

**SELECT STUDY ON DECISION MAKING FOR INTEGRATED
LOGISTICS IN SUSTAINABLE SUPPLY CHAINS**

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**DEPARTMENT OF MANAGEMENT STUDIES
INDIAN INSTITUTE OF TECHNOLOGY DELHI
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LOGISTICS IN SUSTAINABLE SUPPLY CHAINS**

By

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*This thesis is dedicated in the memory
of my beloved Father
Rabi Narayan Mohanty*

CERTIFICATE

This is to certify that the thesis entitled “**Select Study on Decision Making for Integrated Logistics in Sustainable Supply Chains.**” being submitted by **Mahamaya Mohanty** to the Department of Management Studies, Indian Institute of Technology Delhi for the award of degree of **Doctor of Philosophy** is a bonafide record of original research work carried out by her. She has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the requisite standard for Ph.D. degree of this institute. The results presented in this thesis have not been submitted to any other university or institute for the award of any Degree or Diploma.

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Mahamaya Mohanty

ABSTRACT

In recent years, most organizations have complex distribution networks of supply chain due to global sourcing, production outsourcing, and serving customers all over the globe. These supply chain logistics networks are linked by various activities with several facilities which give rise to many emerging challenges. One of the challenges includes establishing sustainability at various stages of multi-echelon supply chain to be sustainable. This requires various decisions to be taken at different planning levels, facility locations, warehousing, inventory management, and transportation. In such systems, supply chain members need to focus on the efficient management and coordination of inventory flow and information flow between different points of integration in an end to end supply chain. Each of the decisions plays a significant role in the overall performance of supply chain. However, these decisions helps in emphasizing the importance of integrating the decisions involved in the supply chains. In the above context, transportation and warehousing decisions are considered jointly for the distribution network design to produce more efficient results for the whole multi-echelon supply chain. The importance of integrating logistics elements is not well recognized so far in the literature and practising world of the supply chain due to the fact at certain point of time logistics of supply chain lags behind its performance level. The benefits of integrating the logistics elements may not be realized due to the independent decision-making of each entity in the outbound logistics. Due to this fact entities involved in supply chain have to enhance their level of decision making capabilities and information sharing by collaboration and coordination among themselves. Some of the previous solution approaches were used to solve the difficult problem of integration due to dynamic environment with multiple objectives. However, these are insufficient to cope with the inability to handle the complex interactions between the supply chain members and to represent the stochastic behaviours existing in many real world problems. Hence, the integrated decisions of the entities involved would increase the overall sustainability performance.

Today, various companies are also recognizing the environmental management as a key strategic issue having a massive impact on organizational performance. The goal of sustainability is to establish an interaction among economy, ecology, and societal related factors. Sustainability is mapped to various supply chain drivers such as facilities, inventory, transportation, sourcing information and pricing with a goal for every firm to measure their triple bottom line with four categories of sustainability such as energy consumption, water consumption, emission of Greenhouse Gases (GHGs), and waste generation.

In response to the aforementioned challenges, one of the primary objectives of this research work is to propose various models and solution method for an integrated supply chain that takes into account the decisions required at the different levels of planning horizon and model an integrated logistics for sustainable supply chain. Due to the complexities of multi-echelon system and the underlying uncertainty, inventories across the supply chain have become a major challenge to reduce the cost and to meet the service requirement of the end customers.

Sustainability positively impacts the environment thus creating value and competitive advantages for companies. The multi-dimensional challenges adversely affect the fragile ecosystem and environment due to increased consumption of natural resources by increasing population and rapid growth of industrialization, who consumes rapidly on natural resources which results in reduced availability of resources. This has given rise to various mismatches in demand-supply which is an important factor of uncertainty.

A comprehensive, structured, and systematic overview of sustainability for an integrated logistics is carried out in this research by development measures, application measures, and modeling approaches. From an extensive literature, the findings of this research reveal that whilst there have been a handful of studies done on integrated logistics, not much has been done with respect to establishment of sustainability in integrated logistics. Thereafter, promising research gaps are identified and research questions along with four objectives were developed to meet the requirements of an organization. The research gaps are: (i) lack of transactional mechanisms that would reduce uncertainties in logistical coordination and increases the availability of information for responsive organizational actions (ii) the concepts and techniques that should be opted by various actors at different level of an integrated logistics system need to be explored (iii) there is lack of integrated operations at various point of integration in an outbound logistics system for achieving sustainability (iv) several studies have identified different indicators of sustainability, but little attention has been given to formulate the performance measurement of integrated logistics. In order to render complete and pragmatic characterization of the integrated logistics effects on sustainability, the evaluation of sustainability measures need to be examined at each level to cater the actual phenomenon and the implementation strategies. Further, the numerical computations were analyzed considering sustainable supply chain performance measures, which help the logistics professionals in scenario generation. Finally, these scenarios answer the initial research questions that what could be the management approach towards integrated logistics for sustainable supply chain of consumer durables. Further, the initial research question is reproduced as (i) what is the need for integration in an outbound logistics system and how sustainability can be attained through

integration? (ii) what are the enablers that motivate logistics system to adopt integration and sustainability and how the performance measures can be modelled for these enablers to adopt sustainability? (iii) how the 3PLSPs can benchmarked based on their outsourcing characteristics and the role of manufacturers can be analyzed to reduce emissions by modelling the demands for various consumer durables? (iv) how to improve operational efficiency and reduce negative externalities between the retailers and customers so as to remain competitive?. These questions help us to derive numerous managerial insights to facilitate logistics professionals and practitioners to use appropriate methodologies and evaluation techniques for their various business operations.

The research question is addressed by four research objectives. From the contemporary literature the research objectives have focused on exploratory study, analytical study and quantitative study for integration and sustainability of outbound logistics of supply chain. The need of integrated logistics system for consumer durables is outlined using soft system methodology (SSM). A questionnaire-based survey has been conducted among logistics service providers, manufacturers and supply chain managers to explore the sustainability practices and to test various hypotheses with different statistical analyses. Among 180 responses, 169 responses were found to be suitable for further analysis having no missing values. The study found an overall response rate of 41.8 percent. Further, a conceptual framework for sustainable integrated logistics is developed.

An extensive literature review has been conducted a) to identify research gaps and relevant issues with integrated logistics for achieving sustainability, b) to list down the enablers, and c) to study the role of manufacturers in the integrated logistics of supply chain. Inter-relationship between various enablers is analyzed using Fuzzy Total Interpretive Structural Modelling (Fuzzy-TISM). Further, a holistic hierarchical model is proposed to assess the performance of the identified enablers that enables integration and sustainability in the logistics system. This hierarchical model is developed by a systematic approach that includes fuzzy analytical hierarchy process (FAHP), an evidential reasoning algorithm (ERA), and expected utility theory (EUT). DEA-ADALINE is carried out to benchmark the third party logistics service providers. This approach attempts to extend the conventional Data Envelopment Analysis (DEA) models to Data Envelopment Analysis-Adaptive Linear Network (DEA-ADALINE) model-based algorithm which is a comprehensive way to benchmark the third party logistics service providers (3PLSPs). The developed model helps in improving the efficiency of decision-making units (DMUs) that are relatively inefficient in a set of 3PLSPs considered for

this study. Further, the role of manufacturer is analyzed and modelled mathematically in a deterministic environment. Lastly, clustering method based on Kohonen Self-Organizing Map (KSOM) is opted to model the operational efficiency of outbound retail logistics considering retailers and consumers. Here, the developed model demonstrates economic and environment benefits that are achieved in terms of reduced delivery time, transportation cost and carbon emissions.

Overall, the research work represents the integration of operations for outbound logistics includes identification of enablers, development of hierarchical model, benchmarking of 3PL, analyzing the role of manufacturers, and finally clustering the retailers and customers. The proposed models are associated with various costs, delivery time, carbon emissions, and transportation activities by measuring the economical, operational, and environmental performances in the outbound logistics. The models developed in this research work would help managers to handle the conflicting goals such as reducing the product's cost and time-to-market as well as increasing its availability. This study provide relevant guidelines to managers, policy makers, government, academicians, decision-makers, manufacturers, third party logistics service providers, retailers, and end-customers at operational level to address various issues related to sustainability in their business arena.

सार

हाल के वर्षों में, अधिकांश संगठनों के पास वैश्विक सोर्सिंग, उत्पादन आउटसोर्सिंग और दुनिया भर में ग्राहकों की सेवा करने के कारण आपूर्ति श्रृंखला के जटिल वितरण नेटवर्क हैं। ये आपूर्ति श्रृंखला रसद नेटवर्क कई गतिविधियों के साथ कई सुविधाओं से जुड़े हुए हैं जो कई उभरती चुनौतियों को जन्म देते हैं। चुनौतियों में से एक टिकाऊ होने के लिए मल्टी-ईक्लोन आपूर्ति श्रृंखला के विभिन्न चरणों में स्थिरता स्थापित करना शामिल है। इसके लिए विभिन्न नियोजन स्तरों, सुविधा स्थानों, वेयरहाउसिंग, इन्वेंट्री प्रबंधन और परिवहन में विभिन्न निर्णय लेने की आवश्यकता होती है। ऐसी प्रणालियों में, आपूर्ति श्रृंखला के सदस्यों को आपूर्ति श्रृंखला के अंत में एकीकरण के विभिन्न बिंदुओं के बीच इन्वेंट्री प्रवाह और सूचना प्रवाह के कुशल प्रबंधन और समन्वय पर ध्यान देने की आवश्यकता होती है। आपूर्ति श्रृंखला के समग्र प्रदर्शन में प्रत्येक निर्णय महत्वपूर्ण भूमिका निभाता है। हालांकि, ये निर्णय आपूर्ति श्रृंखलाओं में शामिल निर्णयों को एकीकृत करने के महत्व पर जोर देने में मदद करते हैं। उपरोक्त संदर्भ में, वितरण नेटवर्क डिजाइन के लिए संयुक्त रूप से परिवहन और वेयरहाउसिंग निर्णयों पर विचार किया जाता है, ताकि पूरे मल्टी-ईक्लोन आपूर्ति श्रृंखला के लिए अधिक कुशल परिणाम मिल सकें। रसद तत्वों को एकीकृत करने के महत्व को साहित्य में अब तक अच्छी तरह से मान्यता प्राप्त नहीं है और आपूर्ति श्रृंखला की दुनिया के अभ्यास के कारण कुछ समय में आपूर्ति श्रृंखला के रसद के अपने प्रदर्शन स्तर से पीछे है। लॉजिस्टिक्स तत्वों को एकीकृत करने के लाभों को आउटबाउंड लॉजिस्टिक्स में प्रत्येक इकाई के स्वतंत्र निर्णय लेने के कारण महसूस नहीं किया जा सकता है। इस तथ्य के कारण आपूर्ति श्रृंखला में शामिल संस्थाओं को निर्णय लेने की क्षमताओं के स्तर को बढ़ाना है और आपस में सहयोग और समन्वय द्वारा जानकारी साझा करना है। पिछले समाधान के कुछ तरीकों का उपयोग कई उद्देश्यों के साथ गतिशील वातावरण के कारण एकीकरण की कठिन समस्या को हल करने के लिए किया गया था। हालांकि, ये आपूर्ति श्रृंखला के सदस्यों के बीच जटिल बातचीत को संभालने और कई वास्तविक दुनिया की समस्याओं में मौजूद स्टोकेस्टिक व्यवहारों का प्रतिनिधित्व करने में असमर्थता के साथ सामना करने के लिए अपर्याप्त हैं। इसलिए, शामिल संस्थाओं के एकीकृत निर्णय समग्र स्थिरता प्रदर्शन को बढ़ाएंगे।

आज, विभिन्न कंपनियां पर्यावरण प्रबंधन को एक महत्वपूर्ण रणनीतिक मुद्दे के रूप में मान्यता दे रही हैं, जो संगठनात्मक प्रदर्शन पर व्यापक प्रभाव डालती है। स्थिरता का लक्ष्य अर्थव्यवस्था, पारिस्थितिकी और सामाजिक संबंधित कारकों के बीच बातचीत स्थापित करना है। सस्टेनेबिलिटी को विभिन्न सप्लाय चैन ड्राइवर्स जैसे कि इन्वेंट्री, ट्रांसपोर्टेशन, सोर्सिंग इंफॉर्मेशन और प्राइसिंग के लिए मैप किया जाता है, जिसमें एक लक्ष्य के साथ हर फर्म के लिए अपनी ट्रिपल बॉटम लाइन को मापने के लिए चार कैटेगरी

होती हैं जैसे कि सस्टेनेबिलिटी, इनर्जी की खपत, पानी की खपत, ग्रीनहाउस गैसों का उत्सर्जन। जीएचजी), और अपशिष्ट पीढ़ी। उपर्युक्त चुनौतियों के जवाब में, इस शोध कार्य के प्राथमिक उद्देश्यों में से एक एकीकृत आपूर्ति श्रृंखला के लिए विभिन्न मॉडलों और समाधान पद्धति का प्रस्ताव करना है जो क्षितिज के नियोजन के विभिन्न स्तरों पर आवश्यक निर्णयों को ध्यान में रखता है और टिकाऊ के लिए एक एकीकृत रसद मॉडल करता है। आपूर्ति श्रृंखला। मल्टी-इकोलोन प्रणाली की जटिलताओं और अंतर्निहित अनिश्चितता के कारण, आपूर्ति श्रृंखला में आविष्कार लागत को कम करने और अंतिम ग्राहकों की सेवा आवश्यकता को पूरा करने के लिए एक बड़ी चुनौती बन गए हैं। स्थिरता पर्यावरण को सकारात्मक रूप से प्रभावित करती है और इस प्रकार कंपनियों के लिए मूल्य और प्रतिस्पर्धी लाभ पैदा करती है। बहु-आयामी चुनौतियाँ बढ़ती जनसंख्या और औद्योगीकरण की तीव्र वृद्धि से प्राकृतिक संसाधनों की बढ़ती खपत के कारण नाजुक पारिस्थितिकी तंत्र और पर्यावरण पर प्रतिकूल प्रभाव डालती हैं, जो प्राकृतिक संसाधनों पर तेजी से खपत करते हैं जिसके परिणामस्वरूप संसाधनों की उपलब्धता कम हो जाती है। इसने मांग-आपूर्ति में विभिन्न बेमेल को जन्म दिया है जो अनिश्चितता का एक महत्वपूर्ण कारक है।

एक एकीकृत रसद के लिए स्थिरता का एक व्यापक, संरचित और व्यवस्थित अवलोकन इस शोध में विकास के उपायों, आवेदन उपायों और मॉडलिंग दृष्टिकोणों द्वारा किया जाता है। एक व्यापक साहित्य से, इस शोध के निष्कर्षों से पता चलता है कि जब तक एकीकृत लॉजिस्टिक्स पर कुछ अध्ययन किए गए हैं, तब तक एकीकृत लॉजिस्टिक्स में स्थिरता की स्थापना के संबंध में बहुत कुछ नहीं किया गया है। इसके बाद, होनहार अनुसंधान अंतराल की पहचान की जाती है और एक संगठन की आवश्यकताओं को पूरा करने के लिए चार उद्देश्यों के साथ शोध प्रश्न विकसित किए गए थे। अनुसंधान अंतराल इस प्रकार हैं: (i) ट्रांसेक्शनल तंत्र की कमी है जो लॉजिस्टिक समन्वय में अनिश्चितताओं को कम करेगा और उत्तरदायी संगठनात्मक क्रियाओं (ii) के लिए सूचना की उपलब्धता को बढ़ाता है जो एक एकीकृत रसद के विभिन्न स्तरों पर विभिन्न अभिनेताओं द्वारा चुना जाना चाहिए। प्रणाली की खोज करने की आवश्यकता है (iii) स्थिरता को प्राप्त करने के लिए एक आउटबाउंड लॉजिस्टिक्स प्रणाली में एकीकरण के विभिन्न बिंदुओं पर एकीकृत संचालन की कमी है (iv) कई अध्ययनों ने स्थिरता के विभिन्न संकेतकों की पहचान की है, लेकिन प्रदर्शन माप को तैयार करने के लिए बहुत कम ध्यान दिया गया है एकीकृत रसद की। स्थिरता पर एकीकृत रसद प्रभावों के पूर्ण और व्यावहारिक लक्षण वर्णन को प्रस्तुत करने के लिए, वास्तविक घटना और कार्यान्वयन रणनीतियों को पूरा करने के लिए प्रत्येक स्तर पर स्थिरता उपायों के मूल्यांकन की आवश्यकता है। इसके अलावा, टिकाऊ आपूर्ति श्रृंखला प्रदर्शन उपायों पर विचार करते हुए संख्यात्मक अभिकलनों का विश्लेषण किया गया, जो कि परिदृश्य निर्माण में रसद

पेशेवरों की मदद करते हैं। अंत में, ये परिदृश्य प्रारंभिक शोध प्रश्नों का उत्तर देते हैं कि उपभोक्ता टिकाऊ वस्तुओं की स्थायी आपूर्ति श्रृंखला के लिए एकीकृत रसद के लिए प्रबंधन दृष्टिकोण क्या हो सकता है। इसके अलावा, प्रारंभिक अनुसंधान प्रश्न के रूप में पुनः पेश किया जाता है (i) आउटबाउंड लॉजिस्टिक्स सिस्टम में एकीकरण की क्या आवश्यकता है और एकीकरण के माध्यम से स्थिरता कैसे प्राप्त की जा सकती है? (ii) रसद और एकीकरण को अपनाने के लिए लॉजिस्टिक्स सिस्टम को प्रेरित करने वाले एनाब्लर्स क्या हैं और इन एनाब्लर्स को स्थिरता को अपनाने के लिए प्रदर्शन के उपायों को कैसे तैयार किया जा सकता है? (iii) कैसे थर्ड पार्टी लॉजिस्टिक्स सर्विस प्रोवाइडर्स उनकी आउटसोर्सिंग विशेषताओं के आधार पर बेंचमार्क किए जा सकते हैं और विभिन्न उपभोक्ता टिकाऊ वस्तुओं की मांग को मॉडलिंग करके उत्सर्जन को कम करने के लिए निर्माताओं की भूमिका का विश्लेषण किया जा सकता है? (iv) परिचालन दक्षता में सुधार और खुदरा विक्रेताओं और ग्राहकों के बीच नकारात्मक बाहरीताओं को कम करने के लिए ताकि प्रतिस्पर्धी बने रहें। इन सवालों से हमें अपने विभिन्न व्यवसाय के लिए उपयुक्त कार्यप्रणाली और मूल्यांकन तकनीकों का उपयोग करने के लिए रसद पेशेवरों और चिकित्सकों की सुविधा के लिए कई प्रबंधकीय अंतर्दृष्टि प्राप्त करने में मदद मिलती है। संचालन।

शोध प्रश्न को चार शोध उद्देश्यों से संबोधित किया जाता है। समकालीन साहित्य से अनुसंधान उद्देश्यों ने आपूर्ति श्रृंखला के आउटबाउंड रसद के एकीकरण और स्थिरता के लिए खोजपूर्ण अध्ययन, विश्लेषणात्मक अध्ययन और मात्रात्मक अध्ययन पर ध्यान केंद्रित किया है। सॉफ्ट सिस्टम पद्धति का उपयोग करके उपभोक्ता टिकाऊ वस्तुओं के लिए एकीकृत लॉजिस्टिक्स प्रणाली की आवश्यकता को रेखांकित किया गया है। स्थिरता प्रथाओं का पता लगाने और विभिन्न सांख्यिकीय विश्लेषणों के साथ विभिन्न परिकल्पनाओं का परीक्षण करने के लिए रसद सेवा प्रदाताओं, निर्माताओं और आपूर्ति श्रृंखला प्रबंधकों के बीच एक प्रश्नावली-आधारित सर्वेक्षण आयोजित किया गया है। 180 प्रतिक्रियाओं के बीच, 169 प्रतिक्रियाओं को आगे के विश्लेषण के लिए उपयुक्त पाया गया, जिसमें कोई लापता मूल्य नहीं था। अध्ययन में 41.8 प्रतिशत की समग्र प्रतिक्रिया दर मिली। इसके अलावा, टिकाऊ एकीकृत रसद के लिए एक वैचारिक रूपरेखा विकसित की गई है।

आपूर्ति श्रृंखला के एकीकृत लॉजिस्टिक्स में निर्माताओं की भूमिका का अध्ययन करने के लिए एम्बलर्स को नीचे सूचीबद्ध करने के लिए अनुसंधान गैप्स और स्थिरता प्राप्त करने के लिए एकीकृत लॉजिस्टिक्स के साथ प्रासंगिक गैप्स और संबंधित मुद्दों की पहचान करने के लिए एक व्यापक साहित्य समीक्षा) का आयोजन किया गया है। विभिन्न समर्थक के बीच अंतर-संबंध का विश्लेषण फजी कुल व्याख्या संरचनात्मक मॉडलिंग का उपयोग करके किया जाता है। इसके अलावा, एक समग्र श्रेणीबद्ध मॉडल को पहचानने वाले समर्थक के प्रदर्शन का आकलन करने का प्रस्ताव है जो रसद प्रणाली में एकीकरण

और स्थिरता को सक्षम बनाता है। यह पदानुक्रमित मॉडल एक व्यवस्थित दृष्टिकोण द्वारा विकसित किया गया है जिसमें फजी विश्लेषणात्मक पदानुक्रम प्रक्रिया, एक साक्ष्य तर्क एल्गोरिथ्म, और अपेक्षित उपयोगिता सिद्धांत शामिल हैं। डीईए-अडेप्टिव लीनियर नेटवर्क को थर्ड पार्टी लॉजिस्टिक्स सर्विस प्रोवाइडर्स को बेंचमार्क करने के लिए किया जाता है। यह दृष्टिकोण पारंपरिक डेटा एनवलपमेंट एनालिसिस (डीईए) मॉडल को डेटा एनवलपमेंट एनालिसिस-अडेप्टिव लीनियर नेटवर्क मॉडल-आधारित एल्गोरिथ्म का विस्तार करने का प्रयास करता है जो कि थर्ड पार्टी लॉजिस्टिक्स सर्विस प्रोवाइडर्स को बेंचमार्क करने का एक व्यापक तरीका है। विकसित मॉडल निर्णय लेने वाली इकाइयों (डीएमयू) की दक्षता में सुधार करने में मदद करता है जो इस अध्ययन के लिए विचार किए गए थर्ड पार्टी लॉजिस्टिक्स सर्विस प्रोवाइडर्स के एक सेट में अपेक्षाकृत अक्षम हैं। इसके अलावा, निर्माता की भूमिका का विश्लेषण किया जाता है और एक निर्धारित वातावरण में गणितीय रूप से मॉडलिंग की जाती है। अंत में, कोहेनन सेल्फ-आर्गेनाइजिंग मैप (केएसओएम) पर आधारित क्लस्टरिंग विधि को खुदरा विक्रेताओं और उपभोक्ताओं को देखते हुए आउटबाउंड रिटेल लॉजिस्टिक्स की परिचालन दक्षता को मॉडल बनाने के लिए चुना गया है। यहां, विकसित मॉडल आर्थिक और पर्यावरण लाभों को प्रदर्शित करता है जो कम प्रसव के समय, परिवहन लागत और कार्बन उत्सर्जन के संदर्भ में प्राप्त होते हैं। कुल मिलाकर, शोध कार्य आउटबाउंड लॉजिस्टिक्स के लिए संचालन के एकीकरण का प्रतिनिधित्व करता है, जिसमें एनाब्लर्स की पहचान, पदानुक्रमित मॉडल का विकास, 3PL का मानदंड, निर्माताओं की भूमिका का विश्लेषण, और अंत में खुदरा विक्रेताओं और ग्राहकों को क्लस्टर करना शामिल है। प्रस्तावित मॉडल आउटबाउंड लॉजिस्टिक्स में किफायती, परिचालन और पर्यावरण प्रदर्शन को मापकर विभिन्न लागतों, डिलीवरी समय, कार्बन उत्सर्जन और परिवहन गतिविधियों से जुड़े हैं। इस शोध कार्य में विकसित किए गए मॉडल प्रबंधकों को उत्पाद की लागत और समय-दर-बाजार कम करने के साथ-साथ इसकी उपलब्धता बढ़ाने के लिए परस्पर विरोधी लक्ष्यों को संभालने में मदद करेंगे। यह अध्ययन प्रबंधकों, नीति निर्माताओं, सरकार, शिक्षाविदों, निर्णय-निर्माताओं, निर्माताओं, तीसरे पक्ष के लॉजिस्टिक्स सेवा प्रदाताओं, खुदरा विक्रेताओं और एंड-कस्टमर्स को अपने व्यावसायिक क्षेत्र में स्थिरता से संबंधित विभिन्न मुद्दों के समाधान के लिए प्रासंगिक दिशा-निर्देश प्रदान करता है।

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LIST OF ABBREVIATIONS

CSCMP	Council of Supply Chain Management Professionals
LM	Logistics Management
SCM	Supply Chain Management
GHGs	Greenhouse Gases
WMS	Warehouse Management System
TMS	Transportation Management System
DEA	Data Envelopment Analysis
ADALINE	Adaptive Linear Network
MINLP	Mixed Integer Non Linear Program
TISM	Total Interpretive Structural Modelling
FERA	Fuzzy Evidential Reasoning Algorithm
KSOM	Kohonen Self Organization Map
AHP	Analytical Hierarchy Process
SSM	Soft System Methodology
3PLSPs	Third Part Logistics Service Providers
3PLs	Third Party Logistics
DMUs	Decision Making Units
FAHP	Fuzzy Analytical Hierarchy Process
ERA	Evidential Reasoning Algorithm
EUT	Expected Utility Theory
MICMAC	Matriced Impact Croises Multiplication Applique
TBL	Triple Bottom Line
LCA	Life Cycle Analysis
GL	Green Logistics
GSCM	Green Supply Chain Management
EOL	End Of Life
IBEF	India Brand Equity Foundation
KPMG	Klynveld Peat Marwick Goerdeler
APS	Advanced Planning System
R&D	Research and Development
EMT	Ecological Modernization Theory

ILE	Integrated Logistic Elements
MS	Market Strategy
RD	Regulatory Decisions
CIP	Coordination and Information Processing
CS	Competitive Strategy
JIT	Just In Time
ECR	Efficient Consumer Response
QR	Quick Response
VMI	Vendor Managed Inventory
IT	Information Technology
SSIM	Structural Self Interaction Matrix
TFNs	Triangular Fuzzy Numbers
ISM	Interpretive Structural Modelling
CFCS	Converting Fuzzy data into Crisp Scores
SE	Sustainability Enablers
FST	Fuzzy Set Theory
CFA	Confirmatory Factor Analysis
SEM	Structural Equation Modelling
CCR	Charnes Cooper Rhodes
ANP	Analytical Neural Process
LR	Learning Rate
TC	Transportation Costs
OC	Operational Costs
TE	Total Emissions
VC	Vehicle Capacity
DE	Delivery Efficiency
CS	Customer Service
ANN	Artificial Neural Network
RMW	Raw Material Warehouses
FGW	Finished Goods Warehouses
IBLS	Integrated Business Logistics System
ECP	Economic Performance
ENP	Environmental Performance
OP	Operational Performance

TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
KMO	Kaiser-Meyer-Olkin
RIF	Research Information System
SWOT	Strengths Weakness Opportunities Threats
WEF	World Economic Forum
WBCSD	World Business Council for Sustainable Development