**Drivers, Barriers and Practices of Net Zero Economy: An** **Exploratory** **Knowledge Based Supply Chain** **Multi-Stakeholder Perspective Framework**

***Abstract:*** Over the past decade, there has been a constant spotlight on introducing sustainability in the supply chain (SC). The materialistic human greed for production and consumption has led to a radically increased level of greenhouse gases. SC has become its principal contributor. We are addressing this socio-economic environmental challenge by developing a multi-stakeholder framework and focusing on a knowledge-based net zero supply chain, as there are no concrete existing studies that have investigated current state-of-the-art operations in this relevant field. Therefore, this research has been conducted to investigate the drivers, barriers and practices through which net zero economy (NZE) can be attained in a knowledge-based SC. In this regard, the paper conducts an exploratory systematic review of selected articles from peer-reviewed journals. The findings indicate that primary stakeholders (i.e. organisations and suppliers) require to take an active role in bringing about sustainable changes in practice. However, external perspectives (i.e. government, society, consumers and community) have also been identified as sources that create challenges as well as have the potential to aid sustainable industrial practices. Additionally, progress can be enhanced through proper policies, regulations and a knowledge-based conceptual framework to pave the way for a sustainable environment. Proper practices for NZE also provide scope for economic growth through cost-effective production. This paper will be beneficial for practitioners as well as policy makers on a global scale who aim to attain NZE for sustainability.

***Keywords:*** Net zero economy, Drivers, Practices, Barriers, Knowledge-based supply chain

1. **Introduction**

The attainment of sustainability among various industries on a global scale has been recognised as a highly significant subject, especially in terms of supply chain management (SCM). As defined by the report of the Brundtland Commission 1987, sustainable development is the adoption of business activities and strategies that meet the needs of an organization and stakeholders while sustaining, enhancing and protecting human resources that will be needed in the future (Brundtland and Khalid, 1987). Moreover, substantial environmental benefits can be leveraged through appropriate actions on climate change such as enhanced and diversified energy security, better air quality, a healthy environment and less traffic congestion to secure the future for forthcoming generations (Sovacool, 2016). To curb the detrimental impacts of industrial activities, it has been proposed to create a net-zero infrastructure to fulfill the needs of today and of future communities and to bring the economy to net-zero emissions (Jenkins et al., 2021). In this regard, a net zero economyframework will benefit the world in achieving environmental sustainability. A framework will acknowledge the development of sustainable industrial practices to create a balance between the amount of greenhouse gas emissions and a targeted reduction (Kılkış and Kılkış, 2018). It will ultimately lead to an absolute reduction of carbon footprints and will help in controlling the issues of global warming. This aspect of NZE has also been addressed by the United Nations, due to the growing population of the world along with the growing rate of pollution that may lead to scarcity of resources (United Nations, 2021).

Furthermore, the UN climate champions have introduced a *Race to Zero Breakthroughs*that includes a roadmap, targeting 20 sectors that constitute the global economy, aiming to reduce current carbon emissions by 50% by 2050 (UNCC 2021). However, the most concerning factor of a supply chain is the high rate of carbon emission that is seen in freight transport, largely driven by the processes of production and consumption when operating a linear model for SCM (Li et al., 2015). Leading industries, such as construction, food, fast-fashion, FMCG, automotive, professional services, electronics and freight services contribute to 50% of the overall carbon footprint on a global scale (Cheng et al., 2018). In this regard, the implementation of an appropriate knowledge management approach is considered an effective strategy to fulfil sustainability objectives (Wernick, 2002; Martínez-Martínez et al., 2018). New opportunities have been offered in the last twenty years concerning knowledge management by information and communications technology that is easy to use, with low cost and offers enhanced performance (Cerchione and Esposito, 2016). It is reported that knowledge-based SC develop an opportunity to attain improved value for customers, to encourage improved utilization of resources in multi-cultural and knowledge-intensive firms and to build sustainable business processes (Kassaneh et al., 2021). Effendi et al. (2021) asserted that a critical element of innovation is knowledge-based SC which offers firms opportunities through advanced, cutting-edge and improved technology to attain improved performance and sustainable SC integration.

As firms with effective supply chains are strongly interconnected, technologies and techniques have become integrated with SCM systems to administer operational performance, environmental performance and to manage knowledge (Wernick, 2002). Innovations that are environmentally favourable and economically sound can be generated (Kassaneh et al., 2021). In addition, lack of proper conceptualisation of a framework for maintaining environmental sustainability will lead to pollution of air, water, land and biodiversity. Hence, in the future economy, there is a need for business professionals to manage their knowledge more effectively to achieve sustainable management. Managers must also learn how to manage the knowledge of all those that are engaged in their practices and processes of business (Kassaneh et al., 2021). This increases the need for knowledge management capabilities through which SC managers can implement fundamental elements of knowledge-based SCM (Handzic, 2017; Flöthmann et al., 2018).

The issues concerning sustainable growth affect every firm in an SC; hence it is necessary to focus on solutions from a collective view as the endeavours of an individual firm are insufficient. Thus, knowledge management among various firms to achieve sustainable growth is more crucial than that of each firm individually (Kassaneh et al., 2021). Furthermore, to address inter-firm knowledge management, there has been a progressive shift in attitudes as knowledge is considered a critical resource that should be controlled properly across SC (Agostini, 2020). Technological innovation is part of the solution for completely decarbonizing the global economy; along with this, the formulation and implementation of relevant policies can enable profitable investment in cleaner manufacturing practices and accelerate reduction in carbon emissions (Rissman et al., 2020). Therefore, it is necessary to address the drivers, barriers and practices of NZE to ensure better implementation of policies. The prevention of an acute environmental crisis through knowledge-based sustainable supply chain management (SSCM) has been addressed in this paper by examining the drivers, barriers and practices of NZE with relation to SCM. In this regard, the following research questions raised in this study are framed:

RQ1: What are the drivers, barriers and practices of a net zero economy with respect to supply chain perspective ?

RQ2: How can a knowledge-based supply chain support the implementation of net zero initiatives/practices?

RQ3: How can a knowledge-based supply chain reduce the barriers or improve performance of net zero initiatives/practcies?

The main objectives of this study are:

* To review and analyze the development of existing literature based on knowledge-based SC and NZE
* To provide a systematic review of the existing literature addressing drivers, barriers and practices of NZE
* To offer future research framwwork and propositions which will help in advancing research in the field of knowledge-based SC and NZE

The following is the structure of this research paper which is divided into five parts. Section 2 explains why there is a need for content analysis and relates the results to mainstream research through a review of literature on sustainable and green SCM. Section 3 addresses the theoretical aspect of sustainable development by focusing on the dynamics of the socio-economic environment. In Section 4, the methodology is discussed. In Section 5, we have classified and built a multi-perspective conceptual framework. Section 6 discusses research findings and provides suggestions for future work. Finally, the conclusion is presented in Section 7.

1. **Literature Review**

The topic of industrial carbon emission and its apprehensive impact on the environment has been addressed time and again by various authors and academic researchers (Bonamente et al., 2014; Han et al., 2018; Pei et al., 2019; Habert et al., 2020). Exposure to excessive greenhouse gases is harmful to all living beings along with the threatening possibility of polluting the environment to a dangerous level from which recovery will be impossible (Sharma et al., 2017). The rate of carbon emission and other greenhouse gases is gradually rising; this can be attributed to transportation, domestic combustion and industrial processes (Bi et al., 2009). In 2010, the industrial greenhouse emissions accounted for 30% of the total emissions globally (Pamenter and Myers, 2021), with greenhouse gas emissions reaching their highest level in 2019 resulting from land use and fossil fuels (Lamb et al., 2021). It was reported that on a global scale, industrial processes constitute most of the carbon emissions and among the most harmful greenhouse gases, carbon dioxide emissions constitute about 65% (Lee et al., 2017).

To confront the problems posed by climate change, growing waste crisis, growth in natural resource depletion and other challenges associated with global warming, a major focus of policy makers globally is to promote technological innovations that will make it possible to achieve circular economy and create NZE (Lee et al.,2017). In this regard, Whitmarsh and Capstick (2018) suggested application of knowledge-based perceptions on climate change for developing effective communication strategies, facilitating policies and socially accepted technologies to diminish climate vulnerability. Similarly, Birch et al. (2010) asserted on the importance of a knowledge-based economy in achieving sustainability where knowledge is regarded or associated with technological innovations. In addition, scholars have increasingly looked at the development of a knowledge-based SC as a means to achieve enhanced value for customers (Kassaneh et al., 2021) and to expand the sustainability of business processes (Martins et al., 2019).

According to Harris (2001), knowledge is considered as the driver of economic growth and productivity, highlighting the role of learning, technology and information in economic performance. The technological innovation in supply chains is a crucial factor in achieving sustainable growth of a firm (Lee et al., 2018) and for eliminating greenhouse gas emissions; various emerging technology solutions are essential (Quarton and Samsatli, 2021). In this regard, Tasleem et al. (2019) investigated the impact of technological innovation on the sustainable performance of a firm through an empirical research and suggested technology advancement for corporate sustainability performance. Similarly, Bag et al. (2020) emphasized the use of big data analytics to develop SSCM through an operational excellence approach. Khan et al. (2019) developed a knowledge-based system to evaluate overall SC performance and asserted that existing models of SC performance are not well aligned with the intensive technological adaptation in SC. Hence, the existing challenges associated with NZE require extensive knowledge-based SC models to evaluate overall SC performances. In this study, various types of existing literature have been analyzed in this section with relation to the topic to identify the key aspects of the issue at hand. The concept of NZE to attain holistic sustainability is aimed at implementing practices that may aid the transitional process (Feng, 2019).

Set research objectives and research scope

Set up theoretical context

Data collection

Data Processing and analysis

* Article Analysis, Content Analysis, Framework Building

Research findings and conceptual research framework

Research implication and conclusion

**Figure 1:** Flowchart for Research

The transition of traditional SC operations to a sustainable system will aid in developing a circular economy, promoting a balance between the rate of carbon emission and reduction (Allen et al., 2021). In essence, the decarbonisation process in the SC has been indicated as one of the most critical practices that require adoption (Labanca et al., 2020). The literature review undertaken has revealed different perspectives on the net-zero economy in terms of its drivers, practices and barriers. Dahlmann et al. (2019) stated that large corporations require active participation in the development of green supply chain management that will aid in climate preservation. On the other hand, companies put fast customer services and large-scale production to meet the demands of the market above all to retain profit and customers. Such duality creates barriers to the implementation of sustainable and green industrial practices (Munten et al., 2021). Various aspects in SCM and environmental sustainability have been evaluated through a meta-analysis and systematic literature review by Khan et al. (2021), who reported that the domain of SSCM needs further examination. Table 1 summarises the main findings of some recent studies in the field of SSCM to provide an insight into existing systematic reviews.

**Table 1:** A literature review of SSCM

|  |  |  |
| --- | --- | --- |
| Author and publication year | Methodology | Main Finding |
| (Khan et al., 2021) | Meta-analysis and systematic review | Emphasis on several factors to improve the current and future advancements of the sustainable SC research field |
| (Mardani et al., 2020) | Systematic literature review | Demonstrate that SEM (search engine marketing) has been applied in the field of green SCM in prior works |
| (Paliwal et al., 2020) | Systematic literature review | Highlight the disruptive power and role of blockchain-based information systems |
| (Chiappetta et al., 2020) | Review paper | Encourage future research towards big data-driven sustainable SC |
| (Nimsai et al., 2020) | Bibliometric literature review | Integration of internal operations and the organizational environment for sustainable SC |
| (Paul et al., 2021) | Systematic literature review | Highlight methods for analyzing challenges, barriers, drivers, criteria, enablers and practices of sustainable SC |
| (Seuring and Müller, 2008) | Literature review | A conceptual framework for SSCM from 1994 to 2007 |
| (Koberg and Longoni, 2019) | Systematic literature review | Need for identifying governance and configurations as key elements in global supply chains |
| (Srivastava, 2007) | Literature review | Frame of reference for green supply-chain management (GSCM) is not adequately developed. |
| (Mangla et al., 2018) | Systematic literature review | Highlights economic prosperity, global warming and employment in SC |
| (Sánchez-Flores et al., 2020) | Literature Review | From an emerging economy perspective, it becomes crucial to research SSCM |
| (Tseng et al., 2019) | Literature review | A lack of studies in GSCM based on the viewpoint of partners |
| (De Oliveira et al., 2018) | Systematic literature review | Lack of articles related to public administration |
| (Luthra, 2014) | Literature review | Issues involving in collaboration of green suppliers, products and adopting environmentally friendly practices |

Evaluation of these articles has indicated that SCM requires strengthening as the carbon emission rate has been primarily due to the excessive logistical operations by various sectors. Bataille (2020) outlines the principles demonstrated in the Paris Agreement that identify various aspects through which industrial practices may be modified to attain a net-zero economy. In conclusion, the necessity of implementing modifying policies for green SCM has been evident throughout the process of the literature review in Table 1.

1. **Theoretical Underpinnings**

The rise in global temperature as a result of carbon emission has been taken as a critical issue that requires definite solutions. The temperature of the earth's surface was hotter than the average 20th-century temperature with a rise of 0.98 Celsius in 2020 (Lindsey and Dahlman, 2021). China has been identified as the biggest emitter of CO2, followed by India and the United States (Magazzino et al., 2021). In essence, the rate of carbon emission is seen to increase among industrially developed countries (Aye and Edoja, 2017). Thus, the development of sustainable and green organizational processes is a priority to attain a NZE with a rapid and radical structural change (Stern and Valero, 2021). On the other hand, the proceeds of decarbonisation are expected to multiply the climate change image significantly. However, commitment to decarbonisation may be faced with critical barriers as management of a global supply chain for a large organization is a complicated process (Labanca et al., 2020).

In this regard, waste management frameworks have been implemented by various corporations, following the *3 R's of reduce, reuse and recycle* methodology (Chiappetta et al., 2020). NZE may be achieved through waste management that enables organizations to reuse resources while preserving geological resources. This particular framework has been enhanced further to incorporate other principles of waste management such as *rethink, refuse, reduce, repurpose, reuse, recycle and rot* which are known as the *7 R’s* of waste management (Nixon et al., 2017). However, the fundamental ideas of these frameworks remain the same. They are aimed at attaining sustainable practices that can be adopted by both individuals and large-scale corporations on a global scale.

Especially for SCM, the decarbonisation process becomes a necessity as it has been seen that carbon footprint rises significantly in an upstream supply chain (Bataille, 2020). As stated by Bataille et al. (2020), in various industries, the rate of carbon emission during direct operations may be low but is multiplied by 10 times by suppliers. This is also attributed to the dispersed nature of SCs. Further analysis has revealed that a 16% rise in international trade has increased during 2015-2019 (Ahmad et al.,2020). Thus, complexity in the global supply chain needs to be managed through decarbonisation while adopting a green supply chain management framework.

Along with societal growth, sustainability has gained growing importance concerning firms trying to achieve competitive advantage (Rosati and Faria, 2019). To reach this goal, knowledge management can play a crucial role (Martins et al. 2019). It is suggested from the knowledge-based view (KBV) that collaboration of firms offers access to strategic knowledge (Grant and Baden‐Fuller, 2004). Also, company performance is associated with capability building by networking with heterogenous resources of knowledge (Singh and Power, 2009). Thus, firms need to progressively rely on their knowledge-creating resources. In a sustainability context, knowledge management is considered as a new paradigm of growth that aims at improving compliance with the regulations of social, environmental and economic sustainability (Van et al., 2015; Chang et al., 2018).

The rise of carbon emissions that has been witnessed after industrialization can be managed with agreen supply chain management framework (Sarkis et al., 2011). As stated by Zaid et al., (2018), the core principles of green supply chain management identify the necessity to integrate environmentally sustainable practices. These practices are to be adopted during material sourcing, product design, material selection process, manufacturing and delivery. The management of waste is further regulated by adopting recycling policies after the end of the product life cycle. Choy et al. (2008) designed K-LPMS (“knowledge-based logistics performance measurement system”) for third party logistics to handle decision making on SC performance management. Another study developed a knowledge-based framework by using machine learning to enable automated SC configuration (Piramuthu, 2005). Moreover, Kassaneh et al. (2021) conducted a systematic literature review focusing on knowledge management practices for sustainable SCM. Therefore, the major frameworks and theories for SSCM can be termed as the foundational pillars upon which a rejuvenated environment may be constructed.

1. **Methodology** 
   1. **Search Criteria**

The methodology followed in the paper is a qualitative method for the evaluation of various articles selected for systematic review. A transparent approach has been taken to attain clarity on the subject. The systematic review was conducted by first selecting appropriate, credible and valid secondary resources, mainly scholarly research articles. As mentioned by Xiao and Watson (2019), a systematic review helps in creating a systematic structure that facilitates in-depth analysis. The articles selected for systematic review were collected from various electronic databases such as *Google Scholar, Science Dissent* and *Proquest.* As stated by Mengist et al. (2020), searching for proper secondary resources is an important initial step for the management of insightful research work. Thus, only credible sources were considered for this particular paper.

The criteria for article search included articles published in scholarly journals, articles that had been published in the English language and published between the years 2011-2021. As per the opinions of Ayaz-Shah et al. (2018), the development of a comprehensive article search criteria helps in the sampling process. In essence, a methodical and organised search criterion has helped in gathering 50 credible, relevant and valid articles that have been used for the process of a systematic review. The article search, inclusion and exclusion method are depicted in Figure 2.

* 1. **Article Search**

The initial search resulted in the attainment of approximately 165 journal articles that had matched the initial criteria. The process of including inclusion-exclusion criteria helps in attaining clarity for a research paper. The inclusion-exclusion process was adopted for further review of the articles. As mentioned by Linnenluecke et al. (2020), gathering valuable resources for a research process is essential for conducting qualitative research. The article search process also requires a careful sampling process that helps in enhancing the value of the article selection process. As per Eriksen and Frandsen (2018), the search process in various electronic databases requires the identification of necessary and relevant keywords. The specific keywords used for the article search process are net zero economy, supply chain, global supply chain, circular economy, climate change, carbon emission, carbon footprint, sustainability, decarbonisation, industrial practice, waste management and green supply chain management. Figure 2 shows the systematic process of conducting the review and inclusion/exclusion criteria for article selection.

Initial Search on database

Keywords for Search

The initial pool of identified articles

N = 165

**Screening**

Final pool of articles for review selected after full text read

N = 50

Included

Systematic review, Framework

**Closely Related (CR)**

**CR:** The article is selected only if it is related to the supply chain. The article should discuss driver, practice, and barriers in net zero economy

**Partially Related (PR)**

**PR1:** An article should mention use of SC, NZE, circular economy, sustainability word in title, abstract or keywords

**PR2**: They should be used to discuss driver, practice, and barriers in net zero economy

**PR3**: SC, NZE, circular economy, sustainability should bone from the research themes

**Closely Related (CR)**

**CR**: An article should include word SC, NZE, circular economy, sustainability in title, abstract or keywords and full text for articles are not available.

**Partially Related (PR)**

**NR:** An article is not related to academic research e.g., editorial, conference review or undefined.

**Loosely Related (LR)**

**LR:**  Paper doesn’t mention about the SC, NZE, circular economy, sustainability and in which these terms are used as

**LR1**: Example only

**LR2:** Discussed future scope only

**LR3**: Used in keywords without the proper research theme.

**Inclusion**

**Exclusion**

N = 115

Excluded

**Figure 2:** A systematic process used for conducting review

After further evaluation, 77 articles were selected from credible authors. 63 articles were then selected after reviewing the materials and identifying limitations that would not be useful in the systematic review. Searching by keywords was the final criteria for inclusion, after which 50 articles were selected for the study.

* 1. **Article Evaluation and Inclusion**

The inclusion-exclusion criteria for a systematic sampling led to the collection of 50 journal articles relevant to the topic. As discussed above in Figure 2, the articles were included if the main content of the article is related to SC and must discuss driver, practice and barriers in NZE. The articles must have words like supply chain, net zero economy, circular economy, sustainability in the title, abstract or keywords. Articles were excluded which do not fulfil the inclusion criteria. Also, articles are excluded if they are not related to academic research e.g. editorial, conference review or undefined. The detailed article inclusion and exclusion process is presented in Figure 2 above. As per Durach et al. (2017), accurate sampling in qualitative research helps in the identification of relevant secondary resources. As this paper specifically focuses upon an in-depth analysis of the contents of existing literature, the inclusion-exclusion sampling criteria for a systematic sampling process helped in moving the research work in a logical and relevant direction. Therefore, these 50 articles had matched all the present criteria and contributed to the fulfilment of the aim of this particular paper.

* 1. **Article Analysis**

The process of article analysis of the selected 50 articles was conducted based on certain set categories that have helped in the development of the paper in a systematic and logical manner. These categories include publication year of the selected articles, methodology used for the articles, analysis of the results found in the selected articles as well as evaluation of industry settings and geographical context of the key findings mentioned in the article.

* + 1. ***Paper distribution by publication year***

The distribution of the selected papers by year has helped in the development of logical understanding in terms of the development of sustainable industrial practices for achieving a NZE. De Angelis et al. (2020) have noted that a rising consciousness for preserving the climate has been witnessed in the last decade. The wave of industrialisation had been viewed solely for its capacity to support the economy of a nation. However, with the passage of time, the identification of the ramifications of global warming has contributed to the rising consciousness among governments, organizations and individuals.

The majority of the articles selected for systematic review have been from recent years. The selected articles were from the years 2011-2021; this ensures maintaining the relevance of information as well as including the famous Paris Arrangement that is highly significant for a NZE. Hence, the fact that the articles are recent has contributed to the development of a critical systematic review where the scope for comparison and contrast has also been presented due to the development of decarbonisation frameworks and processes in the last decade.

* + 1. ***Results of analysis***

The content of each selected article was analyzed to evaluate the relevance and diversity of the content. Each article has used different methods for conducting research work, such as case study analysis, model construction, conceptual frameworks, surveys and systematic review of relevant literature. As stated by Snyder (2019), different research methodology helps in attaining various results from a multi-dimensional perspective. Additionally, analysis of the content through industrial settings and geographical or locational context has helped to define the scope of selected articles. Analysis of the contents and results of the articles has been included in the methodology process to ensure that each article contributes to the development of a comprehensive systematic review process.

* + - 1. *Research methodology*

Research methodology in each of the selected articles had been comprehensive and appropriate to evaluate the concept, principles and practices related to NZE. As mentioned by Snyder (2019), the appropriateness of a research methodology is highly dependent on the topic at hand. Thus, the topic being rooted in the comprehensive analysis of the existing literature to identify new and valuable information has benefited from an extensive literature review. The process of systematic review has identified that the research methodology adopted for the majority of the selected articles had been a qualitative analysis of existing literature, conceptual framework and theoretical frameworks, as shown in Table 2.

* + - 1. *Evaluation of industry settings*

Industry setting is a vital part in terms of SCM in a sustainable manner and the key findings in each article are subject to change as industry settings change. As suggested by Carvalho et al. (2019), different industries use different raw materials, transportation processes, manufacturing technology and so on. Hence, variety in this regard can be an influencing factor in the development of a NZE. For example, FMCG (fast moving consumer goods), fast fashion, automotive, electronics, constructions, professional services and freight services can be regarded as the key carbon dioxide emitters.

The articles selected for systematic review have also indicated that reduction of carbon footprint can be highly critical within the global SC as transportation plays a large part in carbon emission (Lee et al., 2017). As per Bakhsh et al. (2017), the impact of excessive carbon emission due to the traditional SC affects air while excessive waste in the production process is reflected in land and water pollution. The overall evaluation of the industry settings, as indicated in the selected articles, reveals that large industries establish large-scale and dispersed SCs that ultimately multiply the rate of carbon emission. Most industries mentioned in the articles, such as FMCG, fast fashion, automotive, electronics, constructions, professional services, freight services and so on, are required to adopt a decarbonisation framework for a NZE, as shown in Table 2.

* + - 1. *Evaluation of geographic background*

The geographic location of the selected articles had also to be screened in order to understand the changing factors in relation to the changes in geographic location. The majority of the articles presented a general discussion with examples cited from various regions such as Europe, USA, Oceania and Asia. Various articles have been focused on the global aspect of NZE. As mentioned by Kandil et al. (2020), the global SC has expanded significantly with the growth of world trade. Hence, the majority of the articles had been focused on global SCM and its negative implications on climate change.

To maintain the generality of the study, the articles were selected in respect to the global SC as well. Pye et al. (2017) stated that NZE is required on a global scale in order to retain environmental sustainability. Thus, demonstration of these articles had been aimed at specific articles through which a global approach has been selected. Articles that had not mentioned any specific country have been regarded in a general view for the purposes of systematic review. A summary is shown in Table 2.

**Table 2:** Summary on article analysis

|  |  |
| --- | --- |
| Research method | Number of Articles |
| Case study | 1 |
| Literature review | 44 |
| Survey | 5 |
| Industry context | |
| Non-specified industry | 46 |
| Construction | 2 |
| Electronic | 1 |
| FMCG | 1 |
| Geographical context | |
| Global | 6 |
| General | 40 |
| China | 3 |
| UK | 1 |

Table 3 then lists details of the selected 50 articles.

**Table 3:** Shortlisted Research Articles based on NZE and SC.

|  |  |  |  |
| --- | --- | --- | --- |
| **Study ID** | **Author** | **Title** | **Journal** |
| **P 01** | (Alam et al., 2014) | “Economic impact of enhanced forest inventory information and merchandizing yards in the forest product industry supply chain.” | Socio-Economic Planning Sciences |
| **P 02** | (Amann et al., 2014) | “Driving sustainable supply chain management in the public sector: the importance of public procurement in the European Union.” | Supply Chain Management: An International Journal |
| **P 03** | (Attia, 2016) | “Towards regenerative and positive impact architecture: a comparison of two net zero energy buildings.” | Sustainable Cities and Society |
| **P 04** | (Azevedo et al., 2012) | “Influence of green and lean upstream supply chain management practices on business sustainability.” | IEEE Transactions on Engineering Management |
| **P 05** | (Balasubramanian, 2012) | “A hierarchical framework of barriers to green supply chain management in the construction sector.” | Journal of Sustainable Development |
| **P 06** | (Bamberger and Oswald, 2012) | “Impacts of gas drilling on human and animal health.” | New Solutions |
| **P 07** | (Baranikumar et al., 2021) | “Sustainable Green Supply Chain Management and Waste Management in Construction Industry.” | Journal of Contemporary Issues in Business and Government |
| **P 08** | (Bataille, 2020) | “Physical and policy pathways to net‐zero emissions industry.” | Climate Change |
| **P 09** | (Beitzen-Heineke et al., 2017) | “The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain.” | Journal of Cleaner Production |
| **P 10** | (Bloom et al., 2019) | “A toolkit of policies to promote innovation.” | Journal of Economic Perspectives |
| **P 11** | (Bonsu, 2021) | “Net-zero emission vehicles shift and equitable ownership in low-income households and communities: why responsible and circularity business models are essential.” | Discover Sustainability |
| **P 12** | (Bataille et al., 2020) | “Net-zero deep decarbonization pathways in Latin America: Challenges and opportunities.” | Energy Strategy Reviews |
| **P 13** | (Chen et al. 2021) | “An Exploration of the Critical Risk Factors in Sustainable Telecom Services: an Analysis of Indian Telecom Industries.” | Sustainability |
| **P 14** | (Cherian and Jacob, 2012) | “Green marketing: a study of consumers' attitudes towards environment friendly products.” | Asian Social Science |
| **P 15** | (Godar et al., 2016) | “Balancing detail and scale in assessing transparency to improve the governance of agricultural commodity supply chains.” | Environmental Research Letters |
| **P 16** | (Gopalakrishnan et al., 2012) | “Sustainable supply chain management: a case study of British Aerospace (BAe) Systems.” | International Journal of Production Economics |
| **P 17** | (Govindan and Sivakumar, 2016) | “Green supplier selection and order allocation in a low-carbon paper industry: integrated multi-criteria heterogeneous decision-making and multi-objective linear programming approaches.” | Annals of Operations Research |
| **P 18** | (Govindan et al., 2014) | “Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process.” | International Journal of Production Economics |
| **P 19** | (Green et al., 2012) | “Green supply chain management practices: impact on performance.” | Supply Chain Management: An International Journal |
| **P 20** | (Healey et al., 2021) | “Governing Net Zero Carbon Removals to Avoid Entrenching Inequities.” | Frontiers in Climate |
| **P 21** | (Hickel and Kallis, 2020) | “Is green growth possible?” | New Political Economy |
| **P 22** | (Hunt, 2011) | “Sustainable marketing, equity, and economic growth: a resource-advantage, economic freedom approach.” | Journal of the Academy of Marketing Science |
| **P 23** | (Ilyas et al., 2020) | “Unleashing the role of top management and government support in green supply chain management and sustainable development goals.” | Environmental Science and Pollution Research |
| **P 24** | (Jabbour and de Sousa Jabbour, 2016) | “Green human resource management and green supply chain management: linking two emerging agendas.” | Journal of Cleaner Production |
| **P 25** | (Jiang and Tian, 2018) | “Collaborative consumption: strategic and economic implications of product sharing.” | Management Science |
| **P 26** | (Khan et al., 2018) | “Green supply chain management, economic growth and environment: a GMM based evidence.” | Journal of Cleaner Production |
| **P 27** | (Kim and Rhee, 2012) | “An empirical study on the impact of critical success factors on the balanced scorecard performance in Korean green supply chain management enterprises.” | International Journal of Production Research |
| **P 28** | (Kirchherr et al., 2018) | “Barriers to the circular economy: evidence from the European Union (EU).” | Ecological Economics |
| **P 29** | (Kılkış and Kılkış, 2018) | “Hydrogen economy model for nearly net-zero cities with exergy rationale and energy-water nexus.” | Energies |
| **P 30** | (Kumar and Chandrakar, 2012) | “Overview of green supply chain management: operation and environmental impact at different stages of the supply chain.” | International Journal of Engineering and Advanced Technology |
| **P 31** | (Laosirihongthong et al., 2013) | “Green supply chain management practices and performance.” | Industrial Management & Data Systems |
| **P 32** | (Li et al., 2015b) | “Building green supply chains in eco-industrial parks towards a green economy: barriers and strategies.” | Journal of Environmental Management |
| **P 33** | (Long and Young, 2016) | “An exploration of intervention options to enhance the management of supply chain greenhouse gas emissions in the UK.” | Journal of Cleaner Production |
| **P 34** | (Madani and Rasti-Barzoki, 2017) | “Sustainable supply chain management with pricing, greening and governmental tariffs determining strategies: a game-theoretic approach.” | Computers & Industrial Engineering |
| **P 35** | (Manisalidis et al., 2020) | “Environmental and health impacts of air pollution: a review.” | Frontiers in Public Health |
| **P 36** | (Mathiyazhagan et al., 2013) | “An ISM approach for the barrier analysis in implementing green supply chain management.” | Journal of Cleaner Production |
| **P 37** | (Moktadir et al., 2018) | “Modelling the interrelationships among barriers to sustainable supply chain management in leather industry.” | Journal of Cleaner Production |
| **P 38** | (Plambeck, 2012) | “Reducing greenhouse gas emissions through operations and supply chain management.” | Energy Economics |
| **P 39** | (Rana and Paul, 2017) | “Consumer behavior and purchase intention for organic food.” | Journal of Consumer Marketing |
| **P 40** | (Rissman et al., 2020) | “Technologies and policies to decarbonize global industry: review and assessment of mitigation drivers through 2070.” | Applied Energy |
| **P 41** | (Rockström et al., 2017) | “A roadmap for rapid decarbonization | Science |
| **P 42** | (Rogelj et al., 2015) | Zero emission targets as long-term global goals for climate protection.” | Environmental Research Letters |
| **P 43** | (Sachs et al., 2019) | “Six transformations to achieve the sustainable development goals.” | Nature Sustainability |
| **P 44** | (Sarkis et al., 2011) | “An organizational theoretic review of green supply chain management literature.” | International Journal of Production Economics |
| **P 45** | (Stern and Valero, 2021) | “Research policy, Chris Freeman special issue innovation, growth and the transition to net-zero emissions.” | Research Policy |
| **P 46** | (Suryanto et al., 2018) | “The correlates of developing green supply chain management practices: firms level analysis in Malaysia.” | International Journal of Supply Chain Management |
| **P 47** | (Teixeira et al., 2016) | “Green training and green supply chain management: evidence from Brazilian firms.” | Journal of Cleaner Production |
| **P 48** | (Wells et al., 2018) | “A review of Net Zero Energy Buildings with reflections on the Australian context.” | Energy and Buildings |
| **P 49** | (Zhang and Yousaf, 2020) | “Green supply chain coordination considering government intervention, green investment, and customer green preferences in the petroleum industry.” | Journal of Cleaner Production |
| **P 50** | (Zhu et al., 2012) | “Green supply chain management innovation diffusion and its relationship to organizational improvement: an ecological modernization perspective.” | Journal of Engineering and Technology Management |

1. **Analysis of Content and Framework**

* 1. **Drivers in Net Zero Economy**

To understand and identify the driving factors of implementing policies and practices of NZE in a SC, the drivers of NZE were examined. Table 4 is a systematic review of the articles to analyze the drivers of NZE. The articles selected for evaluation can be broadly categorised in accordance with their content. These categories are government policies, protection of the environment, preservation of human and animal health, beneficial contribution towards community and enhancement of product quality. Based on their meaning and similarities, these drivers have been grouped into categories. As indicated in Table 3, nine major drivers of NZE have been identified through a thorough review of collected and shortlisted articles. The content of the articles was thoroughly evaluated and based on this, we identified and classified them into internal or external drivers (As mentioned in Table 3). The categorization of drivers into internal and external is based on the practices that have to be done inside or outside a firm for its adoption to a knowledge-based SC. Evaluation of the content has also indicated that achievement of NZE is likely to produce positive outcomes for all stakeholders including organizations, consumers, suppliers, government, society, community and so on. These drivers can be considered as specific motivating factors that may encourage stakeholders to contribute to the development of organizational practices that will pave the way for a NZE in the coming years.

The selected drivers were classified into clusters based on classification schemes of existing literature and on the functional aspect of the driver. Figure 3 summarises the representation of drivers in NZE with classification into five clusters.

**Drivers**

**Policy and economy**

**Health**

**Environmental protection**

**Society**

**Product Development**

Implementation of governmental laws and regulations (P 2, P 13, P16)

Prospect of economic growth (P 7, P 26, P 44)

Public health protection (P 9, P 11, P 38)

Health preservation of the animals (P6, P 35)

Protecting future growth of population (P 29)

Creation of job (P 4)

Enhancing the quality of product (P 3)

Environmental awareness among consumers puts pressure on industry (P 14, P 39)

Sustainable and eco-friendly use of resources (P 42)

**Figure 3:** Summary of Drivers

**Table 4:** Systematic review of drivers of net zero economy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Drivers** | **Description of content** | **Internal / External** | **Stakeholder** | **Market** | **Source/s** |
| 1. Economic growth through the implementation of GSCM | Implementation of green SC approaches in a holistic manner and regarded as one of the factors that help in economic progress. These strategies are adopted for enhancing reusability and recycling of materials that focus on sustainability. | Internal | Suppliers,  organization | Global market | (Baranikumar et al., 2021), (Green et al., 2012),(Khan et al., 2021) and (Sarkis et al., 2011) |
| 2. Implementation of governmental laws and regulations for changing industrial SC policies | On a political level, cleaner production has been recognised as a requirement. Various regions such as the USA and Europe have been actively implementing laws and regulations to promote proper WM and reduce the carbon footprint in the SC. | External | Organization, suppliers, government | EU, India, UK | (Amann et al., 2014), (Chen et al., 2021) and (Gopalakrishnan et al., 2012) |
| 3. Public health protection | It is subjected to weaken due to heavy pollution. Management of supply chain that aims at reducing carbon footprint and waste is thus regarded as an essential aspect in order to restore the health of the public at large. | External | Citizens,  society | Global, UK | (Beitzen-Heineke et al., 2017), (Bonsu, 2021) and (Plambeck, 2012) |
| 4. Health preservation of animals | Indirect negative impact can be identified due to the excessive pollution of air, water and land. Lack of waste management may also degenerate the lives and health of wild animals. | External | Animals, society, environment | Global environment | (Bamberger and Oswald, 2012) and (Manisalidis et al., 2020) |
| 5. Rising population and the necessity to provide a sustainable future for succeeding generations | Net zero economy provides hope for a sustainable future that will be able to protect the environment and its resources. Use of recyclable materials, renewable energy and processes for reducing industrial pollution are required for this purpose. | External | Society, organization | Global | (Kılkış and Kılkış, 2018) |
| 6. Prevention of earthly resources | Issues of climate changes, global warming and other challenging situations have arisen due to rising industrial pollution. Lack of sustainable environment protection policies is expected to lead to significant changes in the environment, harming the lives of the people. Additionally, rise in global warming will become an imminent issue, causing rise in temperature, ice melt, flood and drought. | External | Society, government, organizations | Global | (Rogelj et al., 2015) |
| 7. Rising social environmental conscious | In recent times, direct consumers and the society at large have been more aware of the environmental conditions. Support towards organizations using green industrial processes had increased. This aspect is identified as a positive driver for organizations to evaluate their present operational processes and implement various strategies for attaining holistic sustainability | External | Consumer, society, organization | Global | (Cherian and Jacob, 2012) and (Rana and Paul, 2017) |
| 8.GSCM leading to creation of jobs | Policy changes in supply chain management may lead to the creation of various job positions within the local domain. The process of decarbonisation in supply chain management entails enhancement of local transportation | Internal | Suppliers, organization, local community | General | (Azevedo et al., 2012) |
| 9. Product quality may be enhanced as sustainable material usage will be promoted in SC. | Development of products through the application of sustainable manufacturing policies is likely to enhance the quality of products and create value. Carbon footprint reduction of the supply chain management will naturally lead to the development of products with higher lifespan. | Internal | Organization, suppliers, customers | Global | (Attia, 2016) |

The study also analyzed the status of the drivers of NZE based on the number of times it appeared in existing and shortlisted articles. This will help researchers and managers to identify the most studied and top identified drivers of NZE. Figure 4 gives a snapshot of the popularity of drivers of NZE.

Chart, bar chart

Description automatically generated

**Figure 4:** Drivers of net zero economy

* 1. **Barriers in Net Zero Economy**

This study identified the major barriers of a SC in achieving NZE through understanding the factors that hinder implementing NZE practices. Table 5 is a systematic review of articles to analyze the barriers of NZE. Analysis of various barriers for achieving NZE in the SC has indicated that these barriers are related to various factors such as financial restraints, technological deficiency, lack of government framework, lack of employee knowledge and training. The 24 barriers presented in Figure 5 indicate a general view of several barriers or challenges that can be faced by organizations during implementation of SSCM for achieving NZE. Based on their meaning and similarities, these barriers have been grouped into categories. Table 5 also indicates the internal and external nature of barriers that can be evaluated later for the development of effective recommendations. These barriers are identified and classified into internal and external barriers based on the thorough review of the shortlisted articles. The content of the articles was thoroughly evaluated; based on this, we identified and classified them into internal or external barriers (As mentioned in Table 5). The categorization of barriers into internal and external is based on the practices that have to be done inside or outside a firm for its adoption in a SC.

The selected barriers were then classified into clusters based on classification schemes of existing literature and on the functional aspect of the barrier. Figure 5 is a summarised representation of barriers in NZE with classification into nine clusters.

**Knowledge and Skill Issues**

**Management Issues**

**Cultural and Social Issue**

**Marketing Issues**

**Government Issues**

**Technological Issues**

**Economic Feasibility Issues**

**Barriers**

Transforming Action (P5,P18)

Consumer Awareness (P5,P7,P9, P17, P18, P24, P28,P36)

Policy Structure (P5, P7, P9, P10, P13, P20, P23, P28, P32, P33, P36, P41, P44, P49)

Insufficient governmental contracts (P5, P7, P18, P32)

Adoption Cost (P5, P7, P18, P28, P33, P36, P44)

Disposal Cost (P5, P18, P36)

Suppliers' environmental practices (P5, P17, P18, P24, P36,P47)

Consumer Demand (P5, P17, P18, P33, P47)

Product Quality (P5,P13, P18,P28, P32, P33,P47)

Market Uncertainty/ Competition (P5,P13, P18,P28, P32, P33,P47)

Packaging Cost (P5,P18)

Fear of Failure (P5 , P18)

Environmental KPIs (P5, P18, P36, P37,P40)

Innovative Technology (P5,P8,P18,P32,P36)

Inadequate management capacity (P5,P18,P24, P27, P47)

Return on Investments (P5,P7,P9, P18,P24)

Training (P5, P13,P18, P46)

Addressing Complexities (P5, P18, P24, P36, P47)

Capital Investment (P5,P7, P9, P18, P27, P32,P33,P36)

IT infrastructure (P5,P18,P27,P28, P32,P33, P36)

Skilled Professionals (P 5, P18, P36, P47)

Visionary Thinking (P5, P18, P27, P43)

Strategic Information Flow (P5, P7, P27, P28)

Business Environmental conscious (P5, P12, P16, P17, P18, P24, P28, P36, P47)

**Environmental Issues**

**Product Development**

**Figure 5:** Barriers in Net Zero Economy

**Table 5:** Systematic review of barriers of net zero economy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Barriers** | **Description of content** | **Internal/ External** | **Stakeholders** | **Market** | **Source/s** |
| 1. Policy Structure | Regulatory authorities are lacking in providing assistance and guidance for development of sustainable SC to achieve NZE | External | Organization, Government | General | (Balasubramanian, 2012), (Baranikumar et al., 2021), (Beitzen-Heineke et al., 2017), (Chen et al., 2021), (Ilyas et al., 2020), (Kirchherr et al., 2018), (Long and Young, 2016), (Mathiyazhagan et al., 2013), (Rockström et al., 2017), (Sarkis et al., 2011) and (Zhang and Yousaf, 2020) |
| 1. Insufficient governmental contracts | Government adoption of GSCM is hindered by a lack of preferential treatment and long-term contracts. | External | Organization,  Government | General | (Balasubramanian, 2012), (Baranikumar et al., 2021) and (Li et al., 2015) |
| 1. Adoption Cost | Expenditure on shifting to new process | Internal | Organization, suppliers | General | (Balasubramanian, 2012), (Baranikumar et al., 2021), (Beitzen-Heineke et al., 2017), (Govindan et al., 2014), (Kirchherr et al., 2018), (Long and Young, 2016), Mathiyazhagan et al., 2013) and (Sarkis et al., 2011) |
| 1. Disposal Cost | Hefty cost of hazardous waste management | Internal | Organization, suppliers | General | (Balasubramanian, 2012), (Govindan et al., 2014) and (Mathiyazhagan et al., 2013) |
| 1. Suppliers' environmental practices | Environmental practices of suppliers are complex to quantify | Internal | suppliers | General | (Balasubramanian, 2012), (Govindan and Sivakumar, 2016) (Govindan et al., 2014), (Jabbour and de Sousa Jabbour, 2016), (Long and Young, 2016) and (Teixeira et al., 2016) |
| 1. Consumer Demand | Lack of demand from customers for sustainable product | External | Community | General | (Balasubramanian, 2012), (Chen et al., 2021) and (Long and Young, 2016) |
| 1. Product Quality | Inconsistent governance leading to inefficiency in product standards | Internal | Organization,  supplier | USA, Canada, Japan, EU, Sweden | (Balasubramanian, 2012), (Chen et al., 2021), (Govindan et al., 2014), (Li et al., 2015), (Long and Young, 2016), (Kirchherr et al., 2018) and (Teixeira et al., 2016) |
| 1. Market Uncertainty/ Competition | Uncertainty in market due to delay in project; project put on hold or cancellation | External | Organization, