through content analysis. The flow diagram to our work is shown below 3.1:

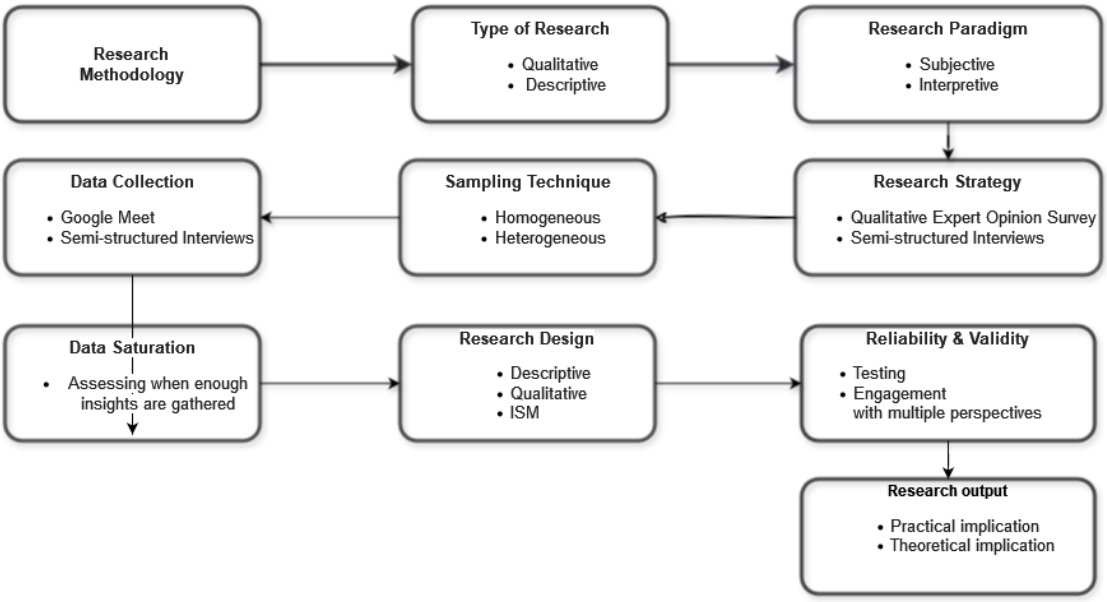

Figure 3.1: Flow chart- Research Methodology

Initially, a comprehensive literature review is carried out and follows narrative literature review with the integrative approach. This provides new perspectives on a particular topic. Further, the review are conceptually structured by the guiding theory Rozas and Klein (2010). The selection of the relevant literature was made by using the keywords: “GSCM”, “IND leather industry ”, “Adoption of GSCM”, “ISM and MICMAC”, “Case study approach”, “GSCM practices”, “GSCM performances”, “Environmental pollution” and “sustainability” on journal databases. According to Johnson and Anglin (1995), the survey strategies are strong with “what” type of research questions. It is because it helps in describing the prevalence concept.

In this study, a set of methodologies Shaukat et al. (2023) are included that resulted thatISM with MICMAC is appropriate technique due to its simple nature for thi kind of study Sushil (2017). ISM transforms unclear articulated mental models into well-defined and applicable models Sushil (2017). It is a mathematics of permuting binary matrices that converts complex phenomena into simpler ones. ISM with MICMAC is used as research methodology and modelling to clarify relationships between parameters or constructs. This model helps establish the relationships in complex constructs.

Expert	Expert Experience in the field	Justification
Environmental Specialist	5 years	Responsible for researching whether firm actions are appropriate in light of the state waste management regulation
Sustainability manager	3.5 years	In charge of overseeing and managing the company's GSCM program
Doctorate researcher on GSCM	7 years	Researchers developing studies on product return, remanufacturing, and reverse logistics. Transversal knowledge by having worked in the field in many industries in India
Full Professor on Supply Chain Management	11 years	Researchers who have worked on the extensive literature on GSCM and RL at many Indian companies that manufacture machinery

Table 3.1: Profiles of interview respondents

The purposive sampling, under non-probability sampling, entails selecting respondents based on a specific rationale instead of randomly Tashakkori and Teddlie (2003). It is more effective if the study must be done with experts within the research area Tongco (2007). Therefore, centralising the purposive sampling method, this study targeted a sample of IND leather industry experts who were well-experienced and knowledgeable in GSCM and leather engineering. However, following data saturation Guest et al. (2006), initially, 30 experts were selected and later increased to 50. However, only 40 responded. Face to face interviews were conducted for around one hour with each interviewee (minimum being 30 min and maximum being 83 min), and audio recording was done with the permission of the interviewees.3.1 presents the profiles of interview respondents and experts in the field. Before carrying out the interviews, two preliminary interviews were conducted as a pre-test to identify the robustness of the interview guidelines and to rehearse the interviewing process.

This research delves into the crucial relationship between int and ext barriers to GSCM in the Ind leather industry. By reviewing international peer-reviewed articles, the study identifies and categorises these barriers. Using Interpretive Structural Modeling (ISM), empirical research analyses the connections between these internal and external barriers, underscoring the significance of this investigation. A comprehensive examination of the barriers to GSCM implementation in the IND leather sector was conducted. ISM was utilised to understand the interactions between various barrier categories and to pinpoint the internal barriers contributing to other challenges. This approach is crucial for

grasping the complexity of GSCM implementation and devising effective strategies to overcome these obstacles. Furthermore, the study examines the impact of GSCM practices on supply chain performance and offers practical insights for the industry. The case-study method is appropriate when the boundaries of a phenomenon are unclear and beyond the researcher's control. This study analyses various green initiatives undertaken by IND leather firms of different sizes and supply chain positions to identify those significantly influencing supply chain performance. Five IND leather supply chain business case studies were selected, providing practical implications for the industry. The case-study methodology includes design, data collection, and analysis. Individual case studies are analysed in the final step to allow for "cross-case" comparisons. The qualitative data-analysis approach, as outlined by Miles and Huberman (1994), involves data collection, reduction, presentation, and conclusion testing, forming the foundation of this study. This research is exploratory due to the need for more empirical data to develop testable hypotheses. Given the potential variation in supply chain environmental behaviour across countries, it focuses on one supply chain within one nation before expanding to cross-supply chain and cross-country studies. The focus on the IND leather supply chain might introduce response bias, which could affect the results. Additionally, expert bias is a limitation, as the data were collected through interviews, with respondents possibly attempting to protect their reputation and image despite assurances of anonymity. These limitations are significant to consider when interpreting the results of this study. ISM is widely used in GSCM research to analyse relationships between different factors and identify key drivers and barriers. In the IND leather industry context, ISM was used to determine the critical behavioural factors influencing implementing GSCM practices. The technique provides a framework for understanding complex situations with multiple variables and interactions. The goal of using ISM is to investigate complex subjects with rigorous and logical reasoning, supported by expert opinions, to uncover subtle relationships between variables, and to present them in an organised format. ISM can be used independently, and the steps involved in the ISM model are illustrated in 3.2.

In the ISM technique, transitivity and reachability are two fundamental ideas. If an element "k" is connected to an element "j," and "j" is related to part I, then element "k" is connected to element I based on the transitivity concept. Transitivity contributes to conceptual coherence. The ISM methodology's foundational idea is reachability. On the other hand, the connection between the

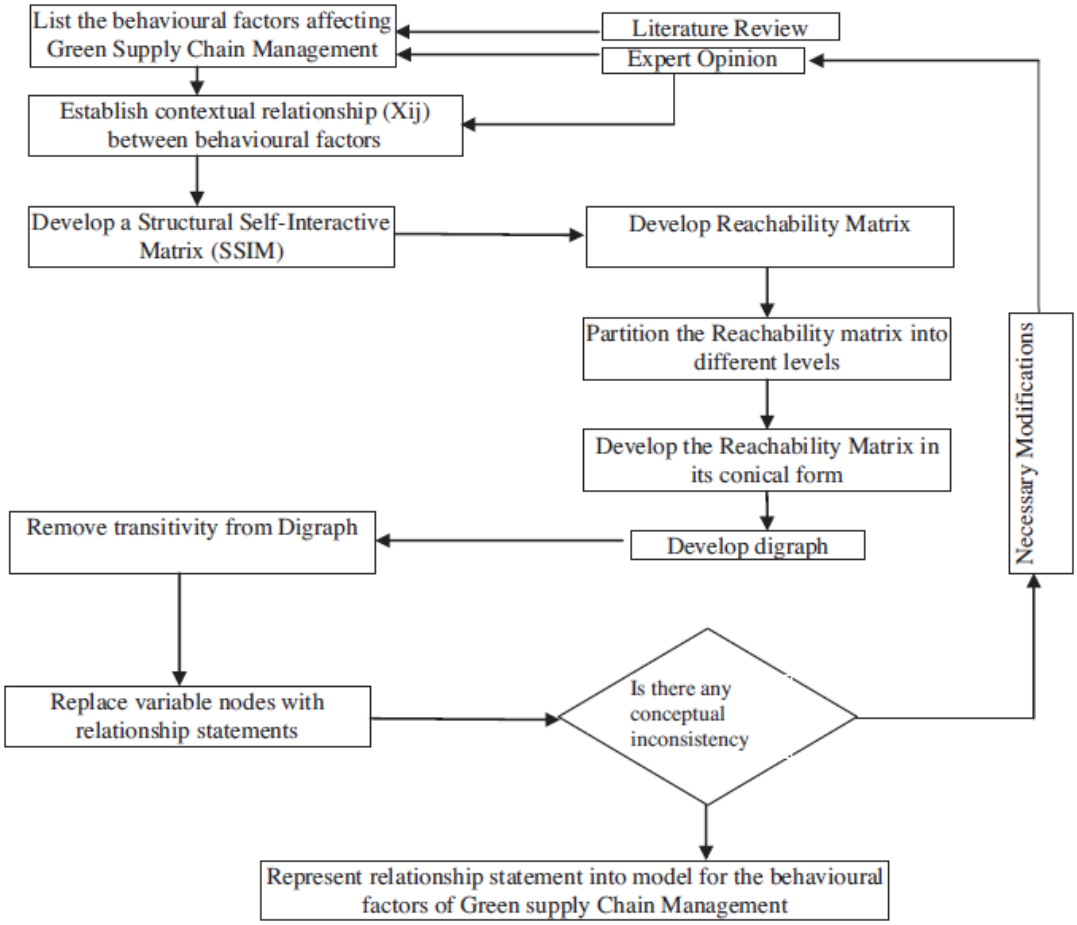

Figure 3.2: Steps in ISM model

identified elements is compared pair-wise. A binary matrix is used to represent this information. If the ith factor will assist in achieving the jth part, then the cell j) of the reachability matrix is assigned a value of "1," and the cell is assigned a matter of "0." (i, j). Additionally, the reachability matrix's transitivity attribute permits some cells to be filled using inference. The entries I j) = 1 and (j, k) = 1 in a matrix imply that I k) = 1. A precise comparison is optional Balon et al. (2016).

ISM is a controlling approach that has remained effective in various industries, including energy saving in the IND cement industry, vendor selection, productivity enhancement, third-party logistics, and reverse logistics. The following are the stages for building an ISM-based model.

The research objective was to arrive at the post-detailed identification of existing research gaps, understand the relationship between internal and external barriers, and study the impact of GSCM practices on performance param-

eters and behavioural factors. Key references include works by Rao and Holt (2005), and Mohanty and Prakash (2014), among others. Further, surveys, interviews, and case studies were conducted to gather primary data from industry stakeholders regarding the adoption of GSCM and the challenges faced. This helped us understand human behaviour, emotions, and experiences influencing GSCM practices. Tools like SPSS or R were used for statistical analysis to establish relationships between variables such as internal and external barriers, GSCM practices, and performance outcomes. The above methods supported the comprehensive analysis required to address the research objectives and promote the adoption of sustainable practices within the IND leather industry. To reiterate, the aim and objectives of our study are as follows:

3.3 Research Aim

To investigate the implementation of GSCM in the IND leather industry by exploring the relationship between internal and external barriers, assessing the influence of GSCM practices on performance parameters, and analysing the impact of behavioural factors on GSCM implementation.

3.4 Research Objectives (ROs)

To effectively implement GSCM in the IND leather industry, the research objectives may adhere to the accepted term, i.e. SMART framework: specific, measurable, achievable, relevant, and time-bound. The following are the proposed research objectives:

1. **RO-01**- To establish a relationship between internal and external barriers in GSCM for IND Leather Industry. in adopting
2. **RO-02**- To analyse the influence of GSCM practices on performance parameters for the IND leather industry.
3. **RO-03**- To analyse the role of various behavioural factors affecting implementation in the IND leather industry

These research objectives aim to provide a comprehensive understanding

of the challenges and opportunities associated with implementing GSCM in the IND leather industry, which will ultimately contribute to the development of sustainable practices within the sector.

3.5 Theoretical underpinning

Our study is underpinned by the TPB, a robust theoretical framework that sheds light on how individual behaviours influence the adoption of GSCM practices within Indian leather manufacturing firms. TPB asserts that an individual's behaviour results from their intention to perform specific actions, shaped by their attitudes, subjective norms, and perceived behavioural control. Our collected data strongly aligns with TPB's concept of attitude, particularly regarding motivation, passion, and enthusiasm. This alignment provides valuable insights into the factors influencing job role or process behaviour. Individuals' drive to excel in their roles or tasks reflects a positive attitude toward work. Additionally, the data highlights societal expectations and cultural norms, aligning with TPB's subjective norms, which are perceived social pressures significantly influencing individuals' attitudes and actions toward work-related activities. Our study applies TPB to the data, providing valuable insights into the factors influencing behaviour in job roles or processes. The data illustrates perceived behavioural control, evident in discussions on skills, experience, and the internal drive to accomplish tasks. These aspects point to individuals' beliefs about their capability to succeed in their work, influencing their motivation and performance. Applying TPB to the data is instrumental in developing interventions that foster positive behavioural changes and enhance organisational performance. It offers valuable insights into how these intentions translate into the actual implementation of GSCM practices and their impact on organisational performance. Moreover, TPB provides actionable insights into how individual behaviours, attitudes, and perceptions can be leveraged to address issues such as resistance to change and lack of employee awareness or motivation. In summary, TPB offers a comprehensive framework for understanding the dynamics of individual behaviours, attitudes, intentions, and the adoption of GSCM practices within Indian leather manufacturing firms. By applying TPB principles, researchers can identify critical barriers, design interventions, and enhance organisational strategies to promote the successful implementation of sustainable supply chain practices.

3.6 Data collection brief

Unlike quantitative surveys, qualitative surveys establish meaningful variations within the population and do not count the number of people with the same characteristics, attitudes or opinions as in a quantitative survey Jansen et al. (2010). The research question of this study could be better answered through a qualitative means as qualitative methods represented different views, attitudes, experiences and beliefs of a set of people and were ideal for research on in-depth investigations with a small number of respondents based on theoretical sampling and data saturation in the analysis Ritchie et al. (2013).

Moreover, sustainability is a holistic approach which has been developing for centuries Wiersum (1995); Saunders and Townsend (2016) and, as a result, is subjective and more suited to being investigated through qualitative means. Given the above facts, the qualitative "expert opinion survey" was selected as the research strategy in this study. The "semi-structured interview method" was chosen as the most appropriate data collection method since it allows the researcher to clarify any doubtful responses and ensure the questions and answers are correctly understood.

Choosing a sampling technique is one of the critical factors for any research, and it becomes more relevant when research is focused on a qualitative approach. The following are the primary steps for the finalisation of the sampling technique for any analysis:-

3.7 Choose Sampling Technique

Before we dive into the different sampling methods, it's important to define sampling and understand why researchers use it. Sampling involves choosing a subset from a larger group or the entire population. Depending on the sampling method, this subset can help draw conclusions about individuals or generalise findings about existing theories. Sampling methods are broadly divided into probability (or random) and non-probability (or non-random). Deciding on the broad sampling category before choosing a specific method is important. 3.3 shows the various sampling techniques.

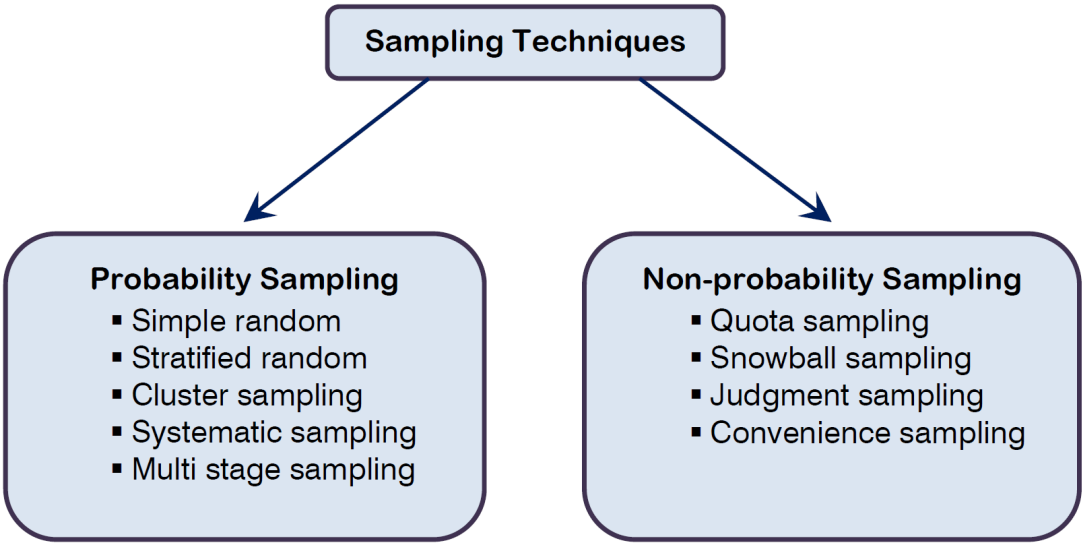

Figure 3.3: Sampling Techniques

1. **Probability Sampling**: Probability sampling ensures that every item in the population has an equal chance of being selected. One method involves creating a sampling frame and using a random number generator to select the sample. This approach minimises bias but can be time-consuming and costly in terms of effort for a given level of sampling error.

2. **Random Sampling**: In simple random sampling, each population member has an equal chance of being included. However, this method requires a complete list of all units in the population. Costs can be high if the units are geographically dispersed, and the standard errors of estimators may be more considerable.

3. **Systematic Sampling**: This method involves selecting members regularly, such as every 15th person on a list. When the population order is random, systematic sampling can mimic the benefits of simple random sampling.

4. **Stratified Random Sampling**: This technique divides the population into subgroups (strata) and then randomly samples from each subgroup. Strata can be based on characteristics like company size, gender, or occupation. Stratified sampling is appropriate when there is significant variation within a population.

5. **Cluster Sampling**: The population is divided into clusters, and a random sample of these clusters is taken. All members of the selected clusters

are included in the final sample. With its efficiency in handling widely dispersed subjects, cluster sampling is a cost-effective and time-saving option. The process involves identifying clusters, randomly selecting clusters, and then including all individuals within those clusters in the sample.

- Choose cluster grouping for the sampling frame, such as type of company or geographical region
- Number each of the clusters
- Select a sample using random sampling

6. **Multi-stage Sampling**: Multi-stage sampling efficiently narrows the sample through a multi-step process. For example, instead of randomly sampling automobile owners throughout Malaysia, a magazine publisher could divide the country into several regions, randomly select some regions, and subdivide them into local authority areas, towns, or cities. This method focuses on samples in specific regions, which saves time and costs and provides valuable insights.

7. **Non-probability Sampling**: Non-probability sampling is commonly used in case study research and qualitative studies, emphasising small samples to explore natural phenomena rather than making broad statistical inferences. Participants or cases are selected based on specific criteria, with a clear rationale for their inclusion.

8. **Quota Sampling**: Quota sampling involves selecting participants based on predetermined characteristics to ensure the sample mirrors the distribution of those characteristics in the larger population.

9. **Snowball Sampling**: Snowball sampling starts with a few initial participants who help recruit additional participants, expanding the sample size. This technique is beneficial for reaching small, hard-to-access populations, such as secret societies or niche professions.

10. **Convenience Sampling**: Convenience sampling involves choosing participants who are easily accessible. This method is popular among students due to its simplicity and cost-effectiveness, such as using friends or family members as part of the sample.

11. **Purposive or Judgmental Sampling**: Purposive or judgmental sampling involves intentionally selecting specific settings, individuals, or events

to provide critical information unavailable from other sources. Researchers include certain cases or participants because they believe these will yield valuable insights.

We will use **purposive or judgmental sampling** for our work. This involves deliberately selecting specific individuals or cases because they can provide valuable information that other sampling methods may not capture. This approach is beneficial when the research aims to gain insights from subjects with unique characteristics or experiences crucial to the study.

Population, Sampling, and Procedure

The population under investigation includes Environmental specialists, Sustainability Managers, Doctorate Researchers, Professors in Supply Chain Management and ground-level workers. There are two options for recruiting such groups, namely, homogeneous and heterogeneous, each requiring different group sizes. The panel size for homogeneous groups varies from 12 to 25 experts, and that of heterogeneous groups ranges from 8 to 16 experts Clayton (1997). In this study, we opted for a homogeneous group of IND leather experts with a panel size of 40 experts.

However, we recruited a heterogeneous group from within the leather staff. The panel was drafted based on their practical, theoretical, and expert knowledge about the phenomenon under study and relevant experience in an authoritative organisation. In recruiting the panel experts, the principle was "quality is more important than quantity" Clayton (1997). The piloting function was performed before the data collection through pretesting, emails, phone calls, and personal meetings via online mode to invite experts to participate in this study. It took almost four months to complete the data collection process, and covid-19 time was utilised. More than 80 experts were approached; only 60 agreed to participate, but 40 participated.

Data collection method

Google Meet was used as the interview platform. It commenced with a reiteration of the purpose of the interview and study. There was a mutual introduction be-

tween the experts and the researcher. The scope of each variable was explained, all clarifications were addressed, and consent was taken before commencing the interview. The interview was a comprehensive, semi-structured interview. A mini-Delphi technique was used to present Yes/No structured questions to capture the contextual relationships between pairs of variables. The experts were allowed to review others' responses before finalising their responses. The unstructured questions were around the experts' justifications for the relationships. The audio recording of the interview was carried out with the explicit permission of the experts. The interview was then transcribed to conduct content analysis while preserving the experts' identities. The online discussion was born in Pune, India.

A semi-structured interview was undertaken using a detailed questionnaire developed through discussion and amendments. This process was initially tested by a leather engineer from an Indian leather company. The pre-test included sending the protocol, followed by conducting phone and in-person interviews to evaluate the clarity and suitability of the questions. This phase significantly improved the research and presentation of the issues. Feedback was provided in written and verbal form, which helped validate the protocol. Based on this feedback, several structural adjustments were made to the technique.

Multiple interviews were conducted to understand better the different green strategies that IND leather industry firms utilise and how they affect SC performance. Each manager was asked their questions. The same structured interview methodology was employed during every session to prevent interviewer bias. I added additional questions when appropriate to explain and build on the answers. Other follow-up questions were emailed following the interviews. According to the general requirement for confidentiality, firm names are always concealed. The participating panel consisted of Environmental specialists, sustainability managers, doctorate researchers, GSCM professors and ground-level workers. All the participants had a minimum experience of 3.5 years in leather manufacturing organisations and were related to the IND leather industry.

Data saturation and research strategy

The saturation is when no further issues or insights can be identified as a result of data collection, and data collection begins to repeat itself as if it is

not needed to collect additional data, indicating that an adequate sample size has been reached. Delphi studies aim to reach consensus rather than saturation and realise this goal, and data is collected in several rounds. Researchers use consensus as a benchmark to determine whether participants have enough agreement about specific concepts or responses to proceed with a study and include it in the final analysis. A consensus has been reached after the distribution of two rounds of questionnaires in this study.

In earlier periods of studying SSCM, most articles used surveys; however, since 2001, this field has witnessed a sharp increase in empirical data from case studies and interviews Carter and Liane Easton (2011). The area of SSCM is mainly the use of empirical data, with a great emphasis on qualitative data through interviews or case studies, due to the ability of empirical data to provide a further understanding of current issues or a better understanding of future situations Seuring and Gold (2013). Hence, to answer the previously mentioned research questions, this study adopts a descriptive research approach using qualitative methodology through individual semi-structured interviews followed by interpretive structural modelling (ISM) for barriers to SSCM to develop an overall structured model representing possible interrelationships between borders.

Reliability and Validity in Qualitative Research

Reliability in qualitative research, traditionally associated with quantitative studies, ensures the study's quality by helping understand situations that might otherwise be confusing. Stenbacka (2001) argues that reliability must be redefined for qualitative research and can be misleading if used as a criterion. Patton (2001) emphasises that validity and reliability are crucial for qualitative researchers in designing studies, analysing results, and assessing quality.

Healy and Perry (2000) suggest that each paradigm should judge study quality by its terms. In qualitative paradigms, credibility, neutrality (or confirmability), consistency (or dependability), and applicability (or transferability) are critical. Lincoln and Guba (1985) advocates for 'dependability' in qualitative research, similar to 'reliability' in quantitative research, and recommends 'inquiry audits process of reviewing and verifying the research process and findings by an independent auditor to enhance dependability. Ensuring reliability involves examining trustworthiness. Corbin and Strauss (1990) suggest redefin-

ing the usual canons of 'good science' to fit qualitative research's realities. Validity in qualitative research is diverse and grounded in specific methodologies and project intentions. Creswell and Miller (2000) suggests that validity is influenced by the researcher's perception and paradigm choice. Researchers have developed terms like quality, rigour, and trustworthiness to describe validity Davies and Dodd (2002); Lincoln and Guba (1985); Stenbacka (2001)). Discussions on quality in qualitative research often stem from concerns about validity and reliability in quantitative traditions.Davies and Dodd (2002) argue for a reconception of rigour, incorporating subjectivity, reflexivity, and social interaction in interviews.

3.8 Testing Validity and Reliability

To test or maximise validity and reliability in qualitative studies, enhancing validity or trustworthiness leads to more credible and defensible results (Johnson and Anglin (1995); Stenbacka (2001)). The quality of research is tied to the generalizability of results and testing the study's validity or trustworthiness. Maxwell (1992) notes that the degree to which an account is generalisable distinguishes quantitative from qualitative research approaches. Triangulation, a strategy for improving validity and reliability, involves using multiple methods or data (Mathison (1988)).

Barbour (1998) argues that mixing methods within one paradigm can be problematic since each method has its assumptions. Triangulation in qualitative research, unlike in quantitative research, typically involves using multiple data sources to confirm a single finding and is a strategy for improving validity and reliability that consists of using various methods or data (Mathison (1988)). Healy and Perry (2000) discuss judging validity and reliability within the realism paradigm, which involves numerous perceptions of a single reality and relies on triangulating various data sources and interpretations. Constructivism views knowledge as socially constructed and changeable depending on the context (Crotty (1998)). The constructivist notion, which views knowledge as socially constructed and changeable depending on the context (Crotty (1998)), acknowledges multiple perspectives and dynamic contexts, facilitating deeper understanding (Hipps (1993)).

3.9 Ethical considerations

The purpose of the interview was explained to the experts. Their consent was taken to record and transcribe the interview, and their participation was voluntary. The experts were contacted via WhatsApp and LinkedIn, after which they confirmed their availability. Neither has this study been registered anywhere nor reviewed by an ethical committee.

