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RESEARCH ARTICLE

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UNDERSTANDING THE IMPORTANCE OF SUSTAINABILITY CONCEPTS IN PRINTING INDUSTRIES- A REVIEW

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ABSTRACT

Over the past two decades due to rapid technological changes a new business model has forced the printing industries to structural decline and the urge of sustainability has been increased. These changes have intensified the need for sustainability as a strategic imperative for the long-term survival of printing industries. In India, printing industries are progressively modernizing through investments in advanced printing technologies; however, many small and medium-scale printing firms remain inadequately digitalized, which adversely affects productivity, resource efficiency, and environmental performance. There is a growing need for integrating sustainable supply chain in Printing Industries. Supply chain is one of the modern productivity tools that encompasses all the facilities functions and activities in productivity and delivering the product. The need of implementing new model productivity tool is essential. This review paper examines the importance of sustainability concepts in the printing industry, with a specific focus on the role and benefits of implementing sustainable supply chain practices. The study synthesizes existing literature to highlight how sustainable supply chain integration can enhance productivity, reduce waste and emissions, improve resource utilization, and strengthen the overall competitiveness of printing industries.



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I. INTRODUCTION

Environmental management has become important concern for manufacturing Industries. In recent years, corporations attempt to move toward environmental sustainability concept in industries, management must take efforts to improve environmental practices across their supply chain. The development of environmental management within the supply chain has been slowly building[1] [2]. The pressure on manufacturing organizations to develop greener products has increased significantly over the last decade. Several manufacturing organizations have turned to their suppliers and customers to find innovative solutions to solve the environmental issues[3]. Sustainability has evolved from a global concept to being implemented at national, regional, and organizational levels. Enterprises are increasingly striving to address environmental and social challenges in order to achieve sustainable development. Consequently, there is a growing need for effective sustainability assessment and implementation tools [4]. Information and communication technology (ICT) tools is currently contributing to support firms in increasing the environmental sustainability of their production processes[5]. Sustainability is an organizing principle that is hinged on innovation. The importance of sustainable innovation management in sustainable supply chain management cannot be underestimated. Studies on sustainable supply chain management have emphasised the need for sustainable innovation in achieving sustainability[6]. Over the last 30 years, sustainability in supply chain has become one continues to increase yearly with the introduction of emerging topics, new modeling and theoretical of the most dynamic and prolific decision management research fields. The volume of research articles approaches, and multidisciplinary perspectives[7]. The development of technology has brought an overhaul to the supply chain management and logistics systems completely. From robotic packaging of products to drone delivery systems, artificial and augmented intelligence is the future of logistics as opposed to the traditional supply chain management[8].

Supply chain management has emerged as a crucial productivity and competitiveness tool in modern manufacturing environments. A supply chain encompasses all facilities, functions, and activities involved in sourcing raw materials, processing, production, storage, transportation, and delivery of products to end customers[9]. In printing industries, the supply chain includes paper and ink suppliers, prepress operations, printing processes, finishing, distribution, and reverse logistics. Integrating sustainability into supply chain management referred to as sustainable supply chain management focuses on minimizing environmental impacts, improving resource efficiency, and ensuring social responsibility across the entire value chain [10]. The adoption of sustainable supply chain practices offers significant potential benefits for printing industries, including waste reduction, energy efficiency, cost savings, improved regulatory compliance, enhanced customer satisfaction, and long-term competitiveness. This review paper aims to examine the importance of sustainability concepts in the printing industry, with a particular emphasis on sustainable supply chain practices. By synthesizing existing literature, the study highlights key sustainability approaches, identifies benefits and implementation challenges, and outlines future research directions. To obtain a broader perspective, this review examines literature across four distinct categories. Table 1 presents studies related to supply chain practices in printing and packaging industries. Table 2 summarizes research on sustainable supply chain management, while Table 3 focuses on sustainability practices in printing industries. Table 4 highlights studies addressing supply chain implementation in printing and other manufacturing industries. Figure 1 illustrates the overall methodology adopted for the review process.

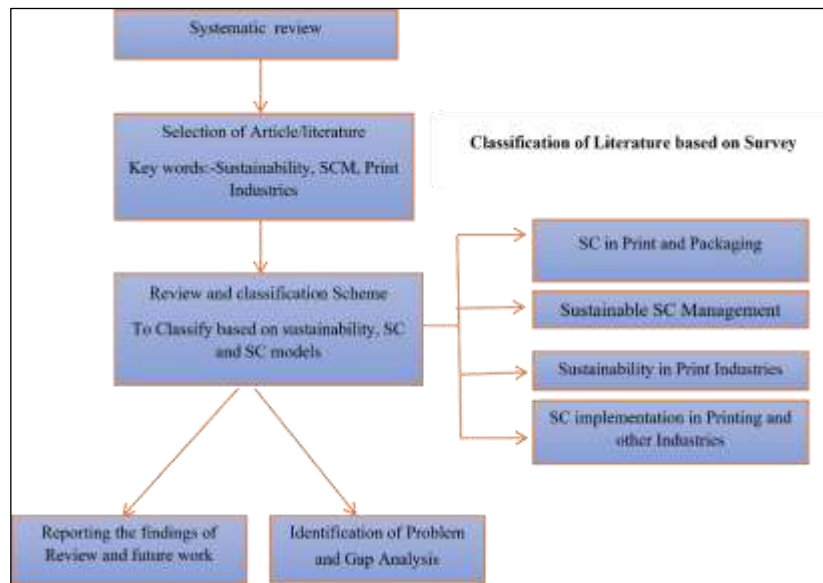


Figure 1: Review Methodology/Framework.

Source: Authors, (2026).

Table 1: Supply chain in printing and packaging industries.

S.No	Papers reporting the Supply Chain practices	Industry in which Supply chain was implemented	Research Reported in the paper
1.	[11]	Book Publishing Industry in Asia, e-book	Formulated map for e-Supply chain
2.	[12]	FMCG industry, eco-friendly packaging	Proposed that there is a direct relationship in which the benefit of eco-friendly packaging brings the company in developing more sustainable supply chain management.
3.	[13]	Printing Industry in Kenya	Study indicated that benchmarking as a supply chain best practice played a pivotal role in customer satisfaction.
4.	[14]	Packaging industry	The development of a value-based performance measurement
5.	[15]	Packaging industry	a novel two-stage hybrid solution method designed for sustainable supply chain systems
6.	[3]	Package printing industry, Canadian and United States package printing industry	Environmental collaboration with suppliers is positively associated with greater investment in pollution prevention technologies while such collaboration with customers has no impact on the adoption and the implementation of pollution prevention technologies.
7.	[16]	Package printing industry Canadian and United States package printing industry	Green project partnership with customers was positively linked to quality, flexibility and environmental performance while partnership with suppliers was associated with better delivery performance.

8.	[1]	North American manufacturers, package printing industry	Examines the impact of environmental collaborative activities on manufacturing performance. that upstream practices were more closely linked with process-based performance, while downstream collaboration was associated with product-based performance.
9.	[17]	Printing Industry, Web offset	This paper is to examine supply chain management practices, issues, role of information technology in printing industry. A convenient sample of 70 companies/individuals from operations department was selected with a questionnaire for conducting survey. The paper is to make a small attempt to understand the advantage of adopting information technology solutions in printing industry for a seamless information flow across entire value chain, so as to operate efficiently by reducing cost.
10.	[18]	Smart Packaging System	This basic information of the common printing techniques for smart packaging system .The conceptual framework was developed. It focuses on how innovative smart packaging solutions are beneficial to the overall quality and safety of food supply
11.	[19]	Packaging Industry, Tetra Pak	This research was conducted in three propositions on how to reduce the gap between supply chain needs and satisfaction in interaction with the product and packaging system. It also proposes a supply chain focused packaging design and development method to better satisfy supply chain needs placed on packaging.
12.	[20]	Packaging Industry	a framework was developed on a conceptual model of socially responsible supply chain-based orientation (SRSC) and the incorporation of this orientation to the socially responsible packaging.
13.	[21]	food and manufacturing industries in Sweden	This paper explores how integrated approaches are used in packaging development processes to increase eco- efficiency along supply chains
14.	[22]	Indonesia Printing industries, CV. Andi Offset Company	Andi Offset is trying to apply the lean supply chain .They are trying Interpretive Structural Modeling (ISM) method to identify the hierarchy variables that affect the successful implementation of lean supply chain in CV. Andi Offset. The results show us that there are 10 success variables of implementing lean supply chain strategy.
15.	[23]	US automobile manufacturing industry and the UK supermarket industry	This study shows how logistics and packaging factors affect the cost of a reusable packaging system.
16.	[24]	Packaging	The purpose of the research is to improve potential of packaging logistics in supply chain practice. The paper identifies and explains improvement areas, trade-offs and gaps in packaging systems from a supply chain perspective.
17.	[25]	Australia industrial packaging	This paper argues sthat environmental innovation in industrial packaging systems requires a cooperative supply chain approach to ensure that environmental and commercial costs are reduced and efficiencies optimized for the chain as a whole.
18.	[26]	Newspaper industry	The purpose of this paper is to assess the responsiveness of supply chain in newspaper industry. Survey was conducted on various entities and events in the entire supply chain found that enough not enough resources were allocated to meet the desired responsive levels in supply chain.
19.	[27]	Printing industry	This paper aims to apply RFID in the supply chain of the printing industry. This papersets reference information for enterprises to evaluate the RFID implementation in the supply chain.

Source: Authors, (2026).

Table 2: Sustainable SC Management.

S.No	Papers reporting the Supply Chain practices	Industry in which Supply chain was implemented	Research Reported in the paper
1	[28]	Portuguese battery producer and distributor	In this paper economic pillar of sustainability is addressed. generic multi- objective mathematical programming model was developed. Model shows that, there is improvements in all the three dimensions of sustainability. Finally, a social indicator appropriate to assess strategic decisions is proposed.
2	[29]	Portuguese automotive supply chain	the impact of lean, resilient and green supply chain management practices on supply chain sustainability was studied. conceptual model was developed. The paper provides a taxonomy for lean, resilient and green supply chain management practices
3	[6]	five Indian manufacturing companies	a sustainable innovation criteria framework was developed for investigating sustainable supply chains in manufacturing companies. The result of this study shows that at which on which criteria to focus on during the implementation stage, to increase sustainability in manufacturing supply chains.

Source: Authors, (2026).

Table 3: Sustainability in Print Industries.

S.No	Papers reporting the Supply Chain practices	Industry in which Supply chain was implemented	Research Reported in the paper
1.	[1]	Package printing industry	This paper examines the impact of environmental collaborative activities on manufacturing Industries. It mainly focus on inter-organizational interactions between supply chain members. The sample was taken using package printing industries. Results concluded that that upstream practices linked with process-based performance, while downstream collaboration was associated with product-based performance.
2.	[4]	Printing Industries	enterprises are striving to be more sustainable in environmental and social issues. Enterprises are rated according to their achievements in sustainability. This paper aims to assess sustainability in printing enterprises and also it gives the area where sustainability has to be improved
3.	[30]	Printing Industries	The paper explains the concept of pollutants in Printing Industries and also harmful substances which are emitted during the printing process is presented. results represent the contribution to the sustainable development management.
4.	[5]	Printing Industries	This study proposes a decision support system for assessing the environmental performance of a specific printing product. It aims to collect and merge environmental features of raw materials with data about printing processes carried out directly by the firm. And also prototypal software tool has been developed based on the approach proposed.
5.	[31]	Printing Industries	The survey was taken on 35 offset printing companies. eco- design checklist was created which covers all stages of the printed products life cycle. The study indicated that most of the printing companies consider ecodesign concept as an important step of their future environmental improvement.
6.	[32]	Packaging Industry	an integrated Sustainable Packaging Design Model(SPkDM) was developed. The strategies of eco-design and tools was incorporated in each phase of the development process so that model bring the

			benefits of time, cost and environmental impact in packaging.
7.	[33] [34] [35]	packaging Industries	Sustainable product packaging design was developed but current design briefs from marketer to the development team are currently not always applied for the specific implementation of sustainable considerations in packaging development. This article addresses this issue and achieved implementation of sustainability considerations in product-packaging development. The scope for eco-friendly packaging in India is very high.

Source: Authors, (2026).

Table 4: Supply chain implementation in print and other industries.

S.No	Papers reporting the Supply Chain practices	Industry in which Supply chain was implemented	Research Reported in the paper
1.	[36]	Bangladesh Printing Industries, Newspaper Industries	study was based on primary and secondary data represents the different channels of supply chain in printing industry of Bangladesh. The results shows that how wastage can be reduced and green supply chain can be implemented.
2.	[37]	Halal food supply chain, 300 Halal food firms in Malaysia, Lean Supply Chain	Survey result shows that More than 70 percent of the firms reported that lean supply chain (LSC) has not yet been implemented in their firm. lack of customer awareness of LSCM practices was recognised as a major barrier in non-lean firms
3.	[38]	Chinese manufacturers, power generating, chemical/petroleum, electrical/ electronic and automobile industries	A survey was conducted on four typical chinese manufacturing industries. 171 valid organizational responses was received. Results shows that the different manufacturing industry types display different levels of GSCM implementation and outcomes.
4.	[39]	Taiwan Company, Electronics industries	the decision to adopt GSCM in electronics industry is associated with the use of a multi-dimensional approach. the paper examines GSCM based on fifteen criteria expressed in five dimensions and proposes a multi-criteria evaluation framework for selecting suitable green suppliers
5.	[40]	Ford Motor Company, Toyota	The Study was based on how Toyota can continuously and consistently achieve its dramatic success. It summarize some solid suggestions and comprehensive ideas for those industries planning to implement lean production.
6.	[41]	Chinese manufacturers	two measurement models of GSCM practices implementation were tested .Studies suggested that both the first-order and the second-order models for GSCM implementation are reliable and valid.
7.	[42]	Thailand electronics industry, Computer Components	This paper survey current green activities in computer parts' manufacturers in Thailand. To survey 11 manufacturers are case studies who provide in-depth interview about green procurement, green manufacturing, green distribution, and/or reverse logistics.

Source: Authors, (2026).

II.OVERVIEW OF REVIEWED LITERATURE

The review of existing literature indicates a growing scholarly and industrial interest in sustainability concepts within the printing industry, particularly over the last decade. Most studies emphasize the environmental dimension of sustainability, followed by economic benefits, while social aspects receive comparatively limited attention. The literature reveals that sustainability in printing industries is predominantly addressed through green printing practices, cleaner production techniques, energy-efficient technologies, and environmental management systems. More recently, researchers have highlighted sustainable supply chain management as a comprehensive approach to achieving sustainability across the entire printing value chain. A significant proportion of reviewed studies focus on developed economies, whereas empirical evidence from developing countries, including India, remains limited. This disparity underscores the critical need for region-specific research that accounts for unique local conditions such as market dynamics, technological limitations, and regulatory frameworks. Addressing this gap is essential to develop contextually relevant sustainability strategies and implementation models that are better suited to the challenges faced by developing economies.

II.1 ENVIRONMENTAL BENEFITS OF SUSTAINABILITY PRACTICES

The results from the reviewed studies consistently demonstrate that adopting sustainability concepts significantly reduces the environmental footprint of printing industries. The most frequently reported environmental benefits include reduced paper waste, lower energy consumption, decreased water usage, and minimized emissions of volatile organic compounds (VOCs). Practices such as the use of recycled and certified paper, vegetable-based and low-VOC inks, waterless printing, and energy-efficient curing systems contribute substantially to environmental performance improvement. Sustainable supply chain practices further enhance these benefits by extending environmental responsibility beyond the printing floor to suppliers and logistics partners. Supplier selection based on environmental criteria, optimized inventory management, and efficient transportation systems reduce upstream and downstream environmental impacts. The findings suggest that sustainability initiatives are most effective when implemented holistically across the supply chain rather than as isolated operational improvements.

II.2 ROLE OF SUSTAINABLE SUPPLY CHAIN MANAGEMENT

The review clearly establishes sustainable supply chain management as a critical enabler of sustainability in the printing industry. Unlike traditional supply chain approaches that focus primarily on cost and efficiency, sustainable supply chain management integrates environmental and social considerations into decision-making processes. The literature reports that sustainable supply chains improve transparency, traceability, and collaboration among stakeholders. In the context of printing industries, sustainable supply chain practices facilitate responsible sourcing of paper and inks, efficient logistics, waste recovery, and reverse logistics for recycled materials. The results indicate that firms adopting sustainable supply chain practices achieve better compliance with environmental regulations, enhanced customer trust, and improved brand reputation. These advantages are particularly significant in markets where customers increasingly demand eco-labeled and environmentally responsible printed products.

II.3 CHALLENGES AND RESEARCH IMPLICATIONS

Despite the evident benefits, the reviewed literature identifies several challenges hindering the widespread adoption of sustainability concepts in printing industries. These include high initial investment costs, lack of standardized sustainability performance metrics, limited awareness among small and medium-sized enterprises, and inadequate integration of digital technologies. Supply chain complexity and dependence on multiple stakeholders further complicate sustainability implementation. From a research perspective, the findings highlight the need for quantitative assessment models to evaluate sustainability performance in printing industries. Future studies should employ multi-criteria decision-making techniques, such as AHP, DEMATEL, or fuzzy-based approaches, to identify critical sustainability factors and their interrelationships. Additionally, empirical studies focusing on developing countries would provide valuable insights into context-specific challenges and solutions. Figure 2 shows the Sustainable supply Chain Framework for Printing Industries.

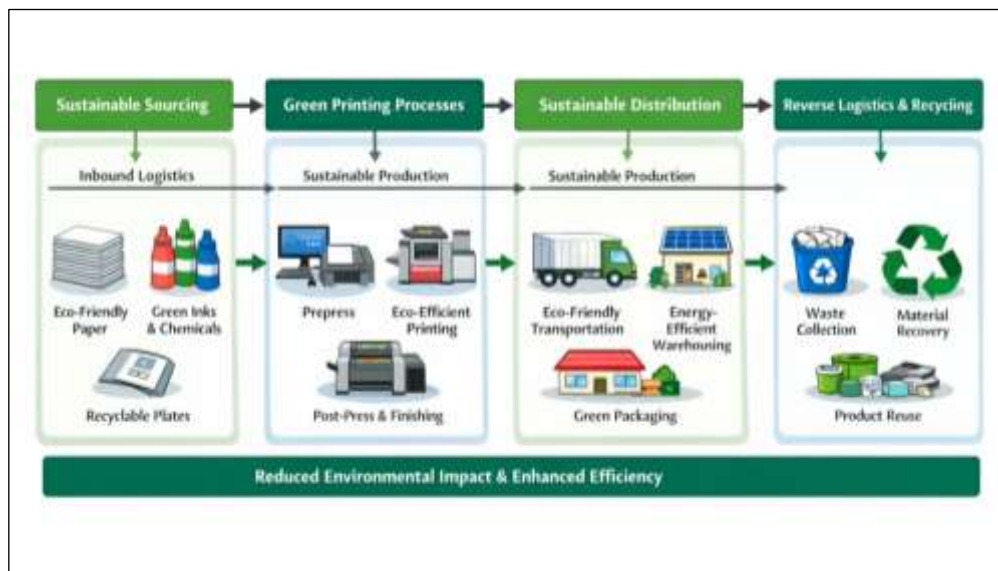


Figure 2: Sustainable supply Chain Framework for Printing Industries.

Source: Authors, (2026).

III RESEARCH GAPS IDENTIFIED IN EXISTING LITERATURE

A critical review of existing literature on sustainability concepts in the printing industry reveals several significant research gaps that warrant further investigation. Although sustainability has been widely discussed in manufacturing contexts, its systematic application and evaluation within printing industries remain limited. Firstly, most existing studies emphasize environmental sustainability, particularly focusing on waste reduction, energy efficiency, and green printing technologies. However, economic and social dimensions of sustainability remain comparatively underexplored. There is a lack of integrated studies that simultaneously evaluate environmental, economic, and social performance in printing industries using a holistic framework.

Secondly, the literature indicates a shortage of quantitative sustainability assessment models tailored specifically to printing industries. Many studies rely on qualitative discussions or case-based observations, with limited use of structured decision-support tools. The application of multi-criteria decision-making (MCDM) techniques, such as AHP, DEMATEL, ISM, or fuzzy-based approaches, to identify critical sustainability factors and their interrelationships remains insufficient. Thirdly, sustainable supply chain management in printing industries has received relatively limited attention compared to other manufacturing sectors. Existing research often examines sustainability at the operational or process level, while neglecting upstream and downstream supply chain integration, including sustainable sourcing, logistics optimization, and reverse logistics. Fourthly, there is a notable lack of empirical studies in developing countries, particularly in the Indian printing industry. Most available research is concentrated in developed economies, which limits the generalizability of findings to regions characterized by small and medium-sized enterprises, limited digitalization, and resource constraints. Region-specific frameworks and empirical validations are therefore needed. Fifthly, the role of digitalization and Industry 4.0 technologies in enabling sustainability within printing supply chains is insufficiently addressed. The interaction between digital transformation, productivity improvement, and sustainability outcomes in printing industries remains an emerging and under-researched area. Finally, the literature reveals an absence of standardized sustainability performance indicators and benchmarking models for the printing sector. The lack of uniform metrics makes it difficult to compare sustainability performance across organizations and to evaluate the effectiveness of sustainability initiatives over time. Addressing these research gaps will contribute to the development of comprehensive sustainability frameworks, support evidence-based decision-making, and promote sustainable development in the printing industry.

IV. CONCLUSION

Overall, the results of this review confirm that sustainability concepts play a crucial role in improving environmental performance, productivity, and competitiveness in the printing industry. Sustainable supply chain management emerges as a comprehensive and effective approach for integrating sustainability across the printing value chain. While environmental and economic benefits are well documented, greater attention is required to address social sustainability and implementation challenges. A strategic, integrated, and digitally enabled approach is essential for achieving long-term sustainable development in the printing sector. Despite these benefits, the review reveals that sustainability implementation in printing industries, especially in developing countries such as India, remains limited due to challenges including high initial investment costs, lack of awareness, insufficient digitalization, and absence of standardized performance metrics. The literature also indicates an imbalance in research focus, with greater emphasis on environmental aspects and limited attention to social sustainability and quantitative evaluation methods. Overall, this study concludes that sustainability concepts are critical enablers of productivity improvement, environmental responsibility, and long-term growth in the printing industry. A holistic and integrated approach that combines sustainable supply chain management, digital technologies, and supportive policy frameworks is essential to advance sustainable development in the printing sector. The insights from this review provide a foundation for future empirical research and practical implementation of sustainability-driven strategies in printing industries.

V. AUTHOR'S CONTRIBUTION

Conceptualization: Miruthubashini T And Balaji M.
Methodology: Miruthubashini T And Balaji M.
Investigation: Miruthubashini T And Balaji M.
Discussion of results: Miruthubashini T And Balaji M.
Writing – Original Draft: Miruthubashini T And Balaji M.
Writing – Review and Editing: Miruthubashini T And Balaji M.
Resources: Miruthubashini T And Balaji M.
Supervision: Miruthubashini T And Balaji M.
Approval of the final text: Miruthubashini T And Balaji M.

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