3.10 Chapter conclusion

This chapter comprehensively elucidates the research methodology and theoretical framework underpinning this work. It provides a detailed overview of the methods employed to gather and analyse data and the theoretical constructs guiding the research. To begin with, the chapter outlines the primary research tools utilised, namely expert opinion surveys and semi-structured interviews. These methods are chosen for their effectiveness in eliciting rich, qualitative insights from participants. The decision to conduct interviews via Google Meet is explained, highlighting the platform's convenience and accessibility for researchers and respondents. Furthermore, the incorporation of the mini-Delphi technique and content analysis of transcripts is described, emphasising their roles in enhancing the validity and reliability of the data collected. The research design is intricately linked to the study's objectives, particularly in exploring GSCM practices and supply chain performance within the context of the IND leather industry. Case studies, a crucial research methodology component, offer a nuanced understanding of green initiatives across different supply chain tiers, thereby highlighting this study's practical implications. By examining real-world examples, the study aims to uncover patterns, challenges, and opportunities related to sustainability practices in the industry. In addition to data collection methods, the chapter delves into the analytical techniques employed, notably Interpretive Structural Modeling (ISM). This approach enables a systematic examination of barriers to GSCM implementation, allowing researchers to identify key drivers and develop targeted strategies for improvement. The chapter also scrutinises the TPB and proposes innovative enhancements to better account for emotional factors, individual differences, and past experiences. By incorporating these novel elements into the theoretical framework, the study seeks to provide a more holistic understanding of human behaviour within the context of the supply

chain. A visual representation in the form of a block diagram is introduced to illustrate the complex interplay between various factors influencing behaviour, further emphasising the uniqueness and novelty of this study. This chapter lays a solid foundation for the subsequent analyses and findings by providing a detailed roadmap of the research methodology and theoretical underpinnings. It underscores the importance of adopting a rigorous and holistic approach to studying GSCM practices and supply chain performance, particularly within the unique context of the IND leather industry.

Chapter 4

Data Analysis

The previous chapter laid a strong foundation for our research by clearly defining the methodology and theoretical framework. This groundwork is essential as it prepares us for detailed analyses and findings. We highlighted the importance of a rigorous and comprehensive approach to studying GSCM practices and SCP by outlining the research methodology and theoretical underpinnings. This is particularly significant in the unique context of the IND leather industry, which plays a crucial role in the country's economy and sustainability efforts.

In this chapter, our focus shifts to a comprehensive data analysis, where we will delve deeply into our three main objectives. This chapter is structured to thoroughly examine each objective, providing a clear and coherent flow for the reader. The depth and breadth of our analysis will ensure our findings' robustness and applicability to real-world scenarios. First, we will explore the various int and ext barriers faced by the IND leather industry. Understanding these barriers is crucial for identifying areas where improvements can be made and developing strategies to overcome them. Next, we will examine how human behaviour significantly influences all aspects of GSCM, from conception to execution. Recognising the human element is vital for implementing effective GSCM practices, as the success of these practices largely depends on the people involved. Finally, we will provide insights into the different GSCM practices employed within the IND leather industry and their effects on company performance. By comprehensively understanding these practices, we can assess their impact and suggest ways to enhance SCP. By sequentially addressing these objectives, we aim to provide a clear and logical flow to our work, making it easy for readers to follow and understand. Now, we examine the various int and ext barriers the IND leather industry encounters.

Study of the interplay among internal and external barriers to GSCM in the IND Leather Industry using the total ISM and MICMAC methodology

This subhead aims to uncover the complex relationships among barriers that affect the sustainable performance of the industry. We will explore these barriers to identify the critical challenges and obstacles that hinder the adoption and implementation of GSCM practices in the IND leather sector. Through thoroughly examining these barriers and their connections, we hope to gain deeper insights into the complexities of sustainability within the industry, enabling us to develop informed strategies and interventions to bring about positive change.

4.1 GSCM barriers classification

Implementing GSCM faces numerous challenges, categorised into ext, int, and individual factors. Ext factors include inadequate infrastructure, limited resources, and geopolitical issues like trade disputes. Other factors include poor communication, insufficient forecasting and planning, and diverse legal and regulatory requirements. Individual factors include needing more knowledge or skills, low motivation, or prioritising other tasks over GSCM initiatives. Understanding these barriers is essential for successfully implementing GSCM in various organisations.

The IND leather industry has specific obstacles to adopting GSCM practices. These include limited awareness, insufficient government policies, and limited resources. A case study of two prominent factories in this industry, both with integrated GSCM programs, focused on the expertise of environmental specialists and sustainability managers guided by their logistics managers. These specialists were deemed most capable of addressing the research questions.

The study identified several key barriers to implementing GSCM programs in the leather industry, revealing significant challenges businesses face in their sustainability efforts.

After the case study, an extensive literature review on GSCM barriers was conducted, revealing 25 distinct obstacles. These barriers were classified into

seven categories based on feedback from industry experts, which improved the researchers' comprehension of int and ext challenges. The categories include:

1. "Technology and Infrastructure Issues (T&I)"
2. "Governance and Supply Chain Process Issues (G&SC)"
3. "Economic Issues (E)"
4. "Knowledge Issues (K)"
5. "Policy Issues (P)"
6. "Market and Competition Issues"
7. "Management Issues"

Each category highlights specific challenges and provides valuable insights into how these challenges can be overcome, thereby facilitating the effective implementation of GSCM initiatives.

This classification offers organisations a structured framework to understand and address barriers, aiding in developing more effective GSCM strategies and promoting sustainable practices within the industry. The details regarding these obstacles are derived from various literature sources, including Bouzon et al. (2015), Dhillon et al. (2016), Chen and Paulraj (2004), Lahane and Kant (2021), Muduli et al. (2013), and Zhu et al. (2013).

4.1 presents a detailed classification of the barriers to GSCM in the IND leather industry, organised into two columns: classification and barriers. These barriers are divided into int and ext categories based on feedback and detailed discussions with GSCM experts and industry representatives. Int barriers (IN) refer to organisational challenges such as lack of top management commitment, inadequate training and awareness programs, resistance to change, insufficient financial resources, and poor int communication. Ext barriers (EX) include obstacles originating outside the organisation, such as lack of government support and regulations, inadequate infrastructure for GSCM, high costs of green technologies, market competition and pressure, and insufficient demand for green products.

Classification	Barriers
Technology and infrastructure (T&I)	T&I-1(IN). Absence of personnel technical skills
	T&I-2(IN). Absence of IT systems standards
	T&I-3(IN). Absence of latest technologies
	T&I-4(IN). Absence of in-house facilities (infrastructure)
	T&I-5(IN). Technology and the R&D issues linked to product recovery
Governance and supply chain process linked concerns (G & SC)	G&SC-1(EX). Difficulties with supply chain members (poor coordination)
	G&SC-2(IN). Inadequate forecasting and planning
	G&SC-3(IN). Unreliable quality
Economic associated matters (E)	E-1(IN). Absence of initial capital
	E-2(EX). Absence of financial support for investments in return monitoring system/storage and handling
	E-3(EX). Uncertainty linked to economic issues
	E-4(IN). Absence of economy of scale
Knowledge allied concerns (K)	K-1(IN). Absence of knowledge on GSCM practices
	K-2(EX). Absence of information on take-back channels
	K-3(EX). Absence of awareness concerning GSCM and its benefits
	K-4(IN). Absence of taxation knowledge on returned products
Policy linked problems (P)	P-1(EX). Absence of specific laws
	P-2(EX). Absence of waste management practices
	P-3(EX). Absence of inter-ministerial communication
	P-4(EX). Absence of motivation laws
Market and competitors (M&C)	M&C-1(EX). Perception of a poorer quality product
	M&C-2(EX). Undeveloped recovery marketplaces
	M&C-3(EX). Little recognition of GSCM competitive advantage
Management correlated problems(M)	M-1(IN). Low importance of GSCM relative to other issues
	M-2(IN). Low involvement of top management and strategic planning

Table 4.1: Classification and barriers

Expert	Expert Experience in the field	Justification
Environmental Specialist	5 years	Responsible for researching whether firm actions are appropriate in light of the state waste management regulation
Sustainability manager	3.5 years	In charge of overseeing and managing the company's GSCM program
Doctorate researcher on GSCM	7 years	Researchers developing studies on product return, remanufacturing, and reverse logistics. Transversal knowledge by having worked in the field in many industries in India
Full Professor on Supply Chain Management	11 years	Researchers who have worked on the extensive literature on GSCM and RL at many Indian companies that manufacture machinery

Table 4.2: Expertś descr and choice justification.

4.2 Data collection

This research aimed to identify the barriers to implementing GSCM within the IND leather industry. The study targeted individuals with expertise in GSCM practices, challenges, and specialists within the sector. It represents one of the first efforts to explore the interplay between int and ext barriers in this industry, underscoring the critical need for accurate data collection.

Experts familiar with GSCM in the IND leather industry were selected based on their knowledge and availability. **??** details these experts, including their years of experience and the rationale for their selection. The study concentrated on two major IND leather factories with established GSCM programs, as recommended by logistics managers. These managers suggested that environmental specialists and sustainability managers would be best suited to address the research questions. Additionally, input was sought from academicians with expertise in GSCM who were available to contribute to the study.

Initially, potential respondents were contacted by phone to schedule in-person interviews. "During these structured interviews, clarifications on GSCM obstacles were provided to ensure a clear understanding of the terminology. Pair-wise comparison questions explored the relationships between barriers to GSCM implementation". The gathered data was analysed to create a self-structural matrix for the ISM method. This matrix formed the basis for applying ISM to establish the connection between int and ext barriers. Industry experts and researchers then reviewed these relationships to gain deeper insights. A flow chart illustrating

the ISM implementation process 3.2 is provided below to aid understanding.

The figure details the steps in using ISM to examine the relationship between int and ext barriers to GSCM in the IND leather industry. This process includes creating a structural self-interaction matrix, which is crucial for analysing variables using ISM. A reachability matrix will also be employed to better understand the interactions among various factors in the study.

To identify research gaps, a review of global peer-reviewed journals on GSCM was conducted to pinpoint both int and ext barriers. Bibliographic databases such as "ISI Web of Science, Scopus, Science Direct, Springer, and Google Scholar were searched using keywords like 'GSCM' and 'barriers.' Data from Advanced Micro Devices (AMD), a multinational with global operations, was also analysed to assess the operational aspects of environmental SCM".

For instance, Wu et al. (2012) examined adopting eco-friendly SCM practices in Taiwan's electronics industry following EU regulations on hazardous substances and waste. Zhu et al. (2007) explored the pressures and drivers of GSCM in China's automotive sector, noting significant regulatory and market constraints and int motivations. Gharaei et al. (2021) investigated closed-loop SCs with quality control and green policies. Lu et al. (2007) used factor analysis to study GSCM in Taiwan's electronics industry, emphasising the importance of effective supplier management. Amjadian and Gharaei (2022) focused on integrated inventory management in multi-level SCs.

Piyathanavong et al. (2019) assessed green practices among Thai electronics manufacturers, considering factors like recycling, transportation, and production. Kainuma and Tawara (2006) explored GSCM implementation in IND's sugar industry by surveying 30 sugar mills in Uttar Pradesh. Gharaei et al. (2021) also examined the environmental impact of leather production, highlighting economic growth in carbon emissions. Their research suggested that GSCM adoption in IND is still in its early stages. Through a detailed literature review and consultations with experts, 45 barriers were identified and categorised based on their meanings and similarities.

4.3 List of barriers and their categories

The most common barriers are identified through a questionnaire survey from various industrial sectors. Hence, this study offers a novel approach to understanding the obstacles to GSCM implementation from an IND leather industry perspective.

The 25 identified barriers were classified into seven categories, i.e. Technology and infrastructure-related issues (T&I), Governance and SC process-related issues (G&SC), Economic related issues (E), Knowledge-related issues (K), Policy-related issues (P), Market and competitors-related issues (M&C), Management-related issues (M),

4.4 Establish contextual relationships between variables (Step 3) and develop Structural Self-Interaction Matrix (SSIM) (Step 4)

To decide which pairings of categories should be studied (Step 3), "a contextual relationship is constructed among the categories based on the variables found in Step 2. Variables (categories) are developed into a structural self-interaction matrix (SSIM), which illustrates pairwise interactions between variables in the system. A "affects" contextual relationship is used to analyse the barrier categories".

In other words, one category affects another category. As a result, the contextual relationships (barrier categories) between the variables are developed using the ISM rule.

4.5 Reachability matrix (RM) (Step 5)

Now SSIM has been transformed into the binary matrix, the initial reachability matrix 4.4, by substituting V, A, X, and O into the binary numbers 0 and 1, as per the rules.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
TI-1(IN). Lack of personnel technical skills		X	A	O	A	O	O	V	O	O	O	O	X	O	O	O	O	O	O	O	V	O	O	O	O
TI-2(IN). Lack of IT systems standards			V	X	V	O	O	O	O	O	O	O	O	O	O	O	O	O	O	V	O	O	O	O	O
TI-3(IN). Lack of latest technologies				O	V	O	V	V	O	V	O	O	O	O	O	O	O	O	O	V	A	O	O	O	O
TI-4(IN). Lack of in-house facilities (infrastructure)					V	O	O	V	X	X	A	X	O	O	O	O	O	O	O	O	A	O	O	O	O
TI-5(IN). Technology and the RD issues related to product recovery						X	O	O	O	O	O	O	X	X	X	X	A	V	O	O	O	A	O	O	A
GSC-1(EX). Difficulties with supply chain members (poor coordination)							V	O	O	A	O	O	O	A	O	A	O	O	O	O	O	O	O	O	A
GSC-2(IN). Limited forecasting and planning								V	V	O	A	A	O	X	A	O	A	O	O	O	O	O	O	O	X
GSC-3(IN). Inconsistent quality									O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	A
E-1(IN). Lack of initial capital										V	O	V	O	O	O	O	O	O	O	O	O	O	O	O	V
E-2(EX). Lack of financial support for investment in return monitoring sys/storage and handling											O	O	A	O	A	A	A	A	A	O	O	A	O	A	A
E-3(EX). Uncertainty related to economic issues												X	O	O	O	O	O	O	O	V	O	O	O	O	V
E-4(IN). Lack of economy of scale													O	O	O	O	O	O	O	O	O	O	O	O	A
K-1(IN). Lack of knowledge on GSCM practices														X	X	X	X	A	O	O	O	O	V	A	A
K-2(EX). Lack of information on take-back channels															A	A	A	A	O	O	O	A	A	O	A
K-3(EX). Lack of awareness concerning GSCM and its benefits																V	V	V	O	O	O	O	A	A	O
K-4(IN). Lack of taxation knowledge on returned products																	A	O	X	O	O	O	O	O	A
P-1(EX). Lack of specific laws																		V	A	V	O	O	V	V	V
P-2(EX). Lack of waste management practices																			O	O	O	A	O	A	A
P-3(EX). Lack of inter-ministerial communication																				O	O	V	V	V	O
P-4(EX). Lack of motivation laws																					O	O	O	A	O
MC-1(EX). Perception of a poorer quality product																						O	O	A	O
MC-2(EX). Undeveloped recovery marketplaces																							O	A	O
MC-3(EX). Little recognition of GSCM competitive advantage																								A	O
M-1(IN). Low importance of GSCM relative to other issues																									A
M-2(IN). Low involvement of top management and strategic																									

Table 4.3: Structural Self-Interaction Matrix (SSIM)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	**Driv Power**
TI-1(IN). Lack of personnel technical skills	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	5
TI-2(IN). Lack of IT systems standards	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6
TI-3(IN). Lack of latest technologies	1	0	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7
TI-4(IN). Lack of in-house facilities (infrastructure)	0	1	0	1	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7
TI-5(IN). Technology and the RD issues related to product recovery	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	8
GSC-1(EX). Difficulties with supply chain members (poor coordination)	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
GSC-2(IN). Limited forecasting and planning	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	5
GSC-3(IN). Inconsistent quality	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E-1(IN). Lack of initial capital	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5
E-2(EX). Lack of financial support for invest in return monitoring sys/storage and handling	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
E-3(EX). Uncertainty related to economic issues	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	6
E-4(IN). Lack of economy of scale	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
K-1(IN). Lack of knowledge on GSCM practices	1	0	0	0	1	0	0	0	0	1	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	9
K-2(EX). Lack of information on take back channels	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	5
K-3(EX). Lack of awareness concerning GSCM and its benefits	0	0	0	0	1	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	9
K-4(IN). Lack of taxation knowledge on returned products	0	0	0	0	1	1	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	7
P-1(EX). Lack of specific laws	0	0	0	0	1	0	1	0	0	1	0	0	1	1	0	1	1	1	0	1	0	0	1	1	1	12
P-2(EX). Lack of waste management practices	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	4
P-3(EX). Lack of inter-ministerial communication	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1	1	1	0	7
P-4(EX). Lack of motivation laws	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
MC-1(EX). Perception of a poorer quality product	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
MC-2(EX). Undeveloped recovery marketplaces	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	5
MC-3(EX). Little recognition of GSCM competitive advantage	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	3
M-1(IN). Low importance of GSCM relative to other issues	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1	1	1	1	0	9
M-2(IN). Low involvement of top management and strategic	0	0	0	0	1	1	1	1	0	1	0	1	1	1	0	1	0	1	0	0	0	0	0	1	1	12
Dependence Power	5	3	3	7	12	6	9	6	3	13	2	5	10	11	5	7	4	7	2	6	3	3	5	4	5	

Table 4.4: Reachability matrix (RM)

4.6 Final reachability matrix (FRM) (Step 6)

ISM also allow ”The final reachability matrix is shown in 4.5 and is derived from the initial reachability matrix using the transitivity rule, which states that if a variable ’1’ is connected to ’2’ and ’2’ is related to ’3’, then ’1’ is undoubtedly associated with 3”.

4.7 Level partitioning(LP)

The reachability mentioned above matrix was divided up into layers. The data in 4.6 were used to generate the reachability and antecedent sets for each category. The reachability set for an individual category includes the category itself and any additional categories that may influence it. A separate category’s antecedent set is the categories that may affect it. For each category, the intersection of these sets was calculated 4.6.

4.8 Level Partitioning Iterations

ISM demands that ”The antecedent set A and intersection set R are finally adjusted to the final level. The standard level in the previous step is clubbed together to decide the top level”. Level partitioning interactions 4.16 are formulated to get the top level among various levels to develop the conical matrix 4.16 in the next step.

4.9 Conical matrix (CM) creation (Step 7) ISM model construction (Steps 8, 9, 10, 11)

Their members reorganise the partitioned reachability matrix according to their level to produce the conical matrix, which indicates that all elements with the same level are pooled. A digraph is a resultant graph. When the transitivity is eliminated, the digraph is eventually turned into the ISM model, as described in the ISM technique.

The subcategories are divided into four clusters or sectors according to

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	**Driv Power**
TI-1(IN). Lack of personnel technical skills	1	1	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	25
TI-2(IN). Lack of IT systems standards	1	1	1	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	25
TI-3(IN). Lack of latest technologies	1	1*	1	1*	1	1*	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	25
TI-4(IN). Lack of in-house facilities (infrastructure)	1*	1	1*	1	1	1*	1*	1	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25
TI-5(IN).Tech and the RD issues related to product recovery	1	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1	1	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	25
GSC-1(EX). Difficulties with supply chain members (poor coordination)	1*	1*	1*	1*	1	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25
GSC-2(IN). Limited forecasting and planning	1*	1*	1*	1*	1*	1*	1	1	1	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	25
GSC-3(IN). Inconsistent quality	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E-1(IN). Lack of initial capital	1*	1*	1*	1	1*	1*	1*	1*	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	25
E-2(EX). Lack of fin support for investment in return monitoring sys/storage and handling	1*	1*	1*	1	1*	1	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25
E-3(EX). Uncertainty related to economic issues	1*	1*	1*	1	1*	1*	1	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1	25
E-4(IN). Lack of economy of scale	1*	1*	1*	1	1*	1*	1	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25
K-1(IN). Lack of knowledge on GSCM practices	1	1*	1*	1*	1	1*	1*	1*	1*	1	1*	1*	1	1	1	1	1	1*	1*	1*	1*	1*	1	1*	1*	25
K-2(EX). Lack of information on take-back channels	1*	1*	1*	1*	1	1	1	1*	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25
K-3(EX). Lack of awareness concerning GSCM benefits	1*	1*	1*	1*	1	1*	1	1*	1*	1	1*	1*	1	1	1	1	1	1	1*	1*	1*	1*	1*	1*	1*	25
K-4(IN). Lack of tax knowledge on return products	1*	1*	1*	1*	1	1	1*	1*	1*	1	1*	1*	1	1	1*	1	1*	1*	1	1*	1*	1*	1*	1*	1*	25
P-1(EX). Lack of specific laws	1*	1*	1*	1*	1	1*	1	1*	1*	1	1*	1*	1	1	1*	1	1	1	1*	1	1*	1*	1	1	1	25
P-2(EX). Lack of waste management practices	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1	1	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	25
P-3(EX). Lack of inter-ministerial communication	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1	1	1*	1	1*	1*	1	1	1	1*	25
P-4(EX). Lack of motivation laws	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
MC-1(EX). Perception of a poorer quality product	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	25
MC-2(EX). Undeveloped recovery marketplaces	1*	1*	1*	1*	1	1*	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1*	25
MC-3(EX). Little recognition GSCM competitive adv	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	25
M-1(IN). Low importance of GSCM vis other issues	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1	1*	1	1*	1*	1	1*	1	1	1	1	1	1*	25
M-2(IN). Low involvement of top mgmt n strategic	1*	1*	1*	1*	1	1	1	1	1*	1	1*	1	1	1	1*	1	1*	1	1*	1*	1*	1*	1*	1	1	25
Dependence Power	23	23	23	23	23	23	23	24	23	23	23	23	23	23	23	23	23	23	23	24	23	23	23	23	23	

Table 4.5: Final reachability matrix (FRM)

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi) ∩ A(Ni)	Level
1	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
2	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
3	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
4	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
5	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
6	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
7	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	8,	1
9	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
10	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
11	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
12	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
13	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
14	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
15	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
16	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
17	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
18	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
19	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
20	20,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	20,	1
21	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
22	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
23	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
24	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2
25	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	2

Table 4.6: Level partitioning(LP)

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi) ∩ A(Ni)	Level
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
3	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	8,	1
9	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
16	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
17	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
19	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
20	20,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	20,	1
21	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
22	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
23	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
24	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	
25	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25,	

Table 4.7: Level Partitioning Iterations

Variables	8	20	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17	18	19	21	22	23	24	25	**Driv Power**	**Level**
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1	1	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	25	2
2	1*	1	1	1	1	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
3	1	1	1	1*	1	1*	1	1*	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
4	1	1*	1*	1	1*	1	1	1*	1*	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
5	1*	1*	1	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1	1	1	1	1*	1	1*	1*	1*	1*	1*	1*	25	2
6	1*	1*	1*	1*	1*	1*	1	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
7	1	1*	1*	1*	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	25	2
9	1*	1*	1*	1*	1*	1	1*	1*	1*	1	1	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	25	2
10	1*	1*	1*	1*	1*	1	1*	1	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
11	1*	1	1*	1*	1*	1	1*	1*	1	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	25	2
12	1*	1*	1*	1*	1*	1	1*	1*	1	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
13	1*	1*	1	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1	1	1	1	1	1*	1*	1*	1*	1	1*	1*	25	2
14	1*	1*	1*	1*	1*	1*	1	1	1	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	25	2
15	1*	1*	1*	1*	1*	1*	1	1*	1	1*	1	1*	1*	1	1	1	1	1	1	1*	1*	1*	1*	1*	1*	25	2
16	1*	1*	1*	1*	1*	1*	1	1	1*	1*	1	1*	1*	1	1	1*	1	1*	1*	1	1*	1*	1*	1*	1*	25	2
17	1*	1	1*	1*	1*	1*	1	1*	1	1*	1	1*	1*	1	1	1*	1	1	1	1*	1*	1*	1	1	1	25	2
18	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1	1	1*	1*	1*	1	1*	1*	1*	1*	1*	1*	25	2
19	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	1*	1	1	1*	1	1*	1	1	1	1*	25	2
21	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1*	25	2
22	1*	1*	1*	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1*	1	1*	1*	1	1*	1*	1*	25	2
23	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1	1*	1*	1*	1*	1*	1*	1	1*	1*	25	2
24	1*	1	1*	1*	1*	1*	1*	1*	1*	1*	1	1*	1*	1	1*	1	1*	1*	1	1*	1	1	1	1	1*	25	2
25	1	1*	1*	1*	1*	1*	1	1	1	1*	1	1*	1	1	1	1*	1	1*	1	1*	1*	1*	1*	1	1	25	2
Dependence Power	24	24	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23		
Level	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		

Table 4.8: Conical matrix (CM)

4.1: autonomous, independent, dependent, and linked. ”Sector I depicts a low driving power and low reliance type of barrier Because this area did not receive any barrier categories, they are all connected”. Different barrier types make up Sector II, which has low driving power but high dependence power. Our study indicates inconsistent quality (8) and lack of motivational law(20) in this Sector. Sector III will comprise barriers with high driving power and strong reliance power. Almost all barriers fall into this sector, barring inconsistent quality (8) and lack of motivational law (20). Sector-IV depicts barriers with high driving and low dependence power; this sector has no barrier”.

4.10 Driving Power and dependence matrix

In ISM, the Driving Power and Dependence Matrix is a fundamental tool used to analyse the interrelationships among various elements within a system. The process begins with identifying the elements or variables to be analysed. Once the elements are identified, the next step involves defining the contextual relationships between each pair of elements, typically through pairwise comparisons, to determine if one element influences or drives another. This information is captured in the Structural Self-Interaction Matrix (SSIM), which uses symbols to indicate the direction and type of influence between elements. The SSIM is then converted into a binary matrix known as the reachability matrix. This conversion is done by replacing the symbols in the SSIM with binary values (0s and 1s) to denote the presence or absence of a direct relationship. ”To ensure completeness, transitivity is applied to the reachability matrix, which means that if element A influences element B and element B influences element C, then element A should also be considered to influence element C. After establishing the reachability matrix, the next step is to partition it into different levels based on reachability and antecedent sets, which helps in identifying the hierarchical structure of the elements”.

The final stage involves calculating the driving power and dependence for each element. Driving power is the total number of elements (including itself) that a component can influence directly or indirectly. At the same time, dependence refers to the total number of elements affecting a particular component. For instance, an element with high driving power can influence many other elements, making it a critical factor in the system. Conversely, many elements heavily influence an element with high dependence and typically represent an

outcome or dependent variable. The Driving Power and Dependence Matrix is crucial in ISM as it helps understand system elements' hierarchical structure 4.1. It aids in identifying key drivers that need attention for strategic planning and decision-making, ensuring that all critical factors are considered in system analysis and design. This method provides a clear and structured approach to managing and optimising the system's performance by breaking down and visualising complex relationships.

"Sector I – Autonomous category, Sector II – Dominated/Dependent category Sector III - Relay/Linkage category, Sector IV- Dominant /independent category"

4.11 Micmac analysis

MICMAC analysis is a powerful method to identify and evaluate the interdependencies among various factors influencing a particular industry. This technique helps to determine which factors are the primary drivers of change within the industry and how these factors impact other elements. Additionally, it identifies which factors are more dependent on other factors. By leveraging expert responses and input, MICMAC analysis provides a comprehensive understanding of the complex interplay between different variables, facilitating better strategic planning and decision-making. The process begins with identifying all relevant factors affecting the industry. These factors range from economic and technological elements to social and environmental considerations. Experts then assess the relationships between these factors through pairwise comparisons, determining whether and how each factor influences the others. The result of this assessment is a matrix where each cell represents the influence of one factor over another. Next, the matrix is analysed to calculate two main measures for each factor: driving power and dependence. Driving power indicates how much a factor can influence other factors within the system, while dependence measures how much others influence a factor. Factors with high driving power and low dependence are classified as independent drivers, meaning they are key influencers in the system and often need to be managed carefully to steer industry outcomes. Conversely, factors with low driving power and high dependence are more likely to be outcomes or dependent variables shaped by other elements within the industry.

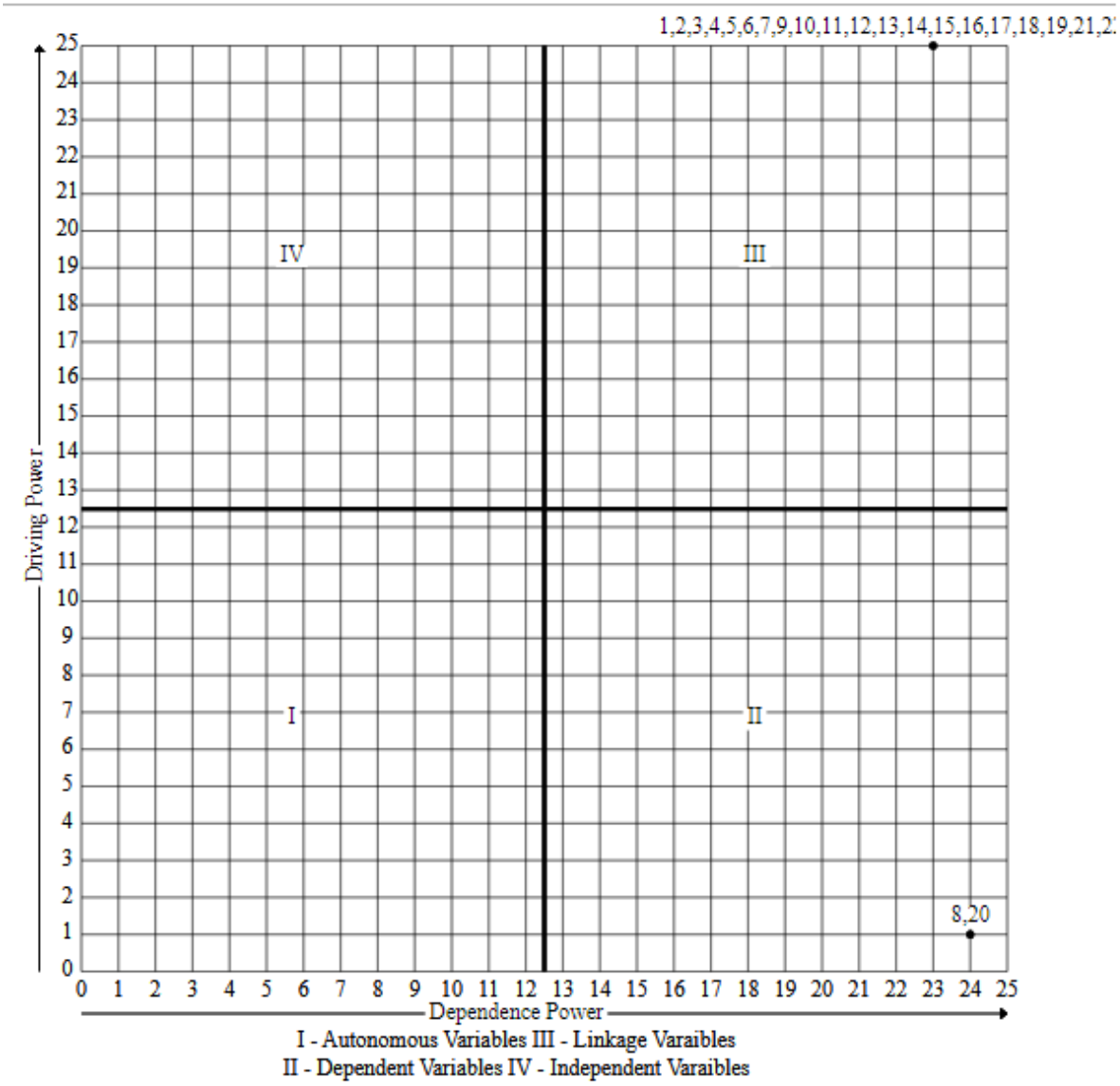

Figure 4.1: Driving power and dependence diagram

Factors exhibiting high driving power and dependence are considered linkage variables. These factors are both influenced by and exert influence on other factors, making them critical nodes in the industry's network. Understanding these linkage variables is crucial because they can create feedback loops that amplify changes within the system. Finally, factors with low driving power and dependence are relatively autonomous and have minimal impact on or from other factors, often representing the industry's isolated or less critical aspects.

Further, Interpretive Structural modelling for barrier classification affecting GSCM are shown in 4.4.

According to the experts' responses, the following are the findings:

1. **Barrier Types and Sector Analysis**: It's crucial to note that all identified barrier types are situated in the third sector of the MICMAC analysis matrix. This placement signifies their high dependence and driving power, indicating the complexity of the challenges IND's leather industry faces. Furthermore, other factors heavily influence these barriers, significantly impacting the overall system, creating intricate interdependencies.

2. **Inconsistent Quality and Motivating Laws**: The analysis highlights inconsistent quality and the lack of motivating laws as critical factors. These elements directly affect the industry's performance and have a cascading impact on other variables, influencing operational efficiency, market competitiveness, and sustainability.

3. **Sector Two Analysis and Interconnectedness**: Inconsistent quality and lack of motivating laws are positioned in the second sector of the MICMAC matrix, characterized by high dependence and low driving power. Despite their low driving power, these factors are interconnected with all other industry variables. The study struggled to establish clear associations between these factors and others, indicating a need for effective management to adopt GSCM practices in IND's leather industry.

The Final model of ISM for the study, depicted in 4.3, serves as a detailed representation of the findings from the MICMAC analysis, showcasing the intricate relationships and interdependencies among various factors affecting IND's

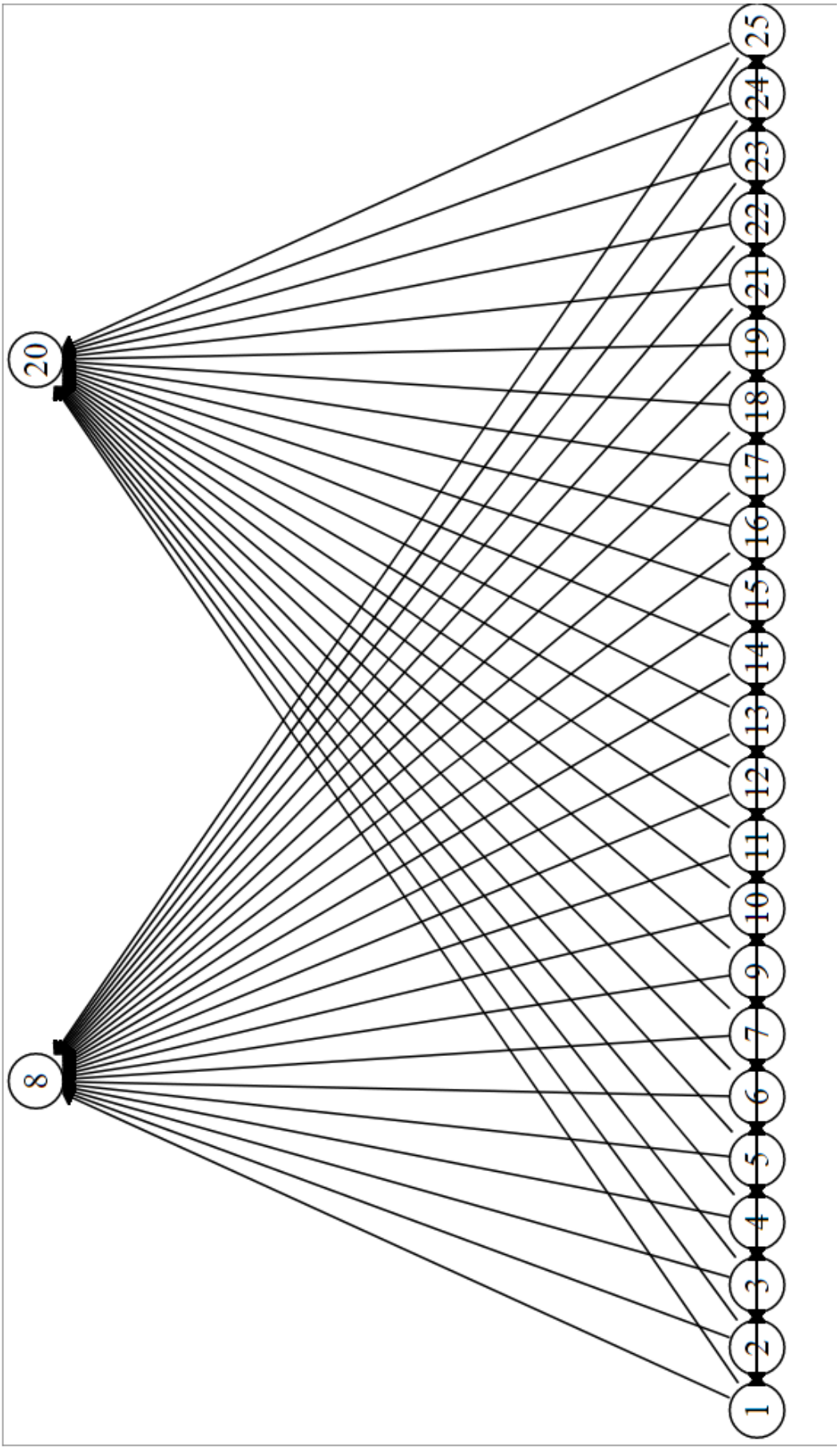

Figure 4.2: Interpretive Structural modelling for barrier classification affecting GSCM

leather industry. This model highlights how different barriers and driving factors interact, providing a clear visual map of the complex dynamics within the industry.

By illustrating these relationships, the model offers stakeholders a comprehensive understanding of which factors are most influential and how they are interconnected. For instance, it shows how primary driving factors, such as regulatory changes and technological advancements, impact other variables like market demand, production efficiency, and environmental sustainability. Conversely, it also depicts how these driving forces influence dependent factors, such as consumer behaviour and quality standards.

4.12 Findings and managerial implications

GSCM integrates environmental concerns into SC processes, which is crucial in the IND leather industry, where both int and ext barriers impact GSCM adoption. Understanding these barriers aids stakeholders in enhancing GSCM adoption, benefiting company compliance and SC sustainability. Of the 13 int and 12 ext barriers studied, only two showed strong interrelationships with other variables: inconsistent quality and a lack of motivational laws. These factors significantly influence GSCM implementation, indicating a need for industry-wide attention. The absence of independent barriers suggests the pervasive impact of the identified obstacles. Inconsistent quality and a lack of motivation laws, as dependent barriers, highlight the industry's weak focus on regulatory compliance and product quality, necessitating reorganisation and stricter enforcement. With 23 obstacles in the linkage enabler category, monitoring environmental norms and GSCM implementation pose significant challenges for IND leather manufacturers. Sector IV, representing barriers supporting GSCM implementation, lacks variables, indicating the absence of solid driving forces with low dependence on other factors. Prioritising these factors is essential for successful GSCM implementation, requiring focused attention from decision-makers and practitioners.

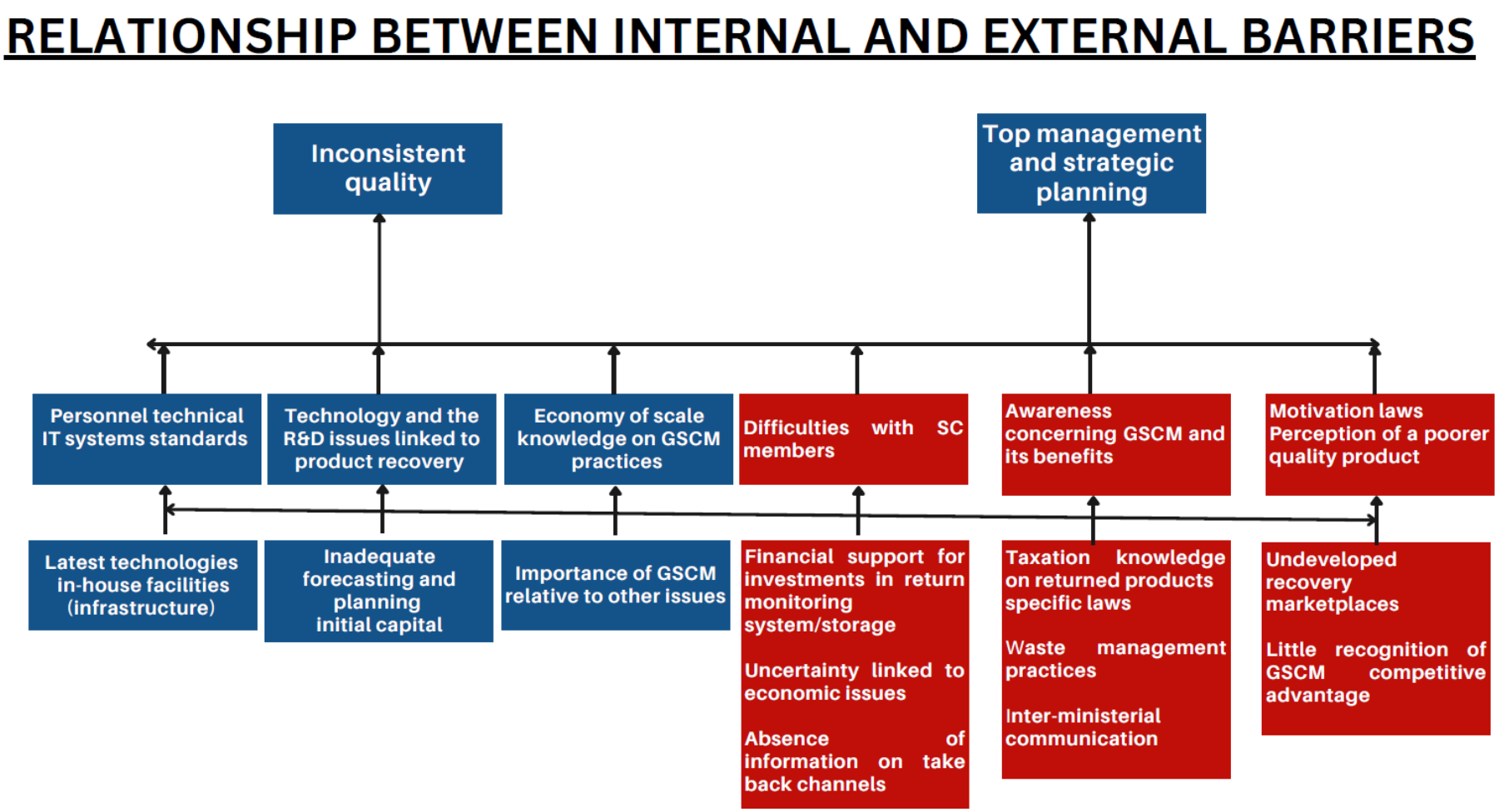

Figure 4.3: Final model of ISM for the study

4.13 Subhead overview

This subhead thoroughly examines the IND leather industry, tracing its historical evolution and current standing while highlighting its profound economic significance. Despite its enduring legacy and substantial contributions to the economy, the industry faces formidable challenges in adopting GSCM, a practice pivotal for achieving holistic sustainability encompassing social, economic, and environmental dimensions. Barriers to effective GSCM implementation within the industry are multifaceted and intricately intertwined, ranging from inconsistent quality issues to the absence of robust regulatory frameworks. When viewed in isolation, these barriers fail to capture the complexity of the industry's challenges. Hence, employing ISM is indispensable to comprehensively understanding the interplay and impact of these barriers. Through ISM analysis, we gain valuable insights into how these barriers intersect and influence each other, illuminating pathways for addressing them strategically and systematically. The historical context and economic importance of the IND leather industry further magnify the weight of these challenges. Consequently, the imperative to embrace GSCM practices becomes increasingly urgent for environmental stewardship and ensuring the industry's long-term viability and competitiveness on the global stage. While the study's findings offer valuable insights into the nature of barriers and their interconnections, it is essential to acknowledge the limitation of not quantifying the impact of each barrier individually. Future research endeavours could explore avenues such as structural equation modelling (SEM) to quantitatively assess the relative significance of each barrier and its implications for GSCM implementation in the IND leather industry. Such quantitative analyses would provide a more nuanced understanding of the challenges and inform targeted interventions for driving sustainable transformation within the industry. Now, we dwell upon our second subhead, i.e., understanding human behaviour in GSCM.

Use Of TISM And MICMAC Methods To Assess The Influence Of Behavioral Factors On The Employment Of GSCM In The IND Leather Industry

Expanding on the groundwork established in the previous subhead, which meticulously examined various barriers to effective GSCM implementation and established their interrelationships through ISM analysis, we now focus on a novel aspect. Acknowledging that human behaviour significantly influences all aspects

of GSCM, from conception to execution, we now aim to identify, locate, and dissect the diverse behavioural factors that shape the application of sustainable practices within the IND leather sector. Understanding the intricate dynamics of human behaviour is paramount to comprehensively comprehending how GSCM practices manifest in real-world contexts. Therefore, this chapter embarks on a journey to unravel the complexities of human behaviour within the realm of GSCM implementation in the IND leather industry. Through rigorous exploration and analysis, we aim to uncover the underlying motivations, attitudes, and perceptions that shape decision-making processes and behaviours related to GSCM. By identifying critical behavioural factors and assessing their impact on the industry's sustainability efforts, we strive to provide valuable insights that can guide strategic interventions and facilitate the adoption of more sustainable practices, thereby offering tangible benefits to the industry and society at large. Ultimately, this chapter will serve as a pivotal exploration into the human dimension of GSCM implementation. It will provide a deeper understanding of the behavioural factors and their implications for the IND leather sector's sustainability journey. Through this examination, we aim to pave the way for more informed decision-making and effective interventions that promote sustainable development within the industry, thereby offering tangible benefits to the industry and society.

Leather manufacturing is a potentially polluting industry, as it can generate toxic by-products, such as chromium, sulfates, and formaldehyde. The leather industry is also associated with air, water, and soil contamination from dyes and other chemicals. To reduce pollution from leather manufacturing, companies can improve their waste-water treatment systems, use more environmentally friendly chemicals and stains, and reduce their use of hazardous substances and materials. Additionally, businesses should take steps to reduce air pollution from tanning processes, such as using more efficient ovens, reducing the amount of dust generated, and using better ventilation systems. The IND leather sector has faced challenges regarding its public image, partly due to concerns about its social and environmental performance. In particular, the industry has been criticised for impacting animal welfare, water and air pollution, and hazardous chemicals in the tanning process. These issues have led to a negative perception of the industry among some consumers, who may prioritise social and environmental considerations over factors such as pricing, quality, and safety when evaluating products from the IND leather sector.

To address this, the IND leather sector has been improving its environmental and social performance by implementing sustainable practices and adopting international standards such as ISO 14001 and Leather Working Group. This approach has helped the sector improve its reputation and align its practices with the expectations of consumers, regulators and other stakeholders. Additionally, the IND leather industry is taking various steps to improve the sector's public image, such as promoting sustainable practices, improving SC transparency and implementing eco-friendly materials in production.

To successfully implement GSCM in the IND leather industry, various factors must be understood to get a more precise and broader idea of GSCM implementation. Since all of these factors are significantly influenced by human behaviour, identifying, locating, and looking into the numerous behavioural factors is the most crucial exercise to completely comprehend the application of GSCM in the IND leather sector. Consequently, the main goal is to investigate the following:

1. To identify and discover the various behavioural factors that can impact the successful implementation of GSCM in IND leather industries.
2. To establish the interdependency among these behavioural factors and evaluate their hierarchy.
3. Brainstorm the utility of this framework for top management and government decision-makers to improve the IND leather framework.

4.14 Method details

ISM is a widely used technique in SCM research to analyse the relationships between different factors and identify the key drivers and barriers of a specific process or phenomenon. In the IND leather industry context, ISM was used to determine the critical behavioural factors influencing the implementation of GSCM practices. Furthermore, it is structurally sound because it may provide a framework for a situation with many variables and interactions. The aims of employing ISM are to investigate a complex subject using rigorous and logical reasoning supported by expert viewpoints, to discover subtle relationships between variables, and to present them in an organised format. ISM may be utilised alone despite being created as a group learning approach. In the ISM

technique, transitivity and reachability are two fundamental ideas. If an element ”k” is connected to an element ”j,” and ”j” is related to part I, then element ”k” is connected to part I based on the transitivity concept. Transitivity contributes to conceptual coherence. The ISM methodology's foundational idea is reachability. On the other hand, the connection between the identified elements is compared pair-wise. A binary matrix is used to represent this information. If the ith factor will assist in achieving the jth element, then the cell j) of the reachability matrix is assigned a value of ”1,” and the cell is assigned a matter of ”0.” (i, j). Additionally, the reachability matrix's transitivity attribute permits some cells to be filled using inference. The entries I j) = 1 and (j, k) = 1 in a matrix imply that I k) = 1. A precise comparison seems unnecessary Balon et al. (2016).

ISM is a controlling approach that has remained effective in various industries, including energy saving in the IND cement industry, vendor selection, productivity enhancement, third-party logistics, and reverse logistics. The following are the stages for building an ISM-based model.

4.15 Structural self-interaction matrix (SSIM)

Creating an initial structural self-interaction matrix (SSIM) illustrating the interrelationships between the variables is the first stage in the ISM approach. Based on several management strategies like brainstorming and nominal group methodology, expert consultation is used to build the contextual relationships between the identified components. The opinions of industry and academic experts are employed to determine the nature of contextual interactions among several behavioural elements influencing GSCM practices in the IND leather sector. The interdependencies among the behavioural factors are diagnosed using a contextual relationship of the 'leads to' kind. Work culture, for instance, encourages employee participation. When constructing contextual relationships among extra variables, the contextual relationship for each variable, the existence of any relationship between any two variables I and j), and the direction of that link are all taken into account.

As stated in 4.9, the SSIM is created for the 12 primary variables acting as behavioural determinants in the GSCM procedures in the IND leather sector based on the relevant linkages.

4.16 Reachability matrix

By replacing V, A, X, and O with 1 and 0 following the replacement criteria Barve et al. (2009) , the SSIM is converted into a binary matrix known as the initial reachability matrix.

4.17 Level partitions

Each variable's reachability and antecedent set were found in the final reachability matrix, divided into levels. A variable's reachability set comprises the variable itself plus any further factors that may help it be achieved. In contrast, its antecedent set contains additional variables that may assist in completing the variable. We first identified the antecedent and reachability set for each variable and then remembered the intersection for each variable. The top level (Level I), or the top place in the hierarchy, is occupied by variables whose intersection set and reachability set match. The top-level variable is removed from the list of variables once it has been partitioned, and this procedure is repeated until all of the variables' levels have been determined. Green innovation, the tenth variable, is found to be the top-level variable in 4.10 and hence holds the top spot in the ISM hierarchy. The digraph and final ISM model were constructed using the specified levels of the variables 4.9.

4.18 ISM-based model formation

The structural model of the behavioural aspects are built using the level divisions, and the final digraph is built using reduced transitivity by the ISM approach. Finally, as illustrated in the digraph is changed into the ISM—support from top management (variable 1), which results in strategic planning (variable 12). Green training (variable 4) is the consequence of strategic planning, and work culture follows (variable 7).

Workplace culture promotes employee empowerment, performance evaluation and incentives, corporate communication, and the lessening of change resistance, all leading to mutual respect and trust. Green motivation arises from respect and mutual trust. Green innovation is the result of a collaborative effort

Variables	1	2	3	4	5	6	7	8	9	10	11	12
Top management support		V	V	V	V	V	V	V	V	V	V	V
Performance appraisal and reward			O	A	O	V	A	V	O	V	V	A
Communication				A	O	V	A	V	O	V	V	A
Green training					V	V	V	V	V	V	V	A
Employee empowerment						V	A	V	O	V	V	A
Teamwork							A	A	A	V	A	A
Work culture								V	V	V	V	A
Mutual trust and respect									A	V	V	A
Minimizing resistance to change										V	V	A
Green innovation											A	A
Green motivation												A
Strategic planning												

Table 4.9: Structural Self-Interaction Matrix (SSIM)

that is sparked by green inspiration.

4.19 Establish a contextual relationship between variables (Step 3) and develop Structural Self-Interaction Matrix (SSIM) (Step 4)

The structural self-interaction matrix (SSIM) is populated after collecting the responses from all stakeholders during various interviews, which is reflected below in 4.9.

4.20 Reachability matrix (RM) (Step 5)

The standard rules of ISM methodology are used to construct the reachability matrix from the SSIM created in the preceding step:

4.21 Final Reachability Matrix (FRM) (Step 6)

The final reachability matrix is reflected in 4.11 and is generated from the Initial reachability matrix taking into consideration the transitivity rule, i.e., if a variable '1' is related to '2' and '2' is related to '3', then '1' is necessarily associated with '3'.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	**Driving Power**
Top management support	1	1	1	1	1	1	1	1	1	1	1	1	12
Performance appraisal and reward	0	1	0	0	0	1	0	1	0	1	1	0	5
Communication	0	0	1	0	0	1	0	1	0	1	1	0	5
Green training	0	1	1	1	1	1	1	1	1	1	1	0	10
Employee empowerment	0	0	0	0	1	1	0	1	0	1	1	0	5
Teamwork	0	0	0	0	0	1	0	0	0	1	0	0	2
Work culture	0	1	1	0	1	1	1	1	1	1	1	0	9
Mutual trust and respect	0	0	0	0	0	1	0	1	0	1	1	0	4
Minimizing resistance to change	0	0	0	0	0	1	0	1	1	1	1	0	5
Green innovation	0	0	0	0	0	0	0	0	0	1	0	0	1
Green motivation	0	0	0	0	0	1	0	0	0	1	1	0	3
Strategic planning	0	1	1	1	1	1	1	1	1	1	1	1	11
Dependence Power	1	5	5	3	5	11	4	9	5	12	10	2	

Table 4.10: Reachability matrix (RM)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	**Driving Power**
Top management support	1	1	1	1	1	1	1	1	1	1	1	1	12
Performance appraisal and reward	0	1	0	0	0	1	0	1	0	1	1	0	5
Communication	0	0	1	0	0	1	0	1	0	1	1	0	5
Green training	0	1	1	1	1	1	1	1	1	1	1	0	10
Employee empowerment	0	0	0	0	1	1	0	1	0	1	1	0	5
Teamwork	0	0	0	0	0	1	0	0	0	1	0	0	2
Work culture	0	1	1	0	1	1	1	1	1	1	1	0	9
Mutual trust and respect	0	0	0	0	0	1	0	1	0	1	1	0	4
Minimizing resistance to change	0	0	0	0	0	1	0	1	1	1	1	0	5
Green innovation	0	0	0	0	0	0	0	0	0	1	0	0	1
Green motivation	0	0	0	0	0	1	0	0	0	1	1	0	3
Strategic planning	0	1	1	1	1	1	1	1	1	1	1	1	11
Dependence Power	1	5	5	3	5	11	4	9	5	12	10	2	

Table 4.11: Final Reachability Matrix (FRM)

Elements (Mi)	**Reachability Set R(Mi)**	**Antecedent Set A(Ni)**	**Intersection Set R(Mi) ∩ A(Ni)**	**Level**
1	1,	1,	1,	9
2	2,	1, 2, 4, 7, 12,	2,	5
3	3,	1, 3, 4, 7, 12,	3,	5
4	4,	1, 4, 12,	4,	7
5	5,	1, 4, 5, 7, 12,	5,	5
6	6,	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12,	6,	2
7	7,	1, 4, 7, 12,	7,	6
8	8,	1, 2, 3, 4, 5, 7, 8, 9, 12,	8,	4
9	9,	1, 4, 7, 9, 12,	9,	5
10	10,	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,	10,	1
11	11,	1, 2, 3, 4, 5, 7, 8, 9, 11, 12,	11,	3
12	12,	1, 12,	12,	8

Table 4.12: Level Partitioning (LP)

4.22 Level Partitioning (LP)

Level partition for categories. The reachability above the matrix was divided into layers. The values in 4.12 served as the foundation for each type's reachability and antecedent sets. Each category's reachability goal includes that category and any other categories it might impact. Its antecedent sets the list of classes that may affect a particular type. For each class, the intersection of these sets was also determined.

4.23 Level Partitioning Iterations

In this stage, ISM mandates that "the standard level from the previous step is combined with the antecedent set A and intersection set R to get the top level". The conical matrix is created in the following stage by formulating level partitioning interactions to determine the maximum tier among numerous groups.

Elements (Mi)	**Reachability Set R(Mi)**	**Antecedent Set A(Ni)**	**Intersection Set R(Mi) ∩ A(Ni)**	**Level**
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,	1,	1,	
2	2, 6, 8, 10, 11,	1, 2, 4, 7, 12,	2,	
3	3, 6, 8, 10, 11,	1, 3, 4, 7, 12,	3,	
4	2, 3, 4, 5, 6, 7, 8, 9, 10, 11,	1, 4, 12,	4,	
5	5, 6, 8, 10, 11,	1, 4, 5, 7, 12,	5,	
6	6, 10,	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12,	6,	
7	2, 3, 5, 6, 7, 8, 9, 10, 11,	1, 4, 7, 12,	7,	
8	6, 8, 10, 11,	1, 2, 3, 4, 5, 7, 8, 9, 12,	8,	
9	6, 8, 9, 10, 11,	1, 4, 7, 9, 12,	9,	
10	10,	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,	10,	1
11	6, 10, 11,	1, 2, 3, 4, 5, 7, 8, 9, 11, 12,	11,	
12	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,	1, 12,	12,	

Table 4.13: Level Partitioning Iterations

Variables	10	6	11	8	2	3	5	9	7	4	12	1	Driving Power	Level
10	1	0	0	0	0	0	0	0	0	0	0	0	1	1
6	1	1	0	0	0	0	0	0	0	0	0	0	2	2
11	1	1	1	0	0	0	0	0	0	0	0	0	3	3
8	1	1	1	1	0	0	0	0	0	0	0	0	4	4
2	1	1	1	1	1	0	0	0	0	0	0	0	5	5
3	1	1	1	1	0	1	0	0	0	0	0	0	5	5
5	1	1	1	1	0	0	1	0	0	0	0	0	5	5
9	1	1	1	1	0	0	0	1	0	0	0	0	5	5
7	1	1	1	1	1	1	1	1	1	0	0	0	9	6
4	1	1	1	1	1	1	1	1	1	1	0	0	10	7
12	1	1	1	1	1	1	1	1	1	1	1	0	11	8
1	1	1	1	1	1	1	1	1	1	1	1	1	12	9
Dependence Power	12	11	10	9	5	5	5	5	4	3	2	1		
Level	1	2	3	4	5	5	5	5	6	7	8	9		

Table 4.14: Conical matrix

4.24 Conical matrix (CM) form (Step 7) and formation of ISM model (Steps 8, 9, 10, and 11)

ISM rule also states, ”The partitioned reachability matrix is reorganised by its members according to their level to create the conical matrix, which implies that all elements with the same level are combined”. The digraph is the name given to the generated graph. The digraph is finally transformed into the ISM model when the transitivities are eliminated, as stated in the ISM approach.

4.25 Driving Power and matrix

The categories were divided into four sectors or clusters: autonomous, dependent, linkage, and independent 4.4. The market is dominated by autonomous barrier kinds with minimal driving force and dependency. Because none of the barrier categories were allocated to this location, all classes are connected to the system relatively weakly. ”Sector II comprises dependent barrier types with a low driving power but a high dependence power”. This sector was not classified under any of the barrier categories. Linkage elements belonging to Sector III are categories with solid driving and dependent capabilities.

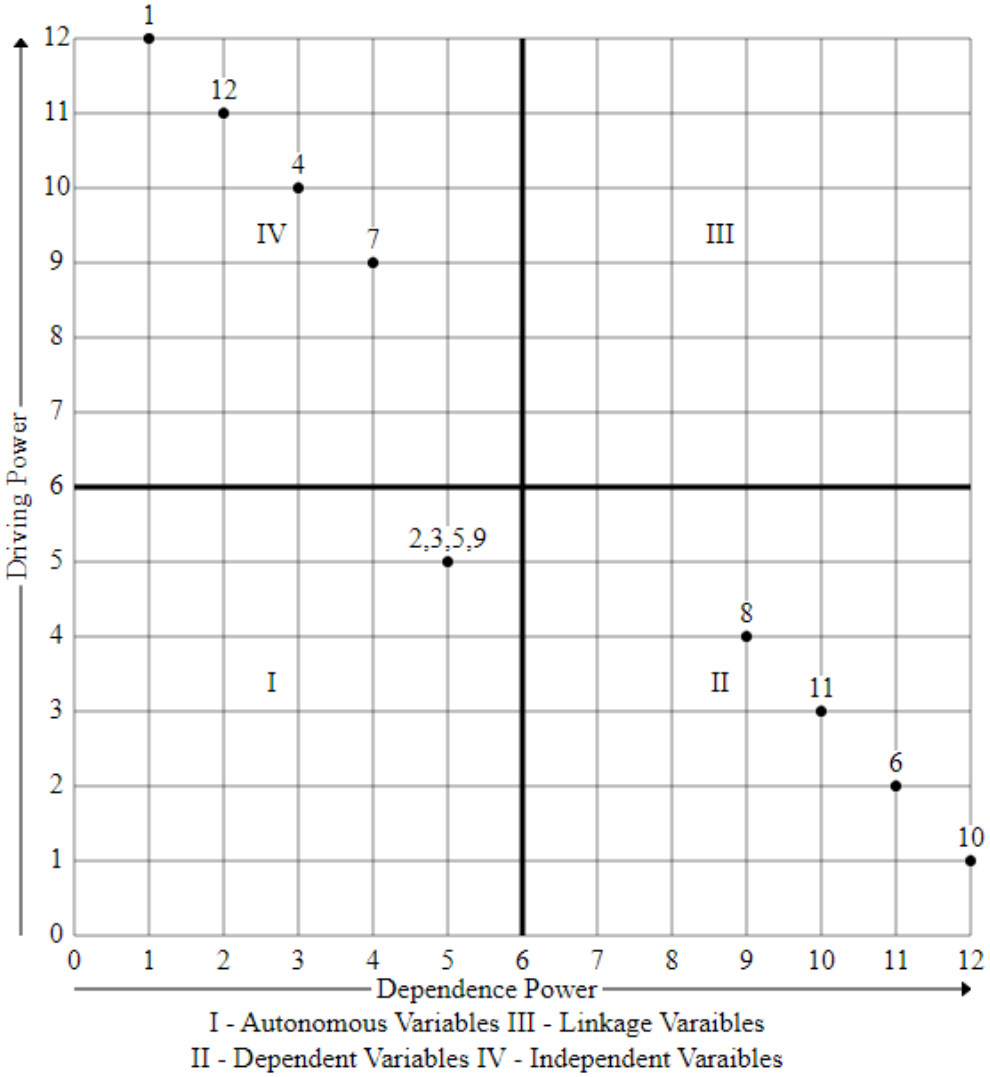

Figure 4.4: Driving power and dependence diagram

4.26 MICMAC analysis

The behavioural components' driving power (DP) and dependence power are analysed using MICMAC analysis, categorising them into four distinct groups. This categorisation helps understand each component's role and influence within the system. The first cluster, Autonomous Variables, plays a significant role in the system. These variables exhibit low driving and dependence power, indicating their minimal influence on other variables and their resistance to considerable influence from others. This isolation results in weak links connecting them to the system, thereby identifying them as less influential variables. Second Cluster: Strongly Dependent Variables: This cluster consists of variables highly dependent on other factors but weak driving forces. These variables are significantly influenced by changes in different components, making them reactive rather than proactive within the system. Their high dependence suggests they are outcome factors influenced by the driving variables rather than driving change.

The third cluster, Linkage Variables, is pivotal due to their high driving and dependence power, making them unstable and critical. Changes to these variables can trigger significant system-wide shifts and positive feedback loops. The fourth cluster, Independent Variables, consists of factors with high driving power but low dependence. These primary drivers influence other components significantly while remaining relatively unaffected, making them crucial for initiating and guiding system-wide transformations. 4.5 depicts the ISM model for the barriers Classification affecting GSCM in IND for our work.

Analysing these behavioural components' driving and dependence powers helps stakeholders identify critical factors for strategic interventions and recognise reactive or isolated ones. This facilitates targeted decision-making to enhance system performance and stability. 4.5 shows the DP and dependency of each factor, with "1" indicating dependencies and DPs in columns and rows. The driver power-dependence diagram is shown in 4.5. Factors 2, 3, 5, and 9 depend on and are driven by factor 5, with 4.5 reflecting a driving power and dependence of 5. The final model is shown in 4.6.

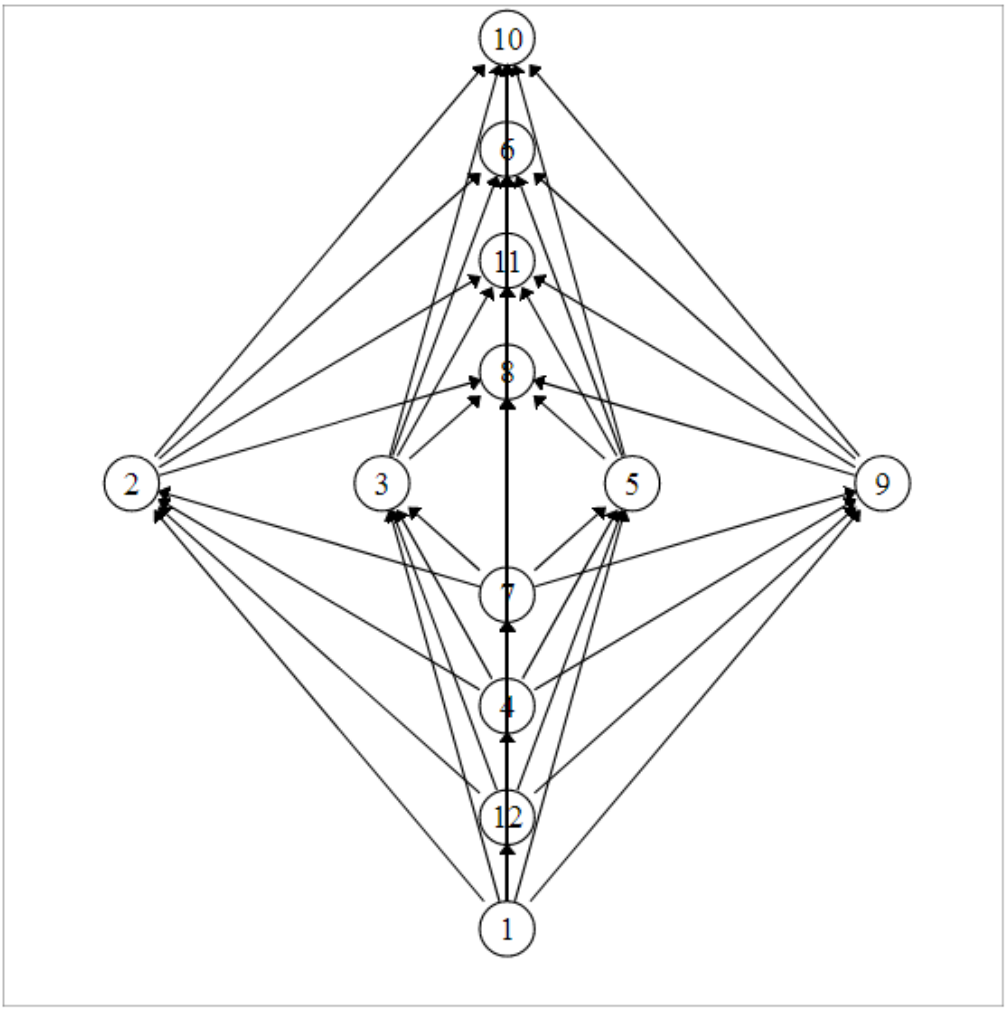

Figure 4.5: ISM model for the barriers Classification affecting GSCM in IND

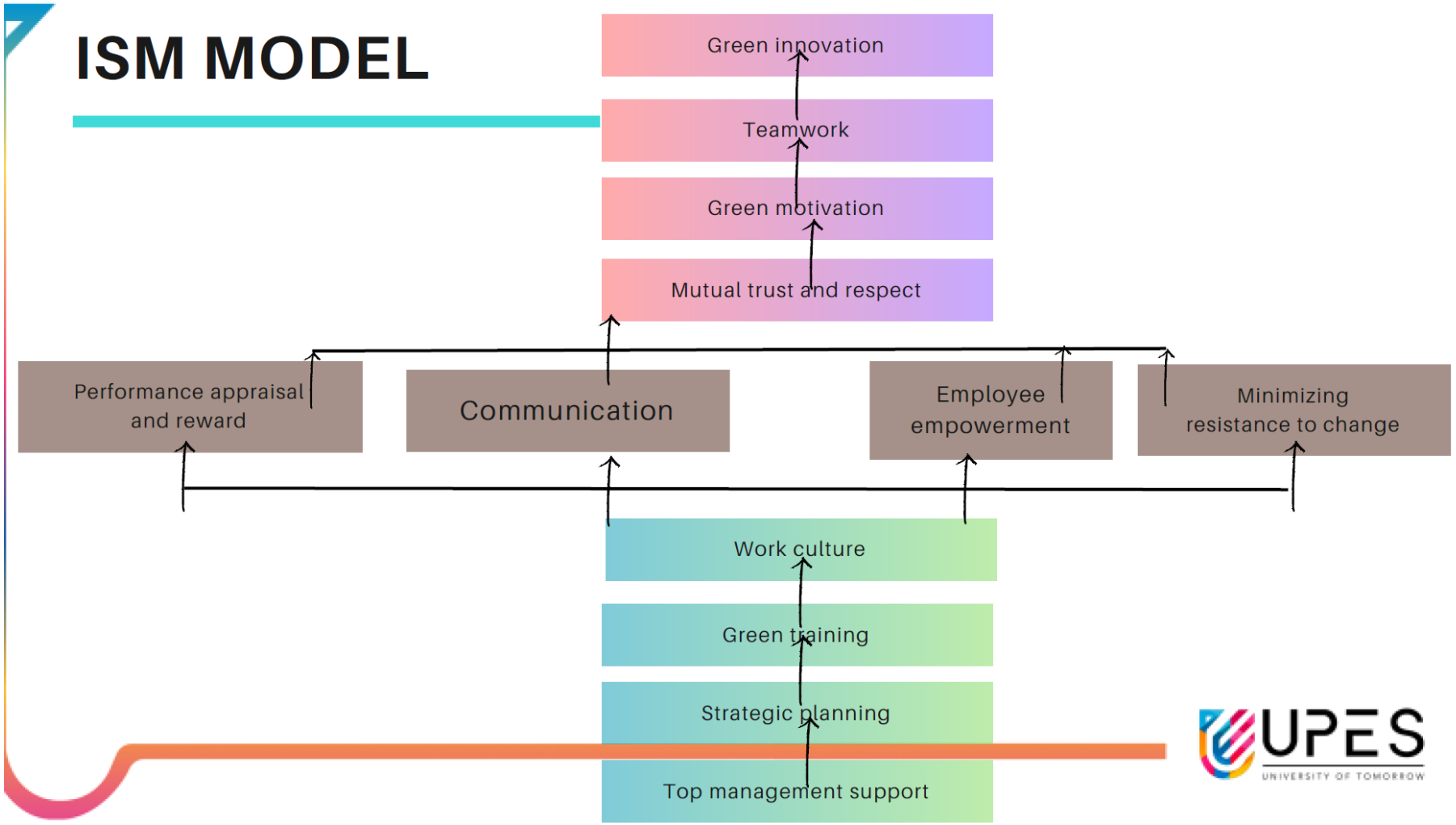

Figure 4.6: Final model

4.27 Subhead overview

This section provides a detailed analysis of the rise and importance of GSCM in the IND leather industry, which incorporates environmental considerations into SC management to enhance or protect the environment by conserving resources and energy. Using ISM, the study carefully examines the behavioural factors influencing the adoption of GSCM in this sector. Top management support, green innovation, teamwork, employee empowerment, and effective communication are crucial in shaping organisational culture and advancing GSCM practices. The study highlights that motivation, job satisfaction, and company loyalty are vital for boosting employee performance, demonstrating the significant role of human resources in transitioning from traditional to GSCMs. Notably, 'top management support' is the foremost driver for GSCM implementation, while 'green innovation' and 'teamwork' are recognised as critical priorities. The study also emphasises the interconnected nature of 'Employee empowerment' and 'communication', underscoring their importance in GSCM implementation.

The ISM model proves to be an effective tool for management, helping prioritise behavioural factors under time constraints. The study reveals that green innovation and teamwork are desirable outcomes of GSCM adoption, reflecting the transformative potential of sustainable practices. However, the 'top management support' is central to advancing GSCM initiatives, stressing the crucial role of leadership in sustainability. This analysis underscores the critical role of human factors in shaping GSCM implementation in the IND leather industry. Future research could further explore and quantify these impacts using advanced structural equation modelling (SEM) methods. SEM is a statistical technique that examines the relationships between multiple variables, making it a powerful tool for understanding the complex interplay of factors in GSCM implementation. The goal is to leverage the benefits of GSCM for a more sustainable and resilient future. The following section will detail how GSCM practices affect firm performance.

A mathematical correlation between GSCM practices and supply chain performance variables: A model of cubical regression

The previous section thoroughly examined the behavioural factors influencing GSCM adoption in the IND leather industry, highlighting the critical roles of top management support, green innovation, teamwork, and employee empowerment in shaping organisational culture and GSCM implementation. Building on this foundation, this study aims to comprehensively understand the various GSCM practices in the IND leather industry and their impact on company performance. The insights we gather from ISM analyses will provide a deeper understanding of these practices and shed light on their effectiveness in driving improvements, thereby enlightening the reader. This investigation covers various GSCM strategies and initiatives, including eco-friendly sourcing, production methods, waste reduction, and recycling programs. We delve into the relationship between these practices and key performance metrics by employing ISM analyses, which allow us to understand the complex interrelationships between different GSCM practices, as well as cubic regression. This statistical technique helps us quantify the impact of these practices on performance metrics. By evaluating GSCM practices through a performance-oriented lens, we seek to understand their impact on organisational metrics like product quality, operational efficiency, customer satisfaction, and profitability. Empirical research and cross-case analyses within the IND leather industry help us identify patterns, best practices, and areas for improvement. Our study goes beyond identification to explore the causal relationships and synergies between sustainable SC initiatives and performance outcomes. By quantitatively assessing the influence of GSCM practices on company performance, we aim to provide actionable insights for strategic decision-making and continuous improvement efforts, encouraging the adoption of sustainable practices. Ultimately, we aim to equip industry stakeholders and decision-makers with the knowledge and tools to navigate GSCM implementation complexities effectively. By highlighting the connection between sustainable practices and organizational performance, we aspire to empower the reader with actionable insights that can catalyze positive change and drive the IND leather industry towards a more sustainable and prosperous future, instilling a sense of hope and optimism for the future. In today's competitive environment, customers demand higher-quality products and services, perceiving businesses as part of interconnected networks rather than standalone entities. The SC functions as a network designed to deliver products and services efficiently, ensuring

timely delivery and compliance with specifications. However, managing such a complex system can be challenging. Lambert and Cooper (1998) define SCM as a collaborative network of interconnected businesses working together to manage and improve the flow of materials, goods, services, and information from the source to the end user, aiming to meet customer expectations while reducing costs for all involved. Under these conditions, manufacturers must integrate environmental considerations into their management practices. Previous research has investigated the connection between environmentally friendly practices and supply chain performance (SCP) using broad variables or aggregated measures. For instance, Zhu et al. (2004) analyzed the relationships between internal environmental management, external GSCM, investment recovery, and eco-design and their impact on economic and environmental performance, finding a positive association between GSCM practices and environmental performance but no statistically significant link with financial outcomes. This study constructs a framework to analyze the effect of green practices on SCP, informed by an extensive literature review. It then examines five case studies from the IND leather SC, chosen due to their significant environmental impact and the potential for improvement through green practices. These case studies explore various research propositions and serve as examples of applying GSCM principles to identify essential green practices and determine appropriate performance indicators. Applying environmental management principles throughout the SC is crucial for enhancing ecological sustainability and maintaining a competitive edge. GSCM incorporates environmental factors into all SCM aspects, including product design, material sourcing, manufacturing processes, product distribution, and end-of-life management. Key GSCM strategies include life cycle management, reverse logistics, and green procurement, aiming to address and mitigate adverse environmental impacts across the SC. This research defines 'green practices' as measures implemented across the SC to address and mitigate adverse environmental impacts. These practices include actions taken by the focal firm and upstream and downstream linkages, encompassing eco-design, reverse logistics, green procurement, and life cycle management. To provide a comprehensive understanding, the study reviews these key GSCM strategies and evaluates the implementation of recommended green practices across the three tiers of SC activities.

1. Implementing environmentally sustainable practices in the early stages of a Firm's operations is closely associated with the Firm's supplier relationships, including environmental considerations.

2. Implementing environmentally sustainable practices inside an organisation's routine int operations is contingent upon the Firm's voluntary adoption of eco-friendly behaviour.

3. Downstream firms embrace green practices by considering environmental considerations in all flows, including materials and information and their partners conducting the downstream delivery activity.

The implementation patterns given by Bowen (2002) are used to categorise the suggested green practices. This typology allows us to classify green practices using the following criteria:

1. Implementing SC practices that consider environmental considerations while managing the Firm's suppliers;

2. More advanced environmental practices include developing cooperative clean technology projects with suppliers and customers.

3. Product-based green practices, which involve changing things in consideration of environmental concerns and

4. Incorporating environmental issues into the organisation's customer-management operations or "greening" the delivery process.

According to Srivastava (2007), implementing GSCM Management (GSCM) can reduce the environmental impacts of industrial activities while improving economic profitability. This can be achieved without compromising quality, cost, reliability, performance, or energy efficiency. Effective GSCM requires a thorough analysis of how these activities affect SCP. Lambert (1998) notes that a lack of adequate SC measures can lead to risks in customer satisfaction, subpar corporate performance, and missed opportunities for improving SCP. Therefore, it is crucial to conduct performance reviews to enhance SCM and ensure the efficiency of the SC. Chan (2003) also presents a conceptual framework for assessing SCP, integrating qualitative and quantitative indicators to evaluate strategic planning, adaptability, information and material flow integration, and effective risk management.

SCP assessment methods are recommended for a variety of reasons:-

	Greening the supply process practices	**Advanced green practices**	**Product-based green practices**	**Greening the delivery process practices**
First-tier supplier <->focal company				
Environmental collaboration with suppliers(E1)				
Providing design specifications to suppliers that include environmental requirements for the purchased item			Zhu et al. (2008)	
Communicating to suppliers environmental and ethical criteria for goods and services	Wang et al. (2006), Zhu et al. (2008) and Ghobadian et al. (1998)			
Working with product designers and suppliers to reduce and eliminate product environmental impacts	Zhu et al. (2007b), Ghobadian et al. (1998) and Paulraj (2009)			
Working with industry peers to standardise requirements for suppliers and purchasing items			Wang et al. (2006)	
Encouraging suppliers to adopt more environmentally friendly behaviours				
Encouraging suppliers to take back packaging	Rao and Holt (2005) and Ghobadian et al. (1998)			
Greening procurement/ sourcing	Ghobadian et al. (1998) and Routroy (2009)			
Using green purchasing or logistics guidelines	Wang et al. (2006) and Ghobadian et al. (1998)			
Using recyclable pallets to deliver materials				Ghobadian et al. (1998)
Environmental monitoring of suppliers				
Promoting recognition of environmentally positive behaviour				
Promoting ISO 14000 certification of suppliers	Zhu et al. (2008)			
Focal company				
Developing environmentally friendly products				
Designing products to avoid or reduce the use of hazardous products and their manufacturing process			Zhu et al. (2008)	

Table 4.15: Green practices in the SC context

1. To support initiatives aimed at enhancing quality, has conducted previous studies citecagnazzo2010role.

2. To examine the impact of information systems on productivity, previous studies conducted by Yang et al. (2009) and Linton et al. (2007) are referenced.

3. This study examines the impact of inter-organizational interactions among members of the SC on performance, as discussed in the works of Flynn et al. (2010).

4. To assess the effectiveness of the closed-loop/reverse SC, the study conducted by Pochampally et al. (2009) was undertaken.

This study aims to provide a practical and comprehensive monitoring system that SC managers can readily implement. The system, designed for ease of use, evaluates the effects of environmentally sustainable practices on SCP, offering decision support for managers in their daily operations. The performance metrics were designed from an organisational perspective to assess each firm's impact on the business's overall success. The proposed Performance Green Score (PGS) is adaptable. It can be used by all entities within the SCM, including manfcr, supplr, distribtr, and other entities, to evaluate how their environmental initiatives affect overall SCP. The PGS framework allows for assessing the impact and effectiveness of incorporating environmentally sustainable practices into the SC, considering various influencing factors. To enhance the monitoring and supervision of SCP in terms of operational efficiency (Bayraktar et al., 2009), economic viability (Rao, 2005), and environmental sustainability (Pochampally et al., 2009), this study systematically reviewed and integrated existing literature on green initiatives within SC settings, forming the PGS framework. Evaluating the impact of environmentally sustainable practices on operational performance is crucial for understanding competitive dimensions such as quality and customer satisfaction. A comprehensive financial performance analysis examines key factors like expenditures, efficiency, earnings from normal operations (ENCs), and profitability. Systematisation entails evaluating environmental data to determine how green activities within the SC, such as waste reduction, energy efficiency, and sustainable sourcing, contribute to reducing a firm's environmental footprint. To study and understand GSCM in the IND leather industry, it is essential to appreciate the effect of SCM practices on SCM performance. Cross-case analysis is optimal for comprehensively understanding the intricate interplay between

practices and performance. 4.16 presents a detailed compilation of metrics and indicators used to evaluate the influence of environmentally sustainable practices on SCP.

4.28 Theoretical framework

This section proposes a theoretical framework to analyse the impact of green practices on SCP within an industrial setting. The initial phase aims to provide a detailed understanding of how green practices affect SCP. The proposed structure, depicted in 4.16, offers a comprehensive overview. This analysis covers the internal green methods employed by the organisation and the external entities, including suppliers and consumers, that transcend national boundaries. 4.16 illustrates green initiatives involving suppliers, such as environmentally friendly purchasing practices, supplier engagement for environmental sustainability, and collaboration with designers and suppliers to mitigate and eliminate product-related ecological impacts. Key environmentally friendly actions in evaluating the firm's green efforts include waste reduction, attainment of ISO 14001 certification, and reducing hazardous and toxic material consumption. Additionally, an analysis is conducted to assess customer commitment to environmental issues by examining actions such as "Engagement with consumers on environmental issues," "E3," "Collaborating with clients to improve product attributes," and "Reverse Logistics (RL)." The theoretical framework offers a range of metrics to evaluate the impact of these policies on SCP from operational, economic, and environmental perspectives. Recommended operational performance indicators include quality and customer service. From a financial perspective, the suggested metrics are "cost," "Earnings from Normal Operations (ENC)," and "Efficiency (EFF)." The term "BWS" pertains to the quantification of ecological impacts. 4.18 comprehensively compiles the various connections between green practices and performance measures investigated in this research. The framework was constructed using multiple case studies, supplementary empirical data, and anecdotal evidence.

Following are the GSCM practices which are majorly used in the industry with details:-

1. **Interaction with suppliers on environmental sustainability:** Engaging in ecological sustainability practices involves exchanging information

Quality(QA)	Customer rejection rate Finished product first pass yield In-plant defect fallow rate Increment product quality = (quality of outgoing reprocessed products - the quality of incoming used products)	Christiansen et al. (2003) Christiansen et al. (2003) Christiansen et al. (2003), and Hugo and Pistikopoulos (2005) and Ninlawan et al. (2010) Pochampally et al. (2009)
Customer satisfaction(CS)	After-sales service efficiency = number of customers served/the number of customers seeking service. On-time delivery Out-of-stock ratio	Pochampally et al. (2009) Christiansen et al. (2003) Kainuma and Tawara (2006)
Economic (EC) Cost	Warranty cost Manufacturing cost Cost per operating hour	Christiansen et al. (2003) Christiansen et al. (2003) Pochampally et al. (2009)
Environmental Cost(ENC)	Cost of scrap/rework Costs for purchasing environmentally friendly materials Disposal costs Recycling cost = transport + storage costs	Christiansen et al. (2003) and Shao et al. (2016) Chen and Paulraj (2004) Zhu and Sarkis (2004) Tsai and Hung (2009) Tashakkori and Teddlie (2003)
Environmental Revenues(ENR)	Revenues from "green" products Recycling revenues Cost avoidance from environmental action	Hervani et al. (2005) Hervani et al. (2005) Hervani et al. (2005)
Efficiency (EFF)	Overhead expense = selling, general and administrative expenses/total sales Operating expenses = (selling, general and administrative expenses + cost of goods sold)/total of sales	Jia et al. (2015) Jia et al. (2015)
Environmental Emissions(ENE)	Energy consumption Greenhouse gas emissions Air emissions	Hervani et al. (2005) (2005) and Zhu et al. (2007a) Hervani et al. (2005) Zhu and Sarkis (2004)
Business waste(BWS)	Solid and liquid wastes Total flow quantity of scrap Percentage of materials remanufactured Percentage of materials recycled or reused Returning customers ratio	Zhu and Sarkis (2004) Tsoulfas and Pappis (2006), AlKhidir and Zailani (2009) Nawrocka et al. (2009) Hervani et al. (2005) Beamon (1999)
Green image(GIM)	Number of fairs/symposiums related to environmentally conscious manufacturing in which the organisation participates	Pochampally et al. (2009)

Table 4.16: Measures and metrics to evaluate the influence of green practices on SCP

Green practices	**Ops measures**		**EC measures**			**Env measures**
	QA	CS	Cost	EFF	ENC	BWS
E1		INC	DEC		DEC	DEC
Environmentally friendly purchasing practices(E2)					INC	DEC
Working with desgnr and splr to reduce and eliminate prdct envir impact		INC			DEC	DEC
Minimization of waste			DEC	INC	DEC	DEC
Decreased consumption of hazard and toxic mtrls					DEC	DEC
ISO 14001 certification	INC				INC	DEC
RLgs					INC	DEC
E2	INC	INC	DEC		DEC	DEC
E3		INC			DEC	DEC
WCC		INC		INC		

Table 4.17: Linkages between green practices and SCP

and collaboration between SC organisations on established environmental knowledge or experience and developing joint environmental planning efforts Vachon and Klassen (2008). Implementing this environmentally conscious practice enhances SC integration, yielding advantages in supplier cooperation similar to other non-green activities within the SC. According to Vachon and Klassen (2008), it enables the coordination of operations and processes across many tiers of the SC to address varying customer expectations. As a result, it enhances customer happiness while reducing costs related to business waste streams, environmental impact, and SC operations.

2. **Environmentally friendly purchasing practice:** Despite the higher cost of green goods, their use may benefit an organisation's image and resource conservation efforts. This is achieved by reducing liability and disposal charges Min and Galle (2001). The use of green buying tech-

Green practices	**Ops measures**		**EC measures**			**Env measures**
	QA	CS	Cost	EFF	ENC	BWS
E1		INC	DEC		DEC	DEC
Environmentally friendly purchasing practices(E2)					INC	DEC
Working with designers and suppliers to reduce and eliminate product environmental impact		INC			DEC	DEC
Minimization of waste			DEC	INC	DEC	DEC
Decreased consumption of hazardous and toxic materials					DEC	DEC
ISO 14001 certification	INC				INC	DEC
RLgs					INC	DEC
E2	INC	INC	DEC		DEC	DEC
E3		INC			DEC	DEC
WCC		INC		INC		

Table 4.18: Theoretical framework for the influence of green practices on SCP

niques mitigates unnecessary purchases, hence leading to a reduction in environmental expenditures Tsoulfas and Pappis (2006). Nevertheless, a limited number of organisations engage in green buying, even among the subset of enterprises that have obtained ISO 14000 certification Chen and Paulraj (2004). Min and Galle (2001) argue that a thorough understanding of suppliers' advances in environmentally friendly goods and packaging impact on existing supplier selection processes is crucial.

3. **Reducing waste:** The objective of waste management is to effectively control and reduce waste generation after its production, as AlKhidir and Zailani (2009) suggested. Lean methodologies use an eco-friendly approach to minimise waste and eliminate non-value-adding processes throughout the SC. Consequently, this leads to the reduction of waste inside the organisation, fosters improvements in the efficiency of the SC process, contributes to price reductions, and results in a drop in environmental and natural resource costs.

4. **Collaborating with designers and suppliers to minimise and eventually eliminate the environmental effect of a product:** According to Tsoulfas and Pappis (2006), designers need to assess the energy and material requirements across the whole lifecycle of a product, including its manufacture, consumption, and future usage. Collaboration with crucial suppliers in product creation reduces the duration required to reach the market. The reduction of both business waste and environmental expenditures is accompanied by improved consumer satisfaction. For this approach to be successful, engaging in substantial ext cooperation with other partners in the SC Zhu et al. (2008) is necessary.

5. **Decreasing the consumption of hazardous and toxic materials:** Due to reduced waste, harmful or dangerous chemical removal and treatment expenses are also lowered Tsoulfas and Pappis (2006). A single Firm may employ this strategy, but it will only have the intended environmental impact if environmentally conscientious suppliers are also engaged. This plan can only be executed if all SC partners share the same ecological concerns.

6. **ISO 14001 certification:** The internationally renowned standard ISO 14001 outlines the criteria for an environmental management system, requiring a commitment to compliance with applicable laws and regulations and continual improvement. It provides a platform for a rigorous

strategy to reduce the adverse environmental effects of organisations. Organisations perceive certification costs to be an ENC. However, it fosters reduced resource use and waste generation and enhances QA Nawrocka et al. (2009).

7. **RLgs:** According to Tsoulfas and Pappis (2006), designers need to assess the energy and material requirements across the whole lifecycle of a product, including its manufacture, consumption, and future usage. Collaboration with crucial suppliers in product creation reduces the duration required to reach the market. An improvement in consumer satisfaction accompanies the reduction of both business waste and environmental expenditures. For this approach to be successful, engaging in substantial ext cooperation with other partners in the SC Zhu et al. (2008) is necessary.

8. **Engagement with customers on environmental issues:** An effective customer engagement improves QA and CS by decreasing SC expenses and preserving the dependability of operations Zhu et al. (2007). This eco-friendly strategy develops environmental awareness and transforms customers into partners by optimising return volumes, reducing BWS and ecological costs, and increasing customer satisfaction Tsoulfas and Pappis (2006). As a result, the fulfilment rate, on-time delivery, and sensitivity to consumers' environmental concerns have all improved.

9. **Environmentally friendly packaging(E3):** According to Nair and Menon (2008), this is one of the most precise indicators of an organisation's environmental commitment. According to Zhu et al. (2008) and Ninlawan et al. (2010), using E3 is anticipated to decrease Firm waste and ENCs while increasing customer satisfaction.

10. **Collaborating with clients to modify product characteristics:** This promotes process EFF and input substitution while improving product durability and adherence to standards, facilitating variable product requirements in response to process changes Vachon and Klassen (2008). As client rejection rates drop, customer satisfaction increases.

Five propositions, each derived from the proposed framework, are presented to conceptualise the impact of green practices on SCP in the IND leather industry. These propositions serve as the foundation for our research and guide our data collection and testing:-

1. P1. “IND leather SC companies must adopt green practices to be considered environmentally friendly”.
2. P2. “IND leather SC companies are adopting environmentally friendly practices.”.
3. P3. “Companies in the IND leather SC believe that certain performance measures more accurately reflect the impact of GSCM practices on SCP.”
4. P4. “IND leather SC companies implement performance measures that reflect the impact of green practices.”
5. P5. “Companies in the IND leather SC are considering green practices to improve the performance measures.”

The research investigates the influence of GSCM practices on SC performance. To achieve this, the research uses grounded theory as a methodological approach. Grounded theory is selected for its ability to identify patterns and relationships in the data, which helps in building theory. This approach is flexible and effective in providing explanations and fresh insights. To facilitate the identification of patterns and linkages that may contribute to the development of theories, the researchers opted for the use of grounded theory (Fellows and Liu, 2003).

4.29 Methodology

This research examines the effects of GSCM SCP strategies. Perry (1998) and Rowley (2002) suggest case studies when a phenomenon’s limits are unclear, and the researcher wants more control over behaviour. How much this study analyses GSCM tactics that may affect SCP needs to be clarified. First, analyse all levels of the SC to discover how green practices affect performance.

The present research might be characterised as exploratory due to the limited availability of data, which hinders the formulation of hypotheses that can be empirically tested. Given the potential variation in SC environmental behaviour across different countries, it is advisable to first analyse a specific SC inside a single nation before doing comparative research, including several SCs and countries Rosenzweig and Singh (1991). A study design focused only on the IND leather SC was used.

This research used a multi-case study approach to examine the many green efforts implemented by IND Leather firms of different sizes and places in the SC. The objective is to determine the initiatives that have the most significant influence on SCP. Five case studies were chosen to examine the operations and practices of IND Leather SC businesses.

The use of this particular criteria has the potential to provide replies that are influenced by bias, consequently impacting the final results. Expert bias also constrained the research findings since subjective evaluations from participants were collected through interviews. Despite the assurance of confidentiality, every participant may be motivated to safeguard their reputation and public perception.

The approach in case studies encompasses many stages, including planning, data collection, and analysis. The last step of the research involves an examination of individual case studies, which enables the production of ”cross-case” reports Yin (2003). The current research utilises the qualitative data analysis approach Miles and Huberman (1994) developed, including collecting, reducing, presenting, and testing contemporary data. The system used in this study is similar to that of Fergusson and Langford (2006) and Wong and Boon-Itt (2008).

4.30 Data collection

Data was collected via semi-structured interviews. Semi-structured interview questions were created based on a thorough literature review on GSCM practises and SCP. The conceptual framework in A.1(Appendix A) guided these queries. An engineer with leather experience tested the technique. Before the official assessment, the subject underwent telephone and face-to-face interviews to check methodological suitability and comprehensibility. This helped examine and explain the topic. The person's written and oral contributions were vital to the procedure's authenticity.

Several interviews were conducted to understand the different environmentally friendly strategies used by organisations in the IND Leather sector and their impact on the performance of the SC. Every manager was interviewed individually. A standardised structured interview protocol was used consistently across all sessions to mitigate the potential influence of interviewer bias. Sup-

plementary inquiries were included where explaining and adding the responses was necessary. After the interviews, further questions were sent over electronic mail. The prevailing need for confidentiality necessitates the consistent concealment of corporate identities.

Data was collected via the use of five case studies (j = 1, 2,..., 5), including ten green practices (k = 1, 2,..., 10) and six performance measures (w = 1, 2,..., 6), as outlined by the suggested theoretical framework. The researchers used the same methodology as Wong and Boon-it (2008) to give weights to the study variables. The consequences were assigned on a scale of 1 to 5 using the following notation—the importance of ecologically sustainable practices in the examined case study.

1. lkj contributes to the creation of a greener SC. The level of green practice application in the case study is j.
2. xkj. The precision with which PM w in the case study represents the impact of green practices on the SC is represented by j.
3. zwj. The degree of performance measure w implementation in the case study is j.
4. (Xk; YW) ywj. The weight j is applied to the relationship between the green practice k and the performance metric.

4.31 Data analysis

The firm individually analysed the data from the five case studies and conducted a cross-case analysis. In summary, this study uses cubic regression analysis to assess the impact of GSCM practices on several aspects of GSCM performance. The most accurate depiction of the link between these variables is achieved using mathematical equations to generate corresponding curves.

4.31 Individual case-study analysis

”Environmental policies refer to the practical application of a Firm’s strategic, operational blueprint” Ghobadian et al. (1998). Business enterprises also use

performance measurement tools to assess and evaluate their environmental performance. This research examines the degree to which organisations embrace green practices based on their level of acceptability towards a particular set of environmentally sustainable behaviours. Additionally, every organisation assesses the magnitude of a group of performance measures. Consequently, two ratings are proposed, as shown in the following table. The Individual Green Practice Adoption Score (IGPIScorej) denotes the cumulative score achieved by adopting green practices in each case study.

$$\text{IGP Score}_j = \sum_{k=1}^{10} X_{kj} \tag{4.1}$$

Equation (1) was formulated to assess the comprehensive environmental conduct of the Firm, which is determined by the summation of the adoption rates of several environmentally friendly initiatives. "The assumption was that implementing green practices would lead to the organisation operating sustainably, with each green approach having an equivalent influence on the overall performance evaluation". The Firm that exhibits the greatest extent of green practice adoption has the best score in terms of overall performance.

A comparative analysis investigates the efficacy of implementing performance metrics in each case study. "The IPMIScorej, which represents the individual performance measure implementation score for each case study, is calculated by summing the six levels of performance measure implementation for each instance".

$$\text{IPM Score}_j = \sum_{w=1}^{6} Y_{wj} \tag{4.2}$$

This level of performance will be used to assess the advantages of eco-friendly behaviour. Equation (2) was created to establish a correlation between increased adoption of the overall performance metric and enhanced firm performance.

4.31 Cross-case analysis

Cross-case analysis may discover significant elements in all case studies. The data helps identify IND Leather SC enterprises' preferred green practices. Performance metrics allow for assessing the execution and SC effects of these environmentally friendly activities. The interdependencies between these factors were fully understood after this investigation. This statement assumes that all organisations employ a standard priority scale. After a rigorous examination, the weighting of the case study analysis is used to assess each variable. The cross-case research uses ratings to show the five organisations' essential traits.

Each green practice's significance in producing a greener SC may be evaluated using the cross-case score defined by Eq. (Eq. 4.3) (GPp_scorek).

$$\text{GP}_p\text{Score}_k = \sum_{j=1}^{5} \mu_{kj} \tag{4.3}$$

Eq. (4.4) (GP_ scorek) determines the total score for each green practice application.

$$\text{GP}_p\text{Score}_k = \sum_{j=1}^{5} X_{kj} \tag{4.4}$$

The overall performance score (PMs_scorew), which is used to indicate how green practices affect performance, is derived from

$$\text{PM Score}_w = \sum_{j=1}^{5} Z_{wj} \tag{4.5}$$

The aggregated score to measure the performance measures implementation level (PM_ score) is obtained from

$$\text{PM Score}_w = \sum_{j=1}^{5} Y_{wj} \tag{4.6}$$

A cross-case study is also conducted to identify the crucial links between GSCM procedures and SCP. The data utilised to conduct this study came from the table in Section C of Appendix A. The associations were classified as favourable if a green practice was adopted and led to an increase in the overall value of the measure or as unfavourable if it led to a decrease in the overall

value of the action. The strength of the relationship was rated on a scale from 1 (no relationship) to 5 (strong relationship). A cumulative score (RS(k; w)) was computed to determine the relevant associations in each case study.

$$\text{RS}(k, w) = \sum_{j=1}^{5} (X_k, Y_w)_j \tag{4.7}$$

4.31 Case studies

This part studies five IND leather SC enterprises as case studies. The goal is to address the preceding section's assertions and construct a conceptual model utilising case-study data analysis and the theoretical framework. "This section is organised: First, the case-study profile is provided, followed by individual case studies (of green practises and performance indicators) and cross-case analysis to further explain SC green behaviour and its impact on SC performance".

4.31 Summary of the case study profile

The IND leather, leather products, and footwear industry is crucial to the economy, ranking among the country's top ten foreign currency sources. In the fiscal year 2020-21, IND exported footwear, leather, and leather goods worth USD 3.68 billion. This sector benefits from a substantial supply of raw materials, as IND is home to 20% of the world's cattle and buffalo and 11% of its goats and sheep. The industry also has access to skilled labour, advanced technology, increasing adherence to international environmental standards, and support from related industries. IND ranks second globally in leather garment exports, third in saddlery and harnesses, and fourth in leather goods. 4.19 presents profiles of five case-study firms categorised by product type, SC role, and company size. Many of these firms are primary suppliers within the leather industry and exhibit shared traits. The SC is characterised by imbalanced power dynamics, with leathermakers overseeing the entire production process, including product design, manufacturing, and component sourcing, often controlling suppliers. This SC has a limited number of raw material suppliers, and leathermakers can impose conditions on second-tier suppliers, who are restricted to purchasing from approved sources. Environmental considerations are extended to suppliers

Firm	Product lines	Position in the SC	Firm size (employees)	Interviewed
Firm Alpha	Raw leather processing, finished products, shoes, handbags and related products.	First-tier supplier	500	Leather engineer
Firm Beta	Raw leather processing, finished products, shoes, handbags and related products.	First-tier supplier	400	Product engineer
Firm Charlie	Finished products like bags, shoes and other leather accessories.	Second-tier supplier	700	Quality Engineer
Firm Delta	Raw leather processing, finished products, shoes, handbags and related products.	First-tier supplier	330	Quality Engineer
Firm Eco	Raw leather processing, finished products, shoes, handbags and related products.	First-tier supplier	750	Logistics manager

Table 4.19: lists the five case-study profiles by product line

by leathermakers, who encourage the development of environmental management systems and improvements in environmental performance. Some firms collaborate with international partners known for their strong environmental policies, global benchmarks, and self-auditing practices. Products are delivered to leathermakers in reusable containers or racks tailored to each product type. When returned to suppliers, these containers or racks are used directly on the assembly line and function as a kanban system, indicating the need for additional components.

The chosen enterprises produce raw materials and end products. Thus, they have "clean production processes" without sophisticated chemical or mechanical processes. However, all industries employ raw materials with significant environmental implications during manufacturing, such as high air emissions, hazardous and toxic chemicals and waste usage, and high energy consumption. This includes solid leather scraps, liquid waste, dust, and trims. Most leather waste is solid leather scraps and cut-offs from the production process. These scraps vary in size and form. Leather industry effluent contains harmful chemicals such as oils, tannins, and biocides, with increased COD, BOD, and decreased

chromium, NaCl, calcium, magnesium, sulphide compounds, and harming the environment and people.

4.32 GSCM practices

This sub-section discusses the need for green practices in overall GSCM and these green practices utilised by each case study.

Nevertheless, Firm Beta asserts that fostering "Interaction with suppliers on environmental sustainability" is crucial for mitigating the environmental consequences of polymer manufacture. Firm Beta, as a constituent of a business association, has initiated a pilot operation at a distinct location to manufacture a greater quantity of components exclusively derived from recycled plastic materials. These components are found inside instrument panel consoles, instrument panel supports, and air ducts.

Furthermore, doing a cross-case analysis of the last column is feasible and Equation (3). Respondents have attributed similar levels of importance to the ten green practices. The variable labelled "RLgs" achieved the highest possible score of 25, thereby earning the distinction of being the top-scoring variable in the category of green practice. This finding illustrates that all five companies see this practice as essential for enhancing the SC's image as an environmentally conscious organisation. The four remaining green initiatives that have achieved scores over 20 are "waste reduction," "ISO 14001 certification," "collaboration with customers to enhance product standards," and "minimisation of hazardous and toxic product consumption." Despite the discriminatory implications, the administration assigned a relatively low level of importance to the selection criteria of ISO 14001 certification. Environmentally conscious procurement methods are considered the least significant green practice for a SC to be ecologically friendly 4.20

This is primarily due to the leathermakers' selection of secondary suppliers, which enables them to exercise control over the flow of materials through the SC. Hence, primary suppliers seldom possess the autonomy to choose an alternative vendor that prioritises environmental sustainability **??**.

Upon analysis of the five organisations, it becomes evident that firms oper-

Green practices	**Firm Alpha**	**Firm Beta**	**Firm Charlie**	**Firm Delta**	**Firm ECO**	**Cross-case GP score**
Interaction with suppliers on environmental sustainability	3	3	3	2	4	15
Environmentally conscious purchasing habits	3	3	3	3	3	15
Collaborating with designers and suppliers to minimise and eventually eliminate the environmental effect of a product	3	3	4	2	2	14
Reducing waste	4	4	4	4	5	21
Reduce consumption of dangerous and poisonous substances.	4	4	3	4	4	19
ISO 14001 certification	4	4	4	5	5	22
RLgs	3	4	5	4	3	19
Engagement with customers on environmental issues	1	3	4	2	2	12
E3	1	4	3	4	4	16
Collaborating with clients to modify product characteristics	2	2	5	2	2	13
IGP score	28	34	38	32	34	

Table 4.20: Cross-case ranking of green practices importance to consider a GSCM

Green practices	**Firm Alpha**	**Firm Beta**	**Firm Char-lie**	**Firm Delta**	**Firm ECO**	**Cross-case GP score**
Interaction with suppliers on environmental sustain-ability	3	4	3	4	4	18
Environmentally conscious purchasing habits	4	3	2	3	5	17
Working with designers and suppliers to reduce and eliminate product environ-mental impact	3	4	4	4	5	20
Reducing waste	5	5	4	5	5	24
Reduce consumption of dangerous and poisonous substances.	5	5	3	4	4	21
ISO 14001 certification	5	3	5	5	5	23
RLgs	5	5	5	5	5	25
Engagement with cus-tomers on environmental issues	4	3	4	5	5	21
E3	4	4	3	5	5	21
Collaborating with clients to modify product charac-teristics	4	5	5	5	5	22

Table 4.21: Cross-case comparison of green practice's importance

ating within the IND leather SC believe that adopting ecologically sustainable practices is paramount to establishing a perception of environmental consciousness within the SC. The findings corroborate the original proposition.

P1. ”It is widely believed among companies operating within the IND leather SC that adopting environmentally sustainable practices throughout their SC is imperative to be recognised as environmentally friendly.”

4.33 Implementation of Green Practices

The report emphasises the utilisation of green methods by IND leather SC organisations, highlighting it as a noteworthy outcome. The interview participants were questioned on the degree to which they have implemented various environmentally conscious practices—the scale for the level criteria needed to be supplied.

Participants were allowed to provide ratings based on their respective areas of specialisation. Firm Delta has been evaluated as executing ”Interaction with suppliers on environmental sustainability” at level 2 because its implementation is confined to a specific subset of suppliers. The level 3 grade assigned to this practice by businesses 1, 4, and 3 signifies the execution of measures to persuade suppliers to adopt environmental management systems and enhance their environmental performance. ECO awarded the practice a grade of level 4 because all suppliers must adopt ecological management systems, comply with environmental rules, and refrain from using illegal chemicals and goods. Delta raises ”Reducing waste” and ”Reduced consumption of hazardous and toxic products” priorities due to the Firm’s lofty aims for collecting manufacturing waste and scrap, minimising landfill disposal, and adopting environmental measures throughout the product life cycle. Chairs are made from natural materials.

ECO’s ”Reducing waste” implementation rating is level 5. This initiative aims to generate zero grams of garbage for each participant via various daily actions. Based on the findings of research businesses, the potential for cooperation with ”Engagement with customers on environmental concerns” seems limited due to the need for leather manufacturers’ primary suppliers to possess environmental management systems and adhere to all ecological standards. The principle above may also be extended to ”Engaging in collaborative efforts with

Green practices	**Firm Alpha**	**Firm Beta**	**Firm Charlie**	**Firm Delta**	**Firm ECO**	**Cross-case GP score**
Interaction with suppliers on environmental sustainability	3	3	3	2	4	15
Environmentally conscious purchasing habits	3	3	3	3	3	15
Collaborating with designers and suppliers to minimise and eventually eliminate the environmental effect of a product	3	3	4	2	2	14
Reducing waste	4	4	4	4	5	21
Reduce consumption of dangerous and poisonous substances.	4	4	3	4	4	19
ISO 14001 certification	4	4	4	5	5	22
RLgs	3	4	5	4	3	19
Engagement with customers on environmental issues	1	3	4	2	2	12
E3	1	4	3	4	4	16
Collaborating with clients to modify product characteristics	2	2	5	2	2	13
IGP score	28	34	38	32	34	

Table 4.22: Individual and cross-case scores for green practices implementation levels

clients to alter product attributes." It is worth noting that leather manufacturers may need to be more willing to accommodate modifications in component design, as such alterations can undermine the vehicle's performance and the anticipated quality assurance measures. Nevertheless, Firm Charlie, identified as a secondary supplier, assigned ratings of 4 and 5 to these practices, respectively. This evaluation was based on the effective communication established with its primary supplier client to ensure it's a good idea to minimise its ecological footprint. Additionally, Firm Charlie adjusted product specifications by incorporating long-life accessories, reducing waste destined for landfills.

The present research conducted individual case investigations to assess the green behaviour of each organisation, with a specific focus on their current green initiatives. Based on the data analysis performed for each organisation, Equation (1) demonstrates that organisation Charlie exhibits the highest level of environmental friendliness, as seen in 4.22. The corporation employs two environmentally-friendly strategies, namely RLgs and promoting consumer-driven modifications to product specifications. "Furthermore, the Firm demonstrates a significant degree of commitment towards various sustainability practices, such as collaborating with designers and suppliers to mitigate and ultimately eradicate the environmental footprint of their products". They also prioritise waste reduction, adhere to ISO 14001 standards, and actively communicate with customers to address ecological issues.

To conduct a cross-case analysis, the five individual case studies were combined, and each green practice was assessed by calculating the overall average score derived from the five case studies. The green methods that exhibit the highest degree of applicability for all enterprises include ISO 14001 certification, waste reduction, the reduction of hazardous and toxic material consumption, and implementing RLgs.

The level of adherence to this standard is considerable, which is to be expected considering that the selection of organisations to participate in the research was primarily based on their possession of ISO 14001 certification. The relatively low adoption rate of collaborative or integrated processes among SC participants indicates enterprises' challenges while endeavouring to become part of a SC. The individuals in question are primarily concerned with their everyday responsibilities, hence presenting difficulties in effectively coordinating certain operations and procedures with other partners within the SC. The activities about

”enhancing product standards through customer collaboration” and ”promoting consumer involvement in environmental matters” had a lower ranking as they descended the hierarchical structure. This underscores the need to establish robust collaboration among prominent leather producers and their primary and secondary suppliers.

The validity of the second argument is supported by the empirical evidence in 4.22, which presents the distribution of ecologically sustainable practices used by various firms operating within the IND leather SC. According to recent research, companies operating within the IND leather SC have been shown to adopt environmentally sustainable practices.

4.34 Supply Chain Performance

This section of the study evaluates the performance indicators used by businesses within the IND leather SC, particularly those that most accurately reflect the impact of environmentally sustainable practices on SCP. The significance of these performance indicators, as they relate to the effects of green practices, is assessed using data collected from interviews 4.22. According to the data in 4.22, participants in the cross-case study, analysed using Equation (5), identified the ”ENC” performance indicator as the most effective at reflecting the impact of green activities on SCP. Following this, indicators such as ”Quality Assurance,” ”Client Satisfaction,” and ”Efficiency” were noted. These indicators align with the competitive objectives of organisations, including providing high-quality products, achieving high customer satisfaction, and optimising resource use to minimise waste. **??** illustrates these rankings. Specific performance measures offer a more precise reflection of the effects of green initiatives on SCP. This supports the thesis that specific metrics are better suited for evaluating the impact of GSCM practices. As noted by Participant 3 (P3), IND leather SC businesses believe that some performance indicators more accurately represent the impact of GSCM strategies on SCP. Performance Measures Implementation The study also explores how participants perceive performance measures' role in indicating sustainable practices' impact on SCP. It investigates which metrics the enterprises utilise in the case studies to evaluate performance 4.20.

Managers were interviewed about the types and extent of performance evaluations within their organisations. Feedback was primarily based on reviews

of annual reports and operational management procedures. This indicates a high degree of reliance on performance measures as strategic indicators. Organisations have immediate access to databases and information systems, which facilitate converting raw data into actionable information for reports, statistical analyses, comparative charts, trend charts, and other visual formats. An essential aspect of adopting performance measures is how the organisation communicates results. All organisations utilise communication strategies to support their environmental goals, as evidenced by their ISO 14001 certification. A survey was conducted to assess managers' views on the implementation level of these metrics in firm management and control. The scale used ranged from 1 (indicating no implementation of the metric) to 5 (indicating full implementation, with the metric regarded as a strategic business indicator). Formal evaluations followed this:

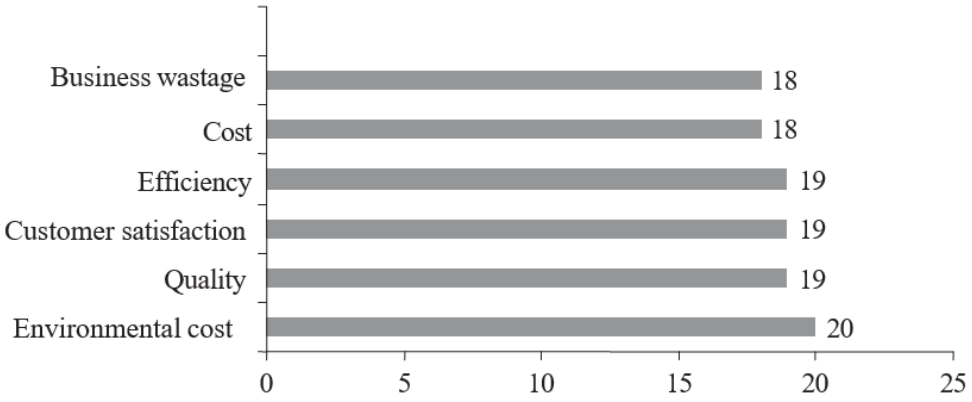

Figure 4.7: Cross-case ranking performance measures importance to reflect the impact of green practices on SCP

For a single case study utilising Equation (2), 4.20 shows that Firm Eco implements more acceptable performance indicators that show how environmentally aware actions affect SCP. The Firm's performance indicators include "QA" (plant defect rate and finished product first-pass yield), "CS" (order to-ship times, on-time delivery, and customer line stopping), "cost" (cost per operating hour and inventory carry fee), "EFF" (operation expenses and sales), and "ENC" (waste management cost, fines, and p). The performance above meets the Firm's competitive objectives for quality assurance, cost, delivery, and innovative solutions.

Firm Delta has fully adopted the quality assurance (QA), efficiency (EFF), and cost measures. For example, Firm Delta has successfully implemented

Performance measures	**Firm Alpha**	**Firm Beta**	**Firm Char-lie**	**Firm Delta**	**Firm ECO**	**Cross-case GP score**
QA	4	4	5	3	3	19
CS	5	3	4	4	3	19
Cost	4	2	4	4	4	18
EFF	5	2	4	4	4	19
ENC	4	3	4	4	5	20
Business wastage	4	2	4	4	4	18

Table 4.23: Cross-case comparison of performance measures importance to reflect the influence of green practices on SCP

Performance measures	**Firm Alpha**	**Firm Beta**	**Firm Char-lie**	**Firm Delta**	**Firm ECO**	**Cross-case GP score**
QA	3	4	5	5	5	22
CS	5	4	4	4	5	22
Cost	4	3	5	5	5	22
EFF	4	3	4	5	5	21
ENC	3	3	3	3	5	17
Business wastage	3	3	3	4	5	18
IPM scorej	22	20	24	26	30	

Table 4.24: Individual and cross-case scores for performance measures implementation

a novel quality assurance project throughout its many sites to cultivate fresh perspectives and attain a high-performance standard. Quality assurance (QA) is a critical business aim for Firm Delta. The environmental indicators of this organisation include trash creation, energy use, and water utilisation. Companies 1 and 3, situated at lower positions within the list, have also devised many performance indicators to assess the effectiveness of their SCs. Firm Beta has a modest degree of implementation for the ”QA” and ”CS” indicators, leading to the lowest scores for both measures.

Based on a cross-case study of Eq., the performance indicators that exhibit the highest implementation scores are customer happiness, quality assurance, and cost (6). The performance indicator known as ENC is shown to have deficiencies levels across the business sector. This exemplifies the contradiction between the performance assessment methods used by corporations and their

consideration of environmental factors or the limited significance attributed to ecological matters.

When examining, an intriguing observation emerges that the indicator "ENC" is seen as the most valuable for assessing the influence of green practices on SCP while being the least often used by firms. QA and CS were considered equally important when assessing the influence of environmentally friendly practices on the performance of SCs. The examination of 4.22 offers substantiation for the fourth assertion.

According to P4, IND leather SC organisations use SCP measures that accurately reflect the influence of environmentally sustainable practices.

4.35 Effect of Green Practices on SCP

The main aim of this part is to analyse the possible associations established by the theoretical framework outlined in part 3.

Each organisation's viewpoints were gathered to analyse the correlations between environmentally sustainable practices and performance metrics. The case studies revealed diverse perceptions and varying degrees of impact on SCP indicators associated with adopting a particular approach. The score for each connection was obtained using Equation (7). 4.25 only comprises correlations that surpass a threshold of 20 out of a possible 25 scores. Among the many case studies, these connections frequently get excellent assessments.

Based on the findings shown in 4.25, it can be seen that ENC, QA, and EFF exhibit the highest level of robustness as performance indicators associated with green practices. For example, "environmentally friendly packaging" pertains to using containers or racks that can be recycled and have enhanced durability, hence minimising product damage during transportation. Reusable packaging has been shown to effectively mitigate product faults and maintain product quality throughout the transportation process. An additional benefit of using this approach is the direct delivery of supplies to the assembly line of leather workers via the use of reusable racks functioning as kanbans, enhancing the system's efficiency. The varying degrees of effect on SCP were ascribed to this practice, which was found to be surprising. As a result, there is a lack of

Green practices	Performance measures					
	Cost	**ENC**	**EFF**	**QA**	**CS**	**BWS**
Interaction with suppliers on environmental sustainability						
Environmentally conscious purchasing habits						
Collaborating with designers and suppliers to minimize and eventually eliminate the environmental effect of a product						DEC
Reducing waste	DEC	DEC	INC	INC		DEC
Reduce consumption of dangerous and poisonous substances.		DEC				
ISO 14001 certification						
RLgs	DEC	DEC	INC		INC	
Engagement with customers on environmental issues				INC	INC	
E3			INC	INC		
Collaborating with clients to modify product characteristics	DEC	DEC	INC	INC		

Table 4.25: Influence of green practices on SCP

consensus among various comments about the potential effects of ”ISO 14001 certification” on SCP. There are comparable disparities in viewpoints about the effectiveness of the SC regarding ”Interaction with suppliers on environmental sustainability” and ”Environmentally conscious purchasing habits.” ISO 14001, a globally recognised environmental management standard, requires certified organisations to pursue enhancements in all significant impacts, including those related to suppliers and products across the whole lifecycle, from manufacture to use and disposal. This standard serves to encourage the adoption of these approaches.

Consequently, it was expected that most case studies would choose ”Interaction with suppliers on environmental sustainability” as the factor with the most significant influence on SCP.

The adverse consequences can be attributed to the fact that numerous organ-

isations employ ISO 14001 certification as an ancillary management instrument rather than as a result of ext pressures from clients, customers, and competitors Arora and Cason (1996),Bowen (2002). According to Pochampally et al. (2009), establishing a favourable environmental image and demonstrating environmental awareness may facilitate the acquisition of environmentally concerned clientele and suppliers for enterprises. The data provided in 4.25 includes support for the fifth proposition. According to the findings, companies operating within the IND leather SC perceive that adopting environmentally sustainable practices significantly influences specific performance indicators within the SC. Assess the theoretical framework's validity. With the qualitative methodology used in this research, managers' views on environmentally friendly practices, their role in advancing a more sustainable SC, and the performance metrics that best capture these practices' effects on SCP can be examined. Exploratory design allows the Firm to create a model that meets its needs. The conceptual framework in 4.8 fully illustrates the effects of environmentally sustainable practices on SCs, as shown by the five case studies and their synthesis.

4.36 A Cubical Regression Model

The theoretical framework illustrates how certain practices impact various organisational performance measures. For instance, a positive correlation is observed when a practice, such as implementing a waste management system, increases the value of a measure, such as reducing business waste. This means that as these practices are enhanced, the overall performance metrics like efficiency and quality also improve. On the other hand, a negative correlation occurs when a method, such as reducing costs by cutting corners on quality, reduces the value of a measure, such as adhering to quality assurance standards. In this scenario, as practices aimed at cost reduction or waste minimisation are implemented, the corresponding performance measures decrease. Despite the theoretical development of this model, our research findings highlight that not all predicted linkages have been successfully implemented in practice. This finding underscores the practical implications of our research in bridging the gap between theory and practice. For instance, case study data indicated that certain green practices, such as "Interaction with suppliers on environmental sustainability," "Environmentally conscious purchasing habits," and "ISO 14001 certification," had limited impacts on overall SCP. While theoretically beneficial, these practices did not translate into significant performance improvements in the studied

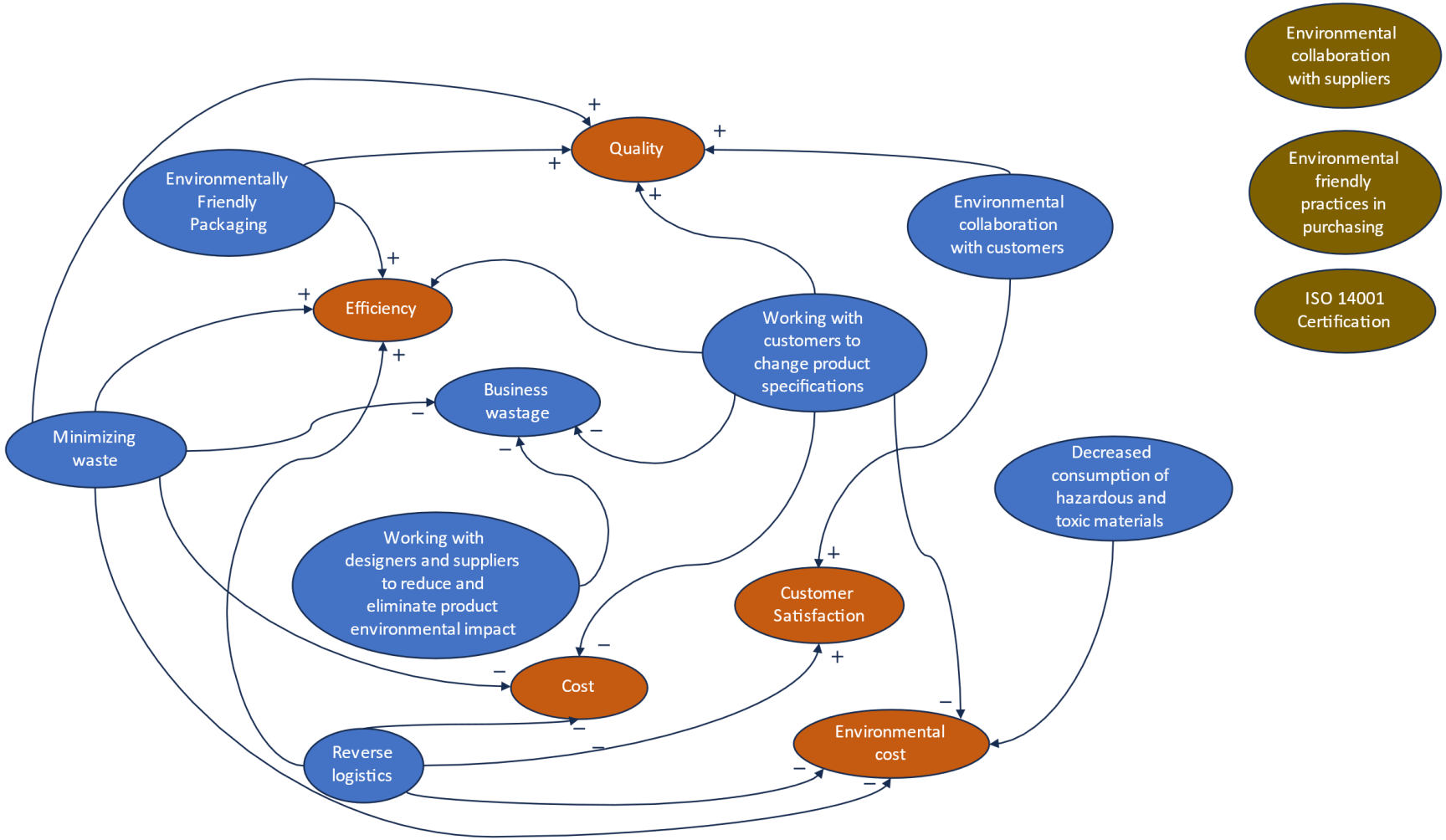

Figure 4.8: Model for the influence of green practices on SCP

cases, emphasizing the need for further practical application of these theories. Cubical regression models, a sophisticated tool, establish the intricate relationship between GSCM practices and SCP. These models are particularly suitable for correlating various performance parameters with GSCM activities within organisations. The model can effectively capture the complex, non-linear relationships between GSCM operations and performance outcomes using cubic regression equations. The following sections will discuss the performance parameters in detail, analysing how each correlates with GSCM practices using the cubic regression models. This detailed examination helps understand green practices' impact on SCP across various dimensions.

QA

The IND leather industry has made considerable strides over the years to improve the quality of its output. The focus on quality assurance has been driven by the need to fulfil international standards, satisfy consumer expectations, and successfully compete in the global market. It is vital to remember that quality assurance may vary amongst manufacturers. Thus, buyers are encouraged to select reputable brands and suppliers renowned for their dedication to QA. By prioritising QA at every organisational level and aiming for continuous improvement, a Firm in the IND leather sector may establish itself as a trusted and favoured source of exceptional leather products for domestic and international markets. In addition, this crucial performance component has been compared to all GSCM methods, and the following cubical regression equation and graphical representation have been developed 4.9:

$$y = 276.0667 - 23.6 * x + 0.6708333 * x^2 - 0.00625 * x^3 \qquad (4.8)$$

Satisfaction

Satisfaction is crucial to the success and expansion of the IND leather industry. Customers' satisfaction contributes to the Firm's immediate income and influences the industry's long-term viability and reputation. CS is a crucial aspect that directly affects the development and expansion of the IND leather industry. By addressing customer demands, offering high-quality products, and providing

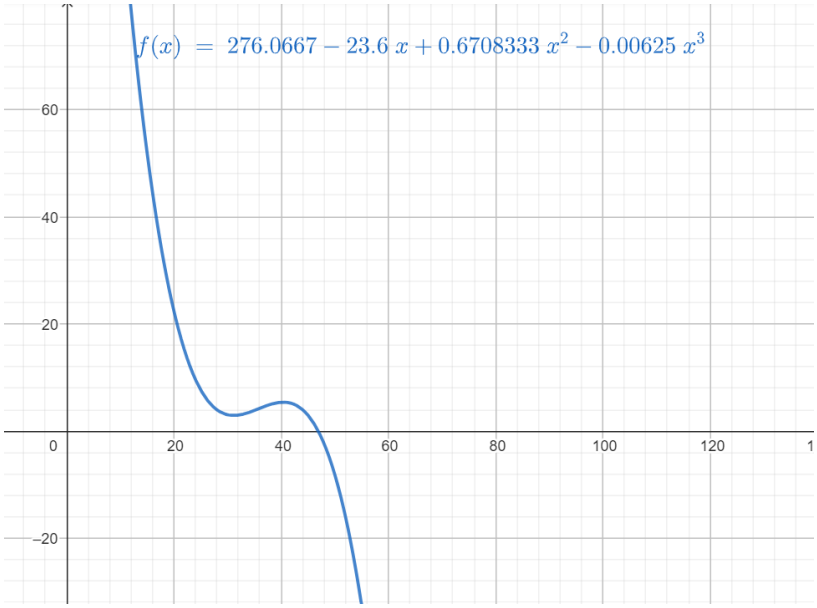

Figure 4.9: Graphical representation of Quality(QA) performance against various practices

superior customer service, businesses may positively impact consumers' lives and position themselves for future market success.

The satisfaction as SCP can be related to the following cubical regression equation and graphical curve for each Firm that employs GSCM practices 4.10

$$y = -533.0667 + 51.18333 * x - 1.608333 * x^2 + 0.01666667 * x^3 \quad (4.9)$$

Cost

In the IND leather industry, cost matters. Good cost management affects a firm's profitability, competitiveness, and success in a competitive industry. Cost reduction and product quality must be balanced. To save money, keep leather products safe and high-quality. In the IND leather industry, price matters. Cost management helps businesses stay competitive and financially stable and adapt to changing market conditions, boosting industry growth. Each of the five cross-case firms was asked to provide this performance factor and a cubical regression

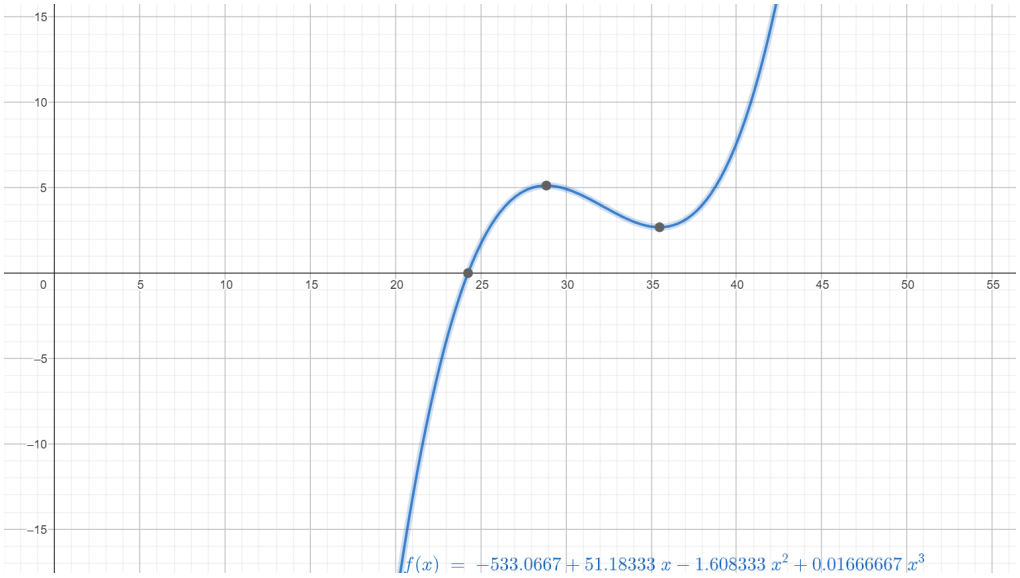

Figure 4.10: Graphical representation of Satisfaction performance against various practices

equation that best matched all SC practices against cost, as shown below 4.11:-

$$y = -705.3333 + 66.16667 * x - 2.041667 * x^2 + 0.02083333 * x^3 \quad (4.10)$$

Efficiency(EFF)

EFF is a vital performance metric for the IND leather sector, directly influencing productivity, profitability, and competitiveness. Enhancing EFF in several facets of the industry can result in numerous advantages. EFF should be sought at all sector levels, from tanneries and leather product makers to suppliers and export methods. Collaboration and coordination among SC players can further improve EFF and contribute to the growth and success of the industry. EFF is a significant feature that can propel the IND leather sector toward enhanced performance, sustainability, and international competitiveness. The optimal equation for this performance measure for all GSCM practices in the IND leather sector has been created using all five case studies 4.12.

$$y = -533.0667 + 51.18333 * x - 1.608333 * x^2 + 0.01666667 * x^3 \quad (4.11)$$

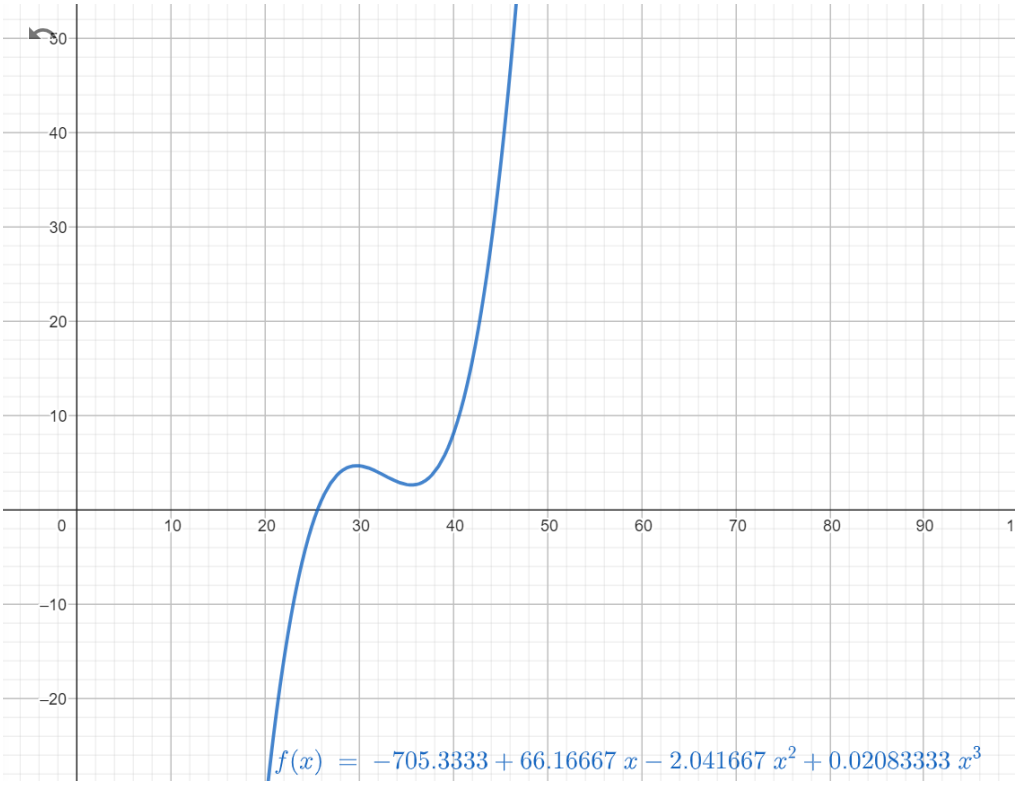

Figure 4.11: Graphical representation of Satisfaction performance against various practices

Environmental cost(ENC)

ENCs affect the IND leather industry, as do many others. Leather production ENCs can significantly impact environmental sustainability. The IND leather industry must adopt eco-friendly practices to combat ENCs. Addressing ENCs can help the IND leather industry become more sustainable, reduce its environmental impact, and improve its reputation as a responsible industry.ENCs' relationship to GSCM practices for all five case studies is best shown by the cubical Equation below, with a graph 4.13:

$$Y = 0.0208x^3 - 2.0417x^2 + 66.1667 * x - 705.3333 \tag{4.12}$$

Business wastage

Business wastage in the IND leather industry refers to the various forms of waste generated during the leather production and manufacturing processes. This

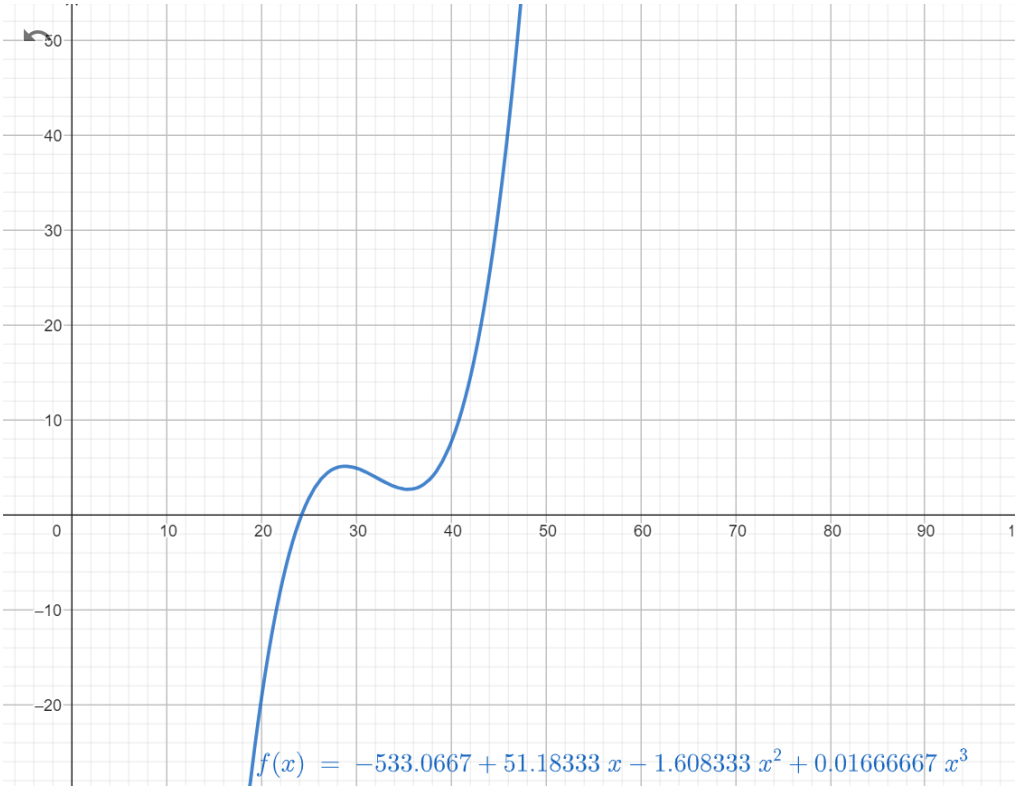

Figure 4.12: Graphical representation of Efficiency (EFF) performance against various practices

wastage can occur at different stages of the leather value chain and has environmental, EC, and social implications. By systematically addressing business wastage, the IND leather industry can achieve greater sustainability, reduce its environmental influence, and improve its competitiveness in the global market.

Following is the graphical representation of the relationship of this performance factor with all GSCM practices with cubical regression equations 4.14:

$$y = -705.3333 + 66.16667 * x - 2.041667 * x^2 + 0.02083333 * x^3 \quad (4.13)$$

4.37 Subhead overview

Drawing upon this subhead, our study unveils a nuanced relationship between environmental practices and performance outcomes in the IND leather industry. Employing a cubical regression model and analysing data from five case

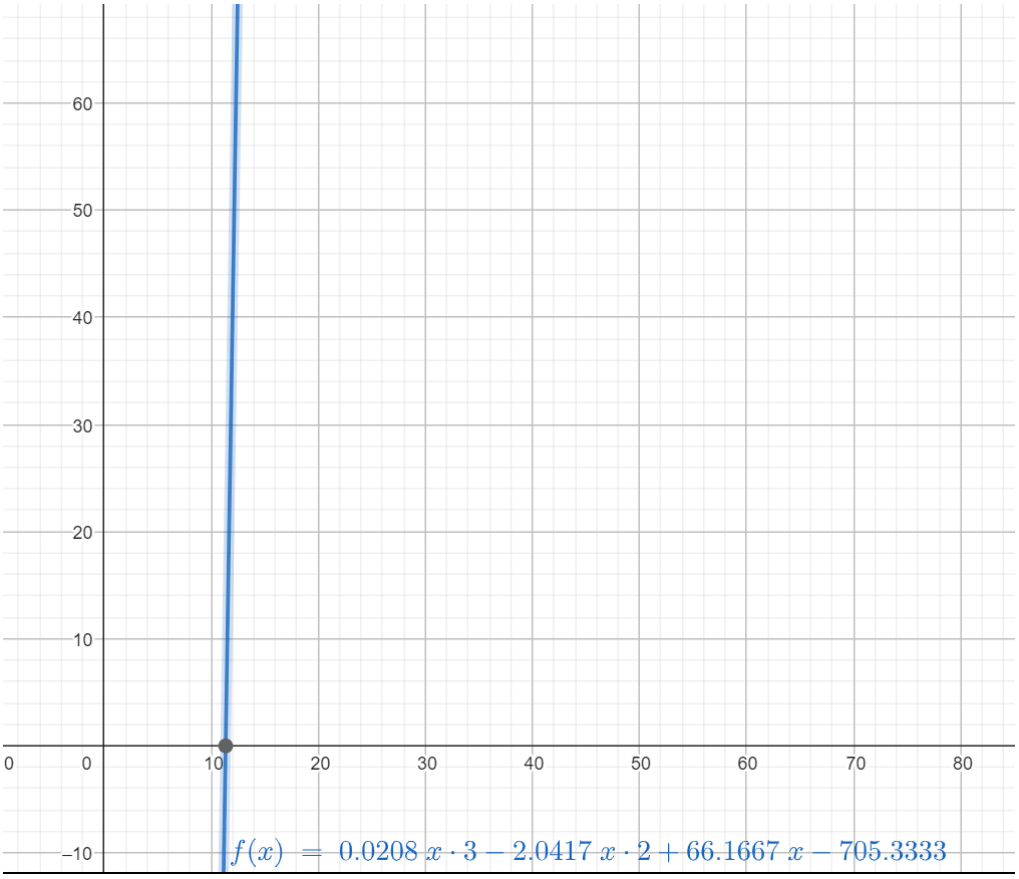

Figure 4.13: Graphical representation of Environmental cost(ENC) performance against various practices

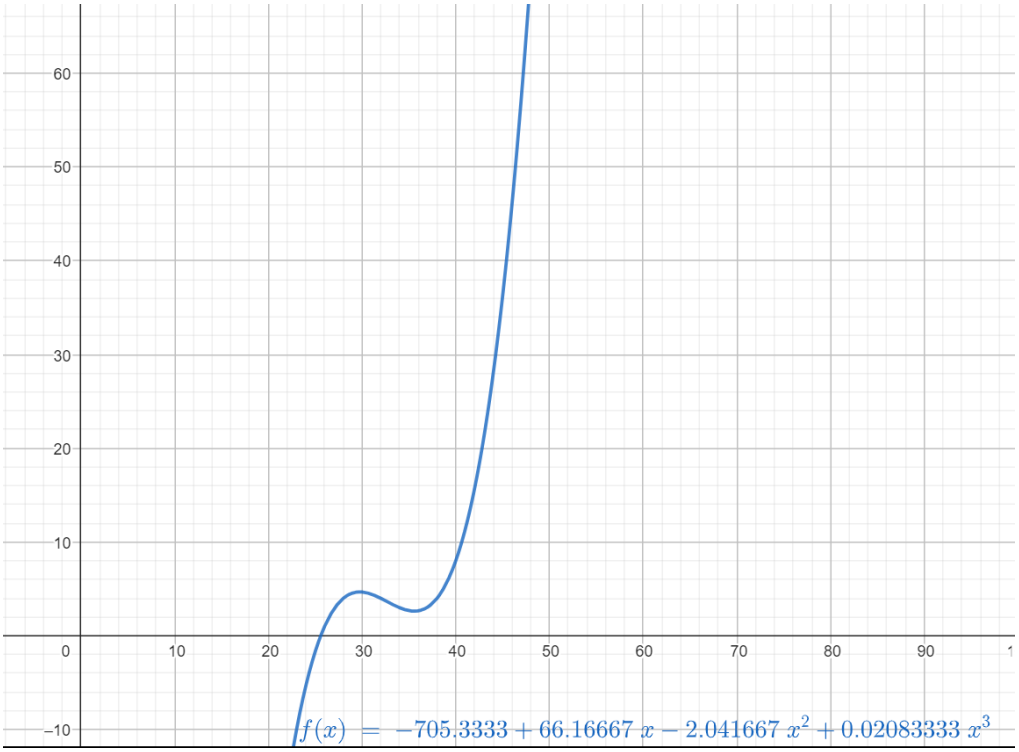

Figure 4.14: Graphical representation of Business wastage performance against various practices

studies, we delve into the impact of environmentally friendly initiatives on operational efficiency, quality assurance, and customer satisfaction. While revealing a positive correlation between certain green practices and enhanced product quality and operational efficiency, we also acknowledge that not all environmental strategies yield favourable performance metrics. Our research emphasises critical practices such as waste reduction and ISO 14001 certification in fostering ecological sustainability within the SC, highlighting the pivotal role of top management support in driving these green practices. This underscores the urgent need for organisational commitment to these practices. Looking ahead, our chapter strongly advocates for a comprehensive empirical evaluation of the conceptual model, suggesting replication studies and cross-cultural investigations across diverse industrial landscapes. By prioritising large-scale data collection on observed GSCM practices and their impact on performance, future research endeavours can lay the foundation for informed decision-making and sustainable business practices across industries, emphasising the necessity of these actions for the future of our environment and business sustainability.

4.38 Chapter conclusion

This chapter delved into GSCM dynamics within the IND leather industry, emphasising the critical significance of environmental sustainability. We explored the industry's historical evolution, current standing, and economic importance, highlighting the multifaceted challenges in adopting GSCM practices, such as inconsistent quality and lack of robust regulatory frameworks. Through ISM, we illuminated the intricate interplay of these barriers, underscoring the urgent need for environmental stewardship. We also examine the pivotal role of human behaviour in GSCM implementation, identifying key factors such as top management support, green innovation, teamwork, employee empowerment, and effective communication. Our analysis reveals that top management support is not just a driver, but the primary driver of GSCM initiatives, underscoring the immense importance of leadership in fostering sustainability. Furthermore, our study unveils a nuanced and promising relationship between environmental practices and performance outcomes, showing a positive correlation between certain green practices and enhanced product quality and operational efficiency. Practices like waste reduction and ISO 14001 are crucial for ecological sustainability and improving product quality and operational efficiency, with top management support being vital for driving these initiatives. In conclusion, this chapter highlights the transformative potential of GSCM practices in the IND leather industry and the critical interplay between barriers, human behaviour, and performance outcomes. Future research should focus on quantitatively assessing these factors and their impacts, employing methodologies like structural equation modelling (SEM) and conducting studies. The industry can achieve sustainable transformation and resilience by prioritising comprehensive empirical evaluations.

Chapter 5

Conclusion

5.1 Introduction

This chapter synthesises our study's key findings and implications on GSC practices and performance in the IND leather industry. It offers recommendations for practitioners and policymakers, highlights theoretical contributions, and suggests future research directions, especially for the Theory of Planned Behavior (TPB). The study emphasises top management support as crucial for implementing GSC practices, highlighting the need for organisational commitment. Recommendations include prioritising green procurement, fostering stakeholder collaboration, and investing in employee training to promote eco-friendly practices. Integrating environmentally friendly practices into SCM enhances efficiency, quality, and sustainability, with practices like waste reduction and ISO 14001 certification being essential. Theoretical contributions in this study involve using the TPB framework to understand the drivers and barriers to adopting GSC practices. These findings have the potential to impact the field significantly, and future research could further expand the model across different industries, regions, and cultures. Incorporating factors like organisational culture, industry dynamics, and regulatory environments can enhance the TPB framework, opening up new avenues for exploration and understanding. This chapter strongly emphasises the urgency of environmental sustainability in SCM. It is a call to action for all stakeholders to step up their efforts and promote a greener, more sustainable future. The time to act is now, and we all must play our part in this collective endeavour.

5.2 Research Cycle

Our research journey involved traversing a comprehensive research cycle to investigate the implementation of GSCM practices within the IND leather industry. The cycle commenced with identifying research objectives, including establishing relationships between internal and external barriers to GSCM adoption, analysing the influence of GSCM practices on performance parameters, and understanding the role of various behavioural factors affecting implementation. We systematically explored these objectives using various methodologies, including cross-case study analysis, cubical regression modelling, and the Theory of Planned Behavior (TPB) framework. These methods enabled us to gather empirical data, analyse complex relationships, and derive meaningful insights into the dynamics of GSCM adoption within the IND leather sector. We encountered challenges and limitations throughout the research process throughout the research process, such as the need to navigate industry-specific complexities and address the interconnected nature of internal and external barriers. However, we overcame these obstacles by leveraging ISM and other analytical tools and gained a deeper understanding of the factors influencing GSCM implementation. At the culmination of our research cycle, we synthesised our findings into a cohesive narrative, offering insights, conclusions, and recommendations to industry stakeholders and policymakers. Our research advanced sustainable SCM knowledge through this iterative and systematic approach. It paved the way for future investigations into GSCM adoption in the IND leather industry.

Following are the research aim and objectives and their corresponding finding from our work:-

Research Aim

We aimed to examine GSCM implementation in the IND leather industry thoroughly. Through an in-depth analysis, we explored the complex interplay between internal and external barriers to GSCM adoption, highlighting the challenges and opportunities within the industry. We also evaluated how GSCM practices impact performance metrics such as operational efficiency, product quality, and environmental sustainability, offering valuable insights for industry stakeholders. Our research extensively examined the role of behavioural factors in GSCM implementation, employing the Theory of Planned Behavior

(TPB) framework to understand the attitudes, subjective norms, and perceived behavioural control of critical actors within the supply chain. By identifying the drivers and barriers to adopting green practices, we have enhanced the understanding of decision-making processes in sustainable SCM, ensuring the robustness and reliability of our findings. We provided practical recommendations for practitioners and policymakers, emphasising the importance of top management support, organisational commitment, and stakeholder collaboration. Through careful analysis and theoretical contributions, our study aims to guide strategic interventions and foster positive change towards a greener and more sustainable future in the IND leather industry.

Research Objectives (ROs)

Through detailed analysis in our study, we were able to address the following objectives effectively:

1. **RO-01- To establish a relationship between internal and external barriers in GSCM for IND Leather Industry**

   Our study meticulously addressed the objective of establishing a relationship between internal and external barriers in GSCM for the IND Leather Industry. Through thorough analysis and examination of various factors, we identified and elucidated the intricate interplay between organisational internal constraints and external challenges stemming from the industry's broader ecosystem. By delving into resource constraints, technological limitations, regulatory pressures, and supplier relationships, we comprehensively understood the barriers hindering GSCM adoption within the IND leather industry. Our findings shed light on the complex dynamics and highlighted the need for holistic strategies to overcome these barriers and foster sustainable practices effectively.

2. **RO-02- To analyse the influence of GSCM practices on performance parameters for the IND leather industry.**

   Furthermore, our study extensively analysed the influence of GSCM practices on performance parameters specific to the IND leather industry, effectively addressing the objective of Objective-02. By evaluating factors such as operational efficiency, product quality, environmental sustainability, and economic viability, we provided valuable insights into the impact

of GSCM adoption on key performance metrics within the industry context. We quantified the benefits and drawbacks of various GSCM practices through empirical research and data-driven analysis, offering actionable recommendations for industry stakeholders to enhance performance and sustainability outcomes.

3. **RO-03- To analyse the role of various behavioural factors affecting implementation in the IND leather industry**

   Additionally, our study comprehensively analysed the role of various behavioural factors affecting implementation in the IND leather industry, aligning with the objective of Objective-03. Employing the Theory of Planned Behavior (TPB) framework, we investigated the attitudes, subjective norms, and perceived behavioural control among critical stakeholders involved in GSCM adoption processes. Our findings provided a nuanced understanding of decision-making processes and behavioural dynamics influencing GSCM implementation, highlighting the importance of organisational culture, leadership support, and stakeholder collaboration in driving successful sustainability initiatives within the industry. Through empirical insights and theoretical contributions, our study offered valuable guidance for industry practitioners and policymakers seeking to navigate the complex landscape of behavioural factors impacting GSCM adoption in the IND leather sector.

5.3 Recommendation

Our study has delved deep into the intricate relationship between environmental sustainability and SCP within the IND leather industry. We have unveiled a significant connection between eco-friendly SCM practices and performance measures through a meticulous cross-case analysis employing a cubical regression model. By examining anecdotal and empirical data, We constructed a robust theoretical framework illustrating how SCP indicators influence green efforts. Our findings have supported and reinforced the notion that firms in the industry recognise the necessity of implementing green practices for ecological sustainability and actively utilise such methods. Moreover, we have identified specific performance metrics that better indicate the impact of GSCM strategies on SCP. We have also underscored the industry's pressing need for environmental enhancement due to regulatory pressures and resource limitations. Our

study has aimed to understand the obstacles hindering GSCM adoption in the IND leather sector and their interconnectedness. Through an in-depth examination of barrier categories using Interpretive Structural Modeling (ISM), we have identified inconsistent quality and the lack of motivating legislation as primary hurdles. Additionally, our research has thoroughly investigated the link between SCP and environmentally friendly practices, providing a comprehensive set of green recommendations applicable to IND leather supply chains. Based on our findings, we offer several practical recommendations to enhance the adoption of GSCM within the IND leather industry. Firstly, stakeholders must recognise and address internal and external impediments hindering GSCM implementation. Understanding these barriers and their interactions can facilitate the adoption of GSCM guidelines, benefiting both internal and external supply chains. Our study identified vital obstacles and their significant reliance and driving force for GSCM adoption, providing valuable stakeholder insights. Furthermore, our case-study analysis highlighted the impact of GSCM practices on SCP, emphasising the importance of practices such as reverse logistics, waste reduction, and ISO 14001 certification for environmental sustainability. We found correlations between green practices and operational success, particularly in quality assurance and customer satisfaction. However, challenges remain in quantifying the impact of behavioural factors on turning traditional supply chains green. Utilising Structural Equation Modeling (SEM) methodologies can validate our findings and better understand how behavioural components drive GSCM adoption in the IND leather sector. Our recommendations aim to guide stakeholders in implementing effective GSCM strategies to foster sustainability and performance within the IND leather industry.

5.4 Practical implication of study

The practical implications of our research are multifaceted and hold the potential to offer actionable insights that can significantly benefit stakeholders within the IND leather industry and beyond.

1. **Informing Strategic Decision-Making**: Our findings provide industry stakeholders, including leather manufacturers, suppliers, and policymakers, valuable insights into the barriers hindering the adoption of GSCM practices. Organisations can develop targeted strategies to address these

challenges and enhance their sustainability efforts by understanding the internal and external obstacles identified in our research.

2. **Enhancing SCP**: Our analysis of the influence of GSCM practices on performance parameters highlights specific areas where improvements can be made within the supply chain. By prioritising waste reduction, ISO 14001 certification, and reverse logistics, companies can enhance operational efficiency, product quality, and environmental sustainability, ultimately leading to improved SCP.

3. **Promoting Collaboration and Stakeholder Engagement**: Our research underscores the pivotal role of collaboration across stakeholders, including manufacturers, suppliers, and regulatory bodies, in driving GSCM adoption. By fostering cooperation and knowledge-sharing initiatives, organisations can overcome barriers and leverage collective expertise to implement sustainable practices effectively, making each stakeholder feel valued and integral to the process.

4. **Guiding Policy Development**: Policymakers can use our research findings to develop regulations and incentives to promote GSCM adoption within the leather industry. By aligning policies with the identified barriers and opportunities, policymakers can create an enabling environment that encourages organisations to invest in sustainable practices.

5. **Empowering Organizational Leadership**: Our study highlights the crucial role of top management support in driving GSCM implementation. By fostering a culture of sustainability and providing leadership buy-in, organisations can create a conducive environment for adopting green practices throughout the supply chain.

6. **Improving Environmental Compliance**: Adopting GSCM practices can help organisations meet regulatory requirements and enhance environmental compliance. By prioritising practices that reduce waste, minimise environmental impact, and promote resource efficiency, companies can align with global sustainability standards and mitigate risks associated with non-compliance.

Our research offers practical insights and recommendations that can guide organisations and policymakers in promoting sustainability and driving positive change within the IND leather industry and beyond. By implementing these

recommendations, stakeholders can enhance their competitiveness, resilience, and long-term sustainability in an increasingly environmentally conscious global market, inspiring them to take action.

5.5 Theoretical contribution of study

According to a study, human emotions connect faith and attitude, and the study also indicates that human beliefs and attitudes are linked through emotions. In addition, the study's findings suggest that goals can be accomplished if customer satisfaction levels correlate with behaviour perspectives. The satisfaction of one's customers is of the utmost importance; a shift in attitude is possible with successful customer satisfaction. In conclusion, as shown in 5.1, the power of teamwork can triumph over the intentions of an individual member of an organisation toward a particular behaviour.

Study findings provide valuable insights into the relationship between beliefs, attitudes, emotions, intentions, customer satisfaction, and teamwork in influencing human behaviour within an organisational context. Following is the summary of key findings:

Importance of Customer Satisfaction: Research highlights the paramount importance of customer satisfaction. When customer satisfaction aligns with positive attitudes toward a specific behaviour, it becomes a powerful driver for achieving intentions. Positive customer satisfaction can lead to attitude changes, which, in turn, influence behaviour.

Teamwork's Role in Overcoming Individual Intentions: The Study underscores the significance of teamwork within an organisation. It suggests teamwork can override individual intentions or attitudes toward a particular behaviour. The study implies that collaborative efforts and a positive team environment can lead to adopting desired behaviours, even if personal meanings initially vary.

In summary, the study emphasises the intertwined nature of beliefs, attitudes, emotions, intentions, customer satisfaction, and teamwork in shaping behaviour within an organisational context. Recognising and understanding these relationships can be valuable for organisations seeking to influence and guide employee behaviour toward desired outcomes. The block diagram shows the whole under-

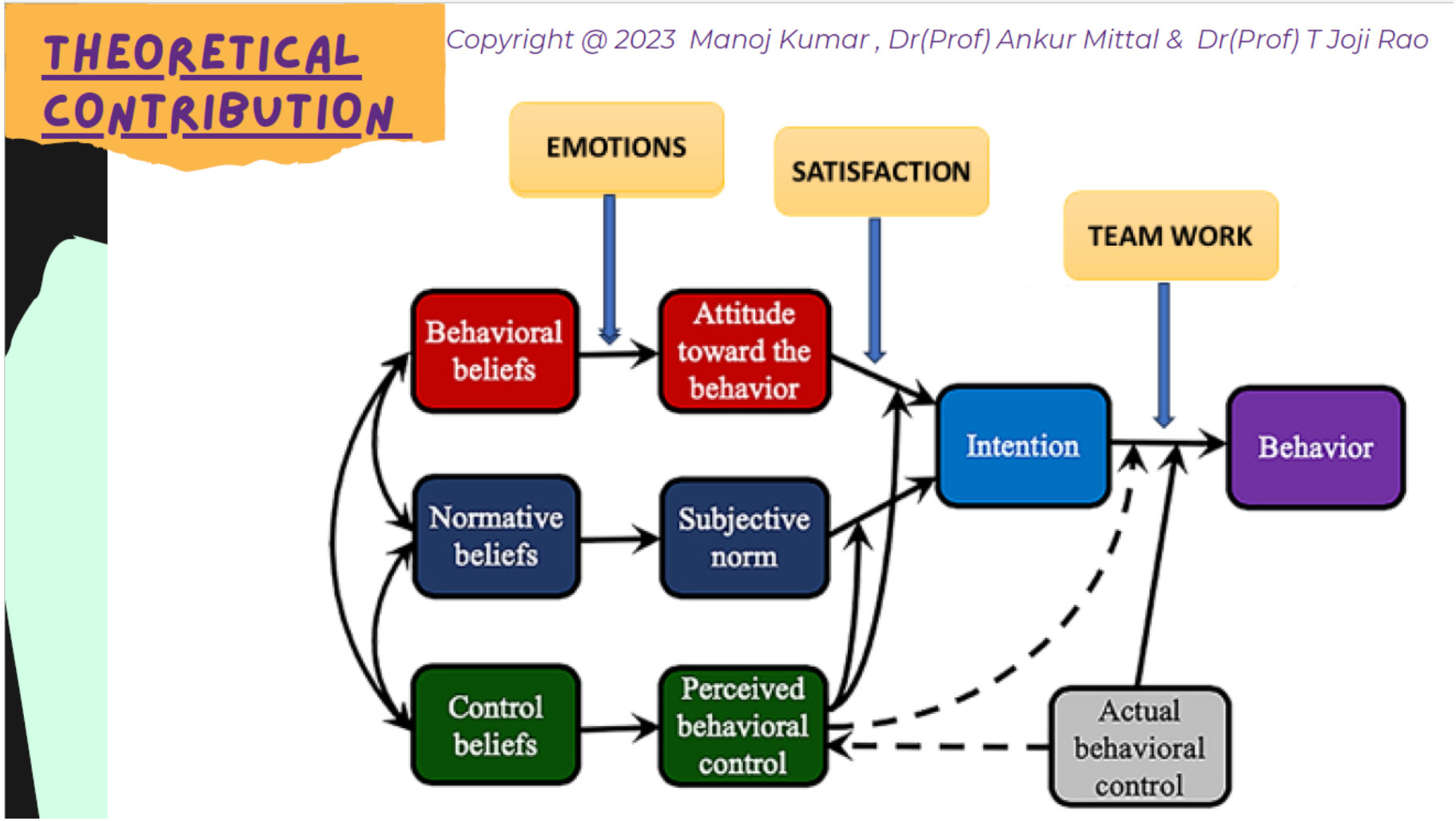

Figure 5.1: Theoretical Contribution

standing.

5.6 Proposed framework for TPB

The theory of Planned Behavior links various beliefs to behaviour. Factors like emotions, differences in human behaviour, and past experience are suggested to be incorporated to understand an individual's behaviour. It can be occupied and incorporated very quickly. Any organisation looking for performance parameters as key areas should include these factors: Emotions, differences in human behaviour and past experience to achieve better and more encouraging results, as shown in 5.2.

Argument underscores the importance of expanding the Theory of Planned Behavior (TPB) to include key factors such as emotions, differences in human behaviour, and experience for a more comprehensive understanding of individual behaviour within an organisational context, particularly in the domain of GSCM. Here is a summary of the points:

- **Incorporating Emotions, Differences in Human Behavior, and Past Experience**: The Study advocates incorporating emotions, variations in human behaviour, and past experiences into the TPB framework. These factors are essential for a more holistic understanding of individual behaviour and decision-making processes.
- **Quick Integration**: It is suggested that these additional factors can be integrated into the TPB relatively quickly, implying that organisations should consider these factors when designing strategies to improve performance.
- **Impact on Organizational Performance**: The Study emphasises that organisations focusing on performance parameters, particularly in GSCM aspects, should not overlook these human factors. Neglecting emotions, differences in behaviour, and past experience can have a detrimental impact on organisational performance.
- **Improved Performance**: Research strongly suggests that organisations can expect more favourable and encouraging results by incorporating these factors into the TPB. The study implies that a more comprehensive under-

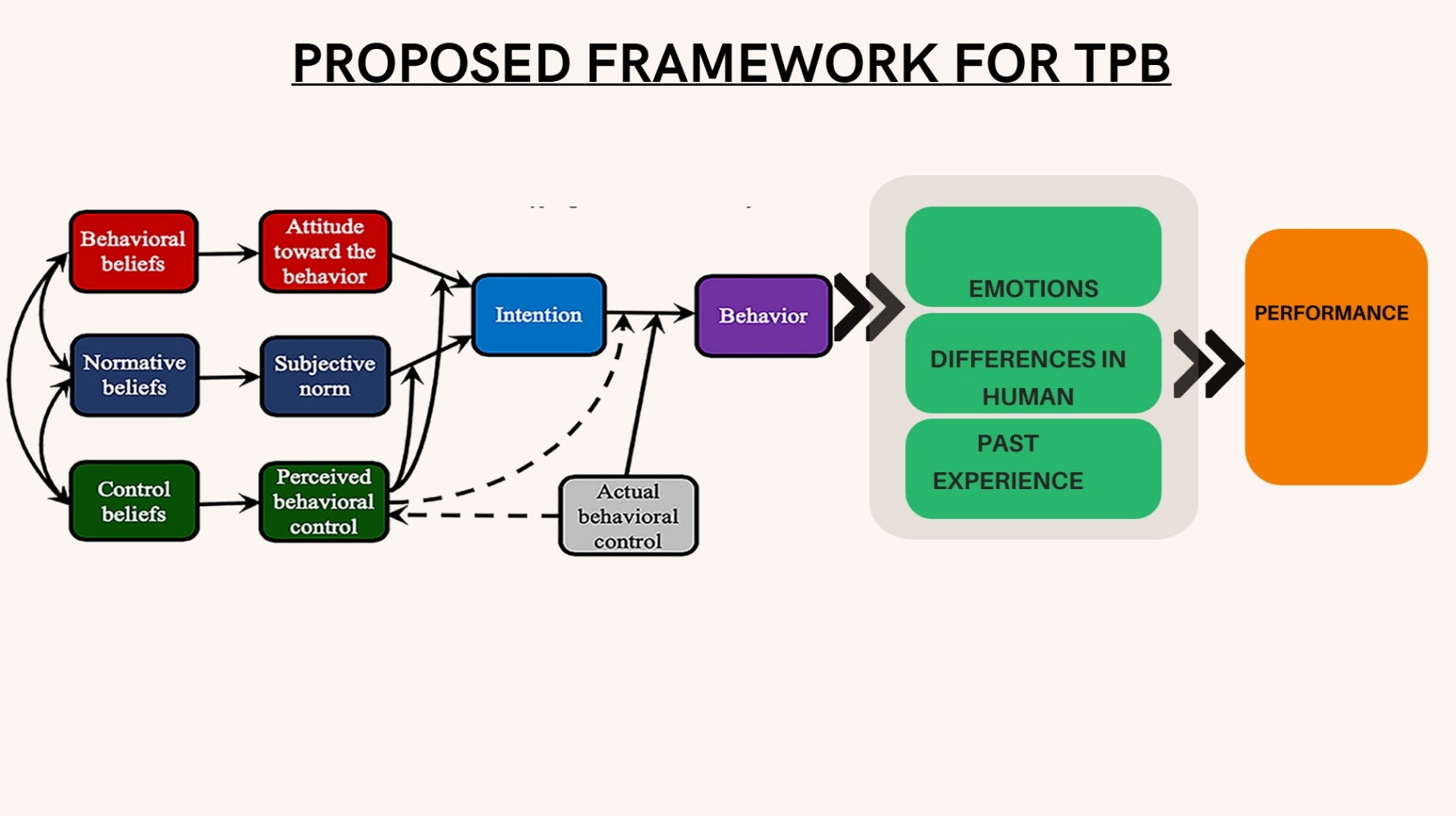

Figure 5.2: Proposed framework for TPB

standing of individual behaviour can lead to more effective strategies and improved performance outcomes.

The study encourages organisations to broaden their perspective on human behaviour by including emotions, variations in human behaviour, and experience within the Theory of Planned Behavior framework. Doing so is seen as a means to enhance organisational performance and achieve better results, particularly in GSCM.

Neglecting these human factors will indeed affect the performance of an organisation, especially in GSCM aspects. The study strongly suggests that if included in the planned behaviour theory, these factors can give an organisation suitable performance. The block diagram shows the whole understanding.

5.7 Future research directions

The study found that all three objectives, behavioural factors, various barriers and practices are interrelated and give feedback to each other. Further, it is also established that the top management perception is moving from behavioural factors to disorders. The study's output is the customer's top management and motivation, which drives further to various barriers. Product quality and maximum management perception were reflected as the output of the study on the diverse internal and external Barriers. Both barriers are internal and are essential in the ISM model and findings at the hierarchy level. Product Quality is also a feeder to performance parameters 5.3.

Further, the study indicates that collaboration with customers and environmental packaging is essential in GSM adoption and significantly contributes to any organisation's performance. The study also highlights and strongly suggests that two parameters, i.e. Customer Satisfaction and Product Quality, are reflected in all three objectives. Collaboration with Customers is an input to performance parameters, also indicated in the study's outcome, Product Quality and Customer Satisfaction. These two performance parameters are the result of the final findings. The block diagram shows the whole understanding.

The study's findings provide a comprehensive overview of the interrelationship between objectives, behavioural factors, barriers, practices, top management

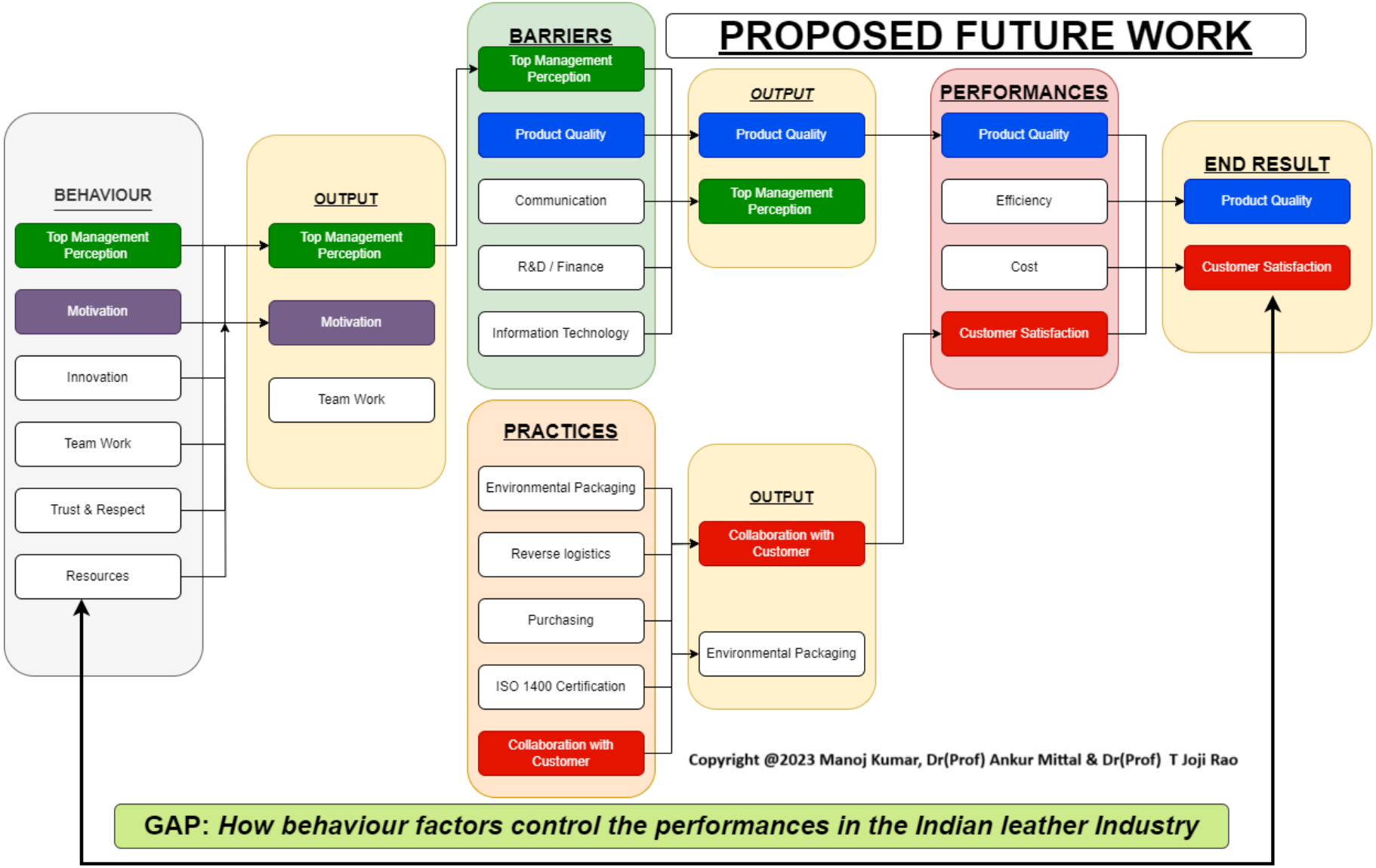

Figure 5.3: Proposed future research direction

perception, customer motivation, product quality, collaboration with customers, environmental packaging, and performance parameters within the context of the IND leather industry. Here is a summary of the key points:

- **Interrelated Factors**: The Study highlights that objectives, behavioural factors, barriers, and practices are interconnected and influence each other. This interdependence forms a feedback loop that impacts organisational dynamics.
- **Shift in Top Management Perception**: Top management has shifted from focusing on behavioural factors to addressing barriers. The study suggests a changing perspective on what influences organisational performance.
- **Output of the Study**: The Study identifies top management and customer motivation as significant outcomes. These outputs subsequently influence various barriers, emphasising their importance in organisational strategy.
- **Product Quality**: Product quality is recognised as a crucial factor linked to internal and external barriers. It is also seen as a contributor to overall performance parameters.
- **Role of Collaboration and Environmental Packaging**: Collaboration with customers and the importance of environmentally friendly packaging are highlighted as essential components of GSCM. These factors significantly contribute to organisational performance.
- **Performance Parameters**: The Study underlines the significance of customer satisfaction and product quality as key performance parameters. These parameters are crucial for achieving organisational objectives and are reflected in all three goals.

The research underscores the importance of examining the connections between various performance metrics and behavioural factors within the IND leather industry. It stresses the necessity of thoroughly understanding how these behavioural aspects affect industry performance. The study provides significant insights into the industry's dynamics, highlighting the interrelation of different elements and their combined impact on organisational performance. It advocates for additional research to investigate the relationship between behaviour and performance within this sector. Although the model discussed does not quantify

the influence of each behavioural element, it sheds light on how these elements interact and influence GSCM practices in the IND leather industry. Future studies could utilise a graphic theoretic and matrix approach to assess the impact of individual factors. Furthermore, since the model is based on expert evaluations and lacks statistical validation, structural equation modelling (SEM) could be used to confirm its conclusions.

5.8 Research limitations/implications

The results of this study are based on expert judgments, which were used to interpret the data and provide insights. While these judgments may introduce some level of subjectivity, they were carefully considered and are a common research practice. They were used to ensure the credibility of the findings and to help field managers understand the critical importance of various barriers and prioritise or eliminate those that hinder the effective impl of GSCM in the IND leather industry.

To generalise these findings, replication studies and cross-cultural or multinational research in different industrial settings are recom. A more compr and empirical evaluation of the conceptual model derived from the case studies is necessary. Future research should gather substantial samples of observed GSCM and SCP data.

Although the model does not quantify the influence of each behavioural element, it provides valuable insights into how these elements interact to affect GSCM practices in the IND leather industry. Future studies could use a graphic theoretic and matrix approach to measure the impact of individual factors. SEM could also be employed to verify the conclusions since the model is not statistically validated and relies on expert assessments.

5.9 Originality and Value

This study addresses a significant concern within the IND leather industry, aiming to understand the intricate dynamics between internal and external barriers and behavioural nuances through industry insights. The research uses the ISM method to identify the key practices influencing firm performance, offering a

nuanced understanding of the industry's complexities. This approach aims to give peers and stakeholders fresh insights and practical solutions.

The impact of this research extends beyond academia, offering tangible benefits to society by addressing the multifaceted barriers to efficient operations within the IND leather sector. By understanding and addressing these barriers, the study aims to unlock the full potential of GSCM, promoting sustainability and environmental stewardship. Specifically, the findings of this research can be used to develop targeted interventions and strategies that can significantly improve the sustainability and operational efficiency of companies in the IND leather industry. This research aspires to contribute to a more sustainable future for the IND leather industry with a deep sense of responsibility, potentially transforming the industry's practices and outcomes.

Practically, this study provides a roadmap for researchers and industry practitioners, equipping them to navigate the complexities of GSCM implementation with greater clarity and effectiveness. By understanding the specific behavioural factors of the industry, stakeholders can develop targeted interventions to drive meaningful change and enhance operational efficiency. Ultimately, this research enriches scholarly discourse by comprehensively analyzing the barriers and opportunities within the IND leather industry, fostering collaboration, innovation, and informed decision-making. In doing so, it contributes to the academic understanding of industrial dynamics, sustainability practices, and the collective efforts towards a more sustainable future for all stakeholders involved, making them feel included and part of a collective effort.

References

AlKhidir, T. and Zailani, S. (2009). Going green in supply chain towards environmental sustainability. *Global Journal of Environmental Research*, 3(3):246–251.

Amjadian, A. and Gharaei, A. (2022). An integrated reliable five-level closed-loop supply chain with multi-stage products under quality control and green policies: Generalised outer approximation with exact penalty. *International Journal of Systems Science: Operations & Logistics*, 9(3):429–449.

Arora, S. and Cason, T. N. (1996). Why do firms volunteer to exceed environmental regulations? understanding participation in epa's 33/50 program. *Land economics*, pages 413–432.

Aziz, F., Md Rami, A. A., Zaremohzzabieh, Z., and Ahrari, S. (2021). Effects of emotions and ethics on pro-environmental behavior of university employees: A model based on the theory of planned behavior. *Sustainability*, 13(13):7062.

Balon, V., Sharma, A. K., and Barua, M. K. (2016). Assessment of barriers in green supply chain management using ism: A case study of the automobile industry in india. *Global Business Review*, 17(1):116–135.

Barbour, R. S. (1998). Mixing qualitative methods: quality assurance or qualitative quagmire? *Qualitative health research*, 8(3):352–361.

Barve, A., Kanda, A., and Shankar, R. (2009). The role of human factors in agile supply chains. *European Journal of Industrial Engineering*, 3(1):2–20.

Beard, C. and Hartmann, R. (1997). Sustainable design: rethinking future business products. *The Journal of Sustainable Product Design*, 1(3):18–27.

Bechtsis, D., Tsolakis, N., Vlachos, D., and Srai, J. S. (2018). Intelligent autonomous vehicles in digital supply chains: A framework for integrating innovations towards sustainable value networks. *Journal of cleaner production*, 181:60–71.

Bouzon, M., Govindan, K., and Rodriguez, C. M. T. (2015). Reducing the extraction of minerals: Reverse logistics in the machinery manufacturing industry sector in brazil using ism approach. *Resources Policy*, 46:27–36.

Bowen, F. E. (2002). Organizational slack and corporate greening: Broadening the debate. *British Journal of Management*, 13(4):305–316.

Bu, X., Dang, W. V., Wang, J., and Liu, Q. (2020). Environmental orientation, green supply chain management, and firm performance: empirical evidence from chinese small and medium-sized enterprises. *International journal of environmental research and public health*, 17(4):1199.

Carter, C. R. and Liane Easton, P. (2011). Sustainable supply chain management: evolution and future directions. *International journal of physical distribution & logistics management*, 41(1):46–62.

Chan, F. T. and Qi, H. J. (2003). An innovative performance measurement method for supply chain management. *Supply chain management: An international Journal*, 8(3):209–223.

Chen, I. J. and Paulraj, A. (2004). Towards a theory of supply chain management: the constructs and measurements. *Journal of operations management*, 22(2):119–150.

Chen, W. and Hu, Z.-H. (2018). Using evolutionary game theory to study governments and manufacturers' behavioral strategies under various carbon taxes and subsidies. *Journal of Cleaner Production*, 201:123–141.

Clayton, M. J. (1997). Delphi: a technique to harness expert opinion for critical decision-making tasks in education. *Educational psychology*, 17(4):373–386.

Corbin, J. M. and Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, 13(1):3–21.

Creswell, J. W. and Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice*, 39(3):124–130.

Cronin, J. J., Smith, J. S., Gleim, M. R., Ramirez, E., and Martinez, J. D. (2011). Green marketing strategies: an examination of stakeholders and the opportunities they present. *Journal of the Academy of Marketing Science*, 39:158–174.

Crotty, M. J. (1998). The foundations of social research: Meaning and perspective in the research process. *The foundations of social research*, pages 1–256.

Davies, D. and Dodd, J. (2002). Qualitative research and the question of rigor. *Qualitative health research*, 12(2):279–289.

Dhillon, M. K., Bentley, Y., and Bukoye, O. T. (2016). The impact of indian smes managers/owners on adopting green supply chain practices.

Fergusson, H. and Langford, D. (2006). Strategies for managing environmental issues in construction organizations. *Engineering, Construction and Architectural Management*, 13(2):171–185.

Flynn, B. B., Huo, B., and Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of operations management*, 28(1):58–71.

Fryxell, G. E., Wing-Hung Lo, C., and Chung, S. S. (2004). Influence of motivations for seeking iso 14001 certification on perceptions of ems effectiveness in china. *Environmental Management*, 33:239–251.

Gharaei, A., Hoseini Shekarabi, S. A., Karimi, M., Pourjavad, E., and Amjadian, A. (2021). An integrated stochastic epq model under quality and green policies: generalised cross decomposition under the separability approach. *International Journal of Systems Science: Operations & Logistics*, 8(2):119–131.

Ghobadian, A., Viney, H., Liu, J., and James, P. (1998). Extending linear approaches to mapping corporate environmental behaviour. *Business strategy and the environment*, 7(1):13–23.

Guest, G., Bunce, A., and Johnson, L. (2006). How many interviews are enough? an experiment with data saturation and variability. *Field methods*, 18(1):59–82.

Harrison, J. S. and Freeman, R. E. (1999). Stakeholders, social responsibility, and performance: Empirical evidence and theoretical perspectives. *Academy of management Journal*, 42(5):479–485.

Hayes, K., Blashki, G., Wiseman, J., Burke, S., and Reifels, L. (2018). Climate change and mental health: risks, impacts and priority actions. *International journal of mental health systems*, 12(1):1–12.

Healy, M. and Perry, C. (2000). Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. *Qualitative market research: An international journal*, 3(3):118–126.

Hipps, J. A. (1993). Trustworthiness and authenticity: Alternate ways to judge authentic assessments.

Jansen, H. et al. (2010). The logic of qualitative survey research and its position in the field of social research methods. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, volume 11.

Johnson, C. J. and Anglin, J. M. (1995). Qualitative developments in the content and form of children's definitions. *Journal of speech, language, and hearing research*, 38(3):612–629.

Juntunen, J. K., Halme, M., Korsunova, A., and Rajala, R. (2019). Strategies for integrating stakeholders into sustainability innovation: a configurational perspective. *Journal of Product Innovation Management*, 36(3):331–355.

Kainuma, Y. and Tawara, N. (2006). A multiple attribute utility theory approach to lean and green supply chain management. *International Journal of Production Economics*, 101(1):99–108.

Lahane, S. and Kant, R. (2021). Evaluating the circular supply chain implementation barriers using pythagorean fuzzy ahp-dematel approach. *Cleaner Logistics and Supply Chain*, 2:100014.

Lambert, D. M., Cooper, M. C., and Pagh, J. D. (1998). Supply chain management: implementation issues and research opportunities. *The international journal of logistics management*, 9(2):1–20.

Li, G., Yang, H., Sun, L., and Sohal, A. S. (2009). The impact of it implementation on supply chain integration and performance. *International journal of production economics*, 120(1):125–138.

Lincoln, Y. S. and Guba, E. G. (1985). *Naturalistic inquiry*. sage.

Linton, J. D., Klassen, R., and Jayaraman, V. (2007). Sustainable supply chains: An introduction. *Journal of operations management*, 25(6):1075–1082.

Lu, L. Y., Wu, C., and Kuo, T.-C. (2007). Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis. *International journal of production research*, 45(18-19):4317–4331.

Mathison, S. (1988). Why triangulate? *Educational researcher*, 17(2):13–17.

Maxwell, J. (1992). Understanding and validity in qualitative research. *Harvard educational review*, 62(3):279–301.

Miles, M. B. and Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. sage.

Min, H. and Galle, W. P. (2001). Green purchasing practices of us firms. *International journal of operations & production management*, 21(9):1222–1238.

Min, H. and Zhou, G. (2002). Supply chain modeling: past, present and future. *Computers & industrial engineering*, 43(1-2):231–249.

Mohanty, R. and Prakash, A. (2014). Green supply chain management practices in india: an empirical study. *Production Planning & Control*, 25(16):1322–1337.

Muduli, K., Govindan, K., Barve, A., and Geng, Y. (2013). Barriers to green supply chain management in indian mining industries: a graph theoretic approach. *Journal of Cleaner Production*, 47:335–344.

Nawrocka, D., Brorson, T., and Lindhqvist, T. (2009). Iso 14001 in environmental supply chain practices. *Journal of Cleaner Production*, 17(16):1435–1443.

Ninlawan, K., O'Hara, S. P., Splinter, P. L., Yongvanit, P., Kaewkes, S., Surapaitoon, A., LaRusso, N. F., and Sripa, B. (2010). Opisthorchis viverrini excretory/secretory products induce toll-like receptor 4 upregulation and production of interleukin 6 and 8 in cholangiocyte. *Parasitology international*, 59(4):616–621.

Patton, A. J. (2001). Modelling time-varying exchange rate dependence using the conditional copula.

Paulraj, A. (2009). Environmental motivations: a classification scheme and its impact on environmental strategies and practices. *Business strategy and the Environment*, 18(7):453–468.

Peano, C., Girgenti, V., Baudino, C., and Giuggioli, N. R. (2017). Blueberry supply chain in italy: Management, innovation and sustainability. *Sustainability*, 9(2):261.

Perry, C. (1998). Processes of a case study methodology for postgraduate research in marketing. *European journal of marketing*, 32(9/10):785–802.

Piyathanavong, V., Garza-Reyes, J. A., Kumar, V., Maldonado-Guzmán, G., and Mangla, S. K. (2019). The adoption of operational environmental sustainability approaches in the thai manufacturing sector. *Journal of Cleaner Production*, 220:507–528.

Pochampally, K. K., Gupta, S. M., and Govindan, K. (2009). Metrics for performance measurement of a reverse/closed-loop supply chain. *International Journal of Business Performance and Supply Chain Modelling*, 1(1):8–32.

Rao, P. and Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International journal of operations & production management*, 25(9):898–916.

Reader, T. W. and O'Connor, P. (2014). The deepwater horizon explosion: non-technical skills, safety culture, and system complexity. *Journal of Risk Research*, 17(3):405–424.

Ritchie, J., Lewis, J., Nicholls, C. M., Ormston, R., et al. (2013). *Qualitative research practice: A guide for social science students and researchers*. sage.

Rosenzweig, P. M. and Singh, J. V. (1991). Organizational environments and the multinational enterprise. *Academy of Management review*, 16(2):340–361.

Rowley, J. (2002). Using case studies in research. *Management research news*, 25(1):16–27.

Rozas, L. W. and Klein, W. C. (2010). The value and purpose of the traditional qualitative literature review. *Journal of evidence-based social work*, 7(5):387–399.

Saunders, M. N. and Townsend, K. (2016). Reporting and justifying the number of interview participants in organization and workplace research. *British Journal of Management*, 27(4):836–852.

Seuring, S. and Gold, S. (2013). Sustainability management beyond corporate boundaries: from stakeholders to performance. *Journal of cleaner production*, 56:1–6.

Seuring, S. and Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production*, 16(15):1699–1710.

Shao, J., Taisch, M., and Ortega-Mier, M. (2016). A grey-decision-making trial and evaluation laboratory (dematel) analysis on the barriers between environmentally friendly products and consumers: practitioners' viewpoints on the european automobile industry. *Journal of Cleaner Production*, 112:3185–3194.

Shaukat, M. Z., Saleem, M., Mirza, M. U. A., Basit, A., and Niazi, A. A. K. (2023). Using interpretive structural modelling (ism) to impose hierarchy on critical issues of contractual bargaining: A study of construction industry of pakistan. *Journal of Policy Research*, 9(3):69–84.

Srivastava, S. K. (2007). Green supply-chain management: a state-of-the-art literature review. *International journal of management reviews*, 9(1):53–80.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management decision*, 39(7):551–556.

Sushil (2017). Modified ism/tism process with simultaneous transitivity checks for reducing direct pair comparisons. *Global Journal of Flexible Systems Management*, 18(4):331–351.

Tashakkori, A. and Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioural sciences: Us perspective. *International journal of social research methodology*, 6(1):61–77.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection.

Tsoulfas, G. T. and Pappis, C. P. (2006). Environmental principles applicable to supply chains design and operation. *Journal of Cleaner production*, 14(18):1593–1602.

Vachon, S. and Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International journal of production economics*, 111(2):299–315.

Wiersum, K. F. (1995). 200 years of sustainability in forestry: lessons from history. *Environmental management*, 19:321–329.

Wong, C. W., Lai, K.-H., and Cheng, T. (2009). Complementarities and alignment of information systems management and supply chain management. *International Journal of Shipping and Transport Logistics*, 1(2):156–171.

Wong, C. Y. and Boon-Itt, S. (2008). The influence of institutional norms and environmental uncertainty on supply chain integration in the thai automotive industry. *International Journal of Production Economics*, 115(2):400–410.

Wu, G.-C., Ding, J.-H., and Chen, P.-S. (2012). The effects of gscm drivers and institutional pressures on gscm practices in taiwan's textile and apparel industry. *International Journal of Production Economics*, 135(2):618–636.

Yang, X., Moore, P., Pu, J.-S., and Wong, C.-B. (2009). A practical methodology for realizing product service systems for consumer products. *Computers & Industrial Engineering*, 56(1):224–235.

Yin, R. K. (2003). Designing case studies. *Qualitative research methods*, 5(14):359–386.

Zhu, Q., Sarkis, J., and Lai, K.-h. (2007). Green supply chain management: pressures, practices and performance within the chinese automobile industry. *Journal of cleaner production*, 15(11-12):1041–1052.

Zhu, Q., Sarkis, J., and Lai, K.-h. (2008). Confirmation of a measurement model for green supply chain management practices implementation. *International journal of production economics*, 111(2):261–273.

Zhu, Q., Sarkis, J., and Lai, K.-h. (2013). Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management*, 19(2):106–117.

Appendix A

Data collection and questionnaire for interview

- **Procedure for a structured interview**

  The primary objective of this framework is to enhance the facilitation of research about the impact of green supply chain management (GSCM) strategies on supply chain efficiency. The adoption of Green Supply Chain Management (GSCM) as an organisational concept has emerged to mitigate environmental risks and effects while enhancing ecological efficiency. This approach helps firms and their partners to create corporate profit and increase their market share.

- **Firm characterization**

  1. Sector.
  2. Number of employees.
  3. Primary product(s).
  4. Primary customer activity(ies).
  5. Your job title.
  6. Your job responsibilities.
  7. Your firm's position in the supply chain.

- **Green practices**

  1. Interaction with suppliers on environmental sustainability.
  2. Environmentally conscious purchasing habits.
  3. Collaborating with designers and suppliers to minimise and eventually eliminate the environmental effect of a product.
  4. Reducing waste.

5. Decreasing the consumption of hazardous and toxic materials
6. ISO 14001 certification.
7. Reverse logistics.
8. Engagement with customers on environmental issues.
9. Environmentally friendly packaging.
10. Collaborating with clients to modify product characteristics.
11. Others. Please specify.

- **Supply chain performance measures**

  1. Quality.
  2. Customer satisfaction.
  3. Cost.
  4. Efficiency.
  5. Environmental cost.
  6. Business waste.
  7. Others. Please specify.

  Please indicate which are implemented in your firm and the extent of implementation.

- **Effect of green practices on supply chain performance** Please list the relationships you believe exist between green practices and performance measures, indicating whether they are positive or negative, and the corresponding intensity of the relationship, using a scale from 1 (no relationship) to 5 (strong relationship). A positive relationship exists when the practice increases supply chain performance measures, and a negative relationship exists when the method decreases supply chain performance measures.

- **Please describe the extent of the deployment of each in your Firm**

  1. Please respond based on your knowledge of greening your supply chain:
  2. How conversations with suppliers about environmental sustainability affect product quality.
  3. How environmentally responsible buying methods affect the quality of products.

4. Working with designers and suppliers to decrease and remove a product's environmental impact and effect on product quality.
5. How reducing waste impacts the quality of the product.
6. How attaining ISO 14001 certification affects the quality of the product.
7. How does limiting the use of toxic and hazardous items affect product quality?
8. What influence reverse logistics have on product quality (RLgs)
9. How customer engagement in environmental issues affects the quality of the product.
10. How modifying product features in collaboration with consumers affects product quality.
11. How negotiations with suppliers about environmental sustainability affect the product's price.
12. How the price of a product is affected by eco-friendly buying behaviour.
13. Working with designers and suppliers to decrease and remove a product's environmental effect affects its price.
14. How lowered waste impacts the product's price.
15. How attaining ISO 14001 certification influences the price of the goods.
16. How lowering the use of dangerous items impacts product costs.
17. What influence reverse logistics have on product pricing (RLgs)
18. How client participation in environmental issues impacts the product's price.
19. How modifying product features in collaboration with consumers affect product pricing.
20. How conversations with suppliers on environmental sustainability affect consumer satisfaction.
21. How environmentally responsible buying methods affect consumer happiness.
22. Working with designers and suppliers to decrease and eliminate a product's environmental effects impacts consumer happiness.

23. How waste reduction impacts consumer happiness.
24. How attaining ISO 14001 certification influences customer satisfaction.
25. How limiting the use of hazardous and destructive items impacts customer happiness.
26. The influence of reverse logistics on customer satisfaction (RLgs)
27. How customer participation in environmental issues influences customer happiness.
28. How collaborating with consumers to modify product features influences customer happiness.
29. How conversations with suppliers about environmental sustainability affect efficiency.
30. What effect do environmentally responsible buying habits have on efficiency?
31. Working with designers and suppliers to decrease and remove a product's environmental effect impacts its efficiency.
32. How the reduction of waste impacts efficiency.
33. How obtaining ISO 14001 certification affects the efficiency of a business.
34. How limiting the use of toxic and hazardous items impacts efficiency.
35. What influence reverse logistics has on efficiency (RLgs)
36. What effect does customer engagement in environmental issues have on efficiency?
37. How does working with consumers to modify product features affect efficiency?
38. Environmental sustainability conversations with suppliers and their effect on the business's trash.
39. How environmentally responsible buying habits affect the garbage produced by businesses.
40. Working with designers and suppliers to decrease and eliminate a product's environmental effect on corporate waste.
41. How a reduction in waste impacts Firm waste.
42. How getting ISO 14001 certification affects the trash produced by a firm.

43. The effect of limiting the use of toxic and hazardous items on corporate waste.
44. What influence reverse logistics have on corporate waste and why (rugs)
45. How consumer engagement in environmental issues affects the business's waste management.
46. The effects of collaborating with customers to modify product features on corporate waste.

- **Supply chain performance measures**

  Which of the following supply chain performance metrics, in your opinion, best captures the impact of green supply chain management strategies?

  1. Quality(QA)
  2. Customer satisfaction(CS)
  3. Cost.
  4. Efficiency(EFF)
  5. Environmental Cost(ENC)
  6. Business waste(BWS)
  7. Others. Please specify.

  Please indicate which are implemented in your Firm and the extent of implementation.

- **Effect of green practices on supply chain performance**

  Kindly enumerate the correlations that you see to exist between green practices and performance indicators, specifying their positive or negative nature, as well as the associated severity of each relationship. Please use a scale ranging from 1 (showing no relationship) to 5 (representing a high association). A positive correlation is seen when implementing a particular practice, which leads to improving supply chain performance measures. In contrast, a negative correlation is shown when implementing the practice, which results in a decline in supply chain performance measures.

Performance	Quality		Environmental Cost		Cost		Business waste		Customer satisfaction		Efficiency	
Practices	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC
ISO 14001 Certification Reducing waste												
Environmentally friendly purchasing practices												
Decreased consumption of hazardous and toxic materials												
Environmental collaboration with customers												
Reverse logistics												
Working with designers and suppliers to reduce and eliminate product environmental impact												
Environmentally friendly packaging												
Environmental collaboration with suppliers												

Table A.1: Effect of green practices on supply chain performance

Appendix B

List of Publications

1. Kumar, M., & Joji, R. T. (2023). Study of the interplay among internal and external barriers to GSCM in the Indian leather industry using the total ISM and MICMAC methodology. Cogent Business & Management, 10(2), 2234697.

2. Kumar, M., & Rao, T. J. (2023). Use of TISM and MICMAC methods to assess the influence of behavioral factors on the employment of GSCM in the Indian leather industry. MethodsX, 10, 102164.

3. Mittal ,A.,Kumar, M., & Rao, T. J. (2024). A Mathematical Correlation between Green Supply Chain Management Practices and Supply Chain Performance Variables: A Model of Cubical Regression. MethodsX,(Accepted).

ManojSirPhD_Library_31_Jul_24.pdf

ORIGINALITY REPORT

9%	7%	7%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

3%

★ Azevedo, S.G.. "The influence of green practices on supply chain performance: A case study approach", Transportation Research Part E, 201111

Publication

Exclude quotes	On	Exclude matches	< 14 words
Exclude bibliography	On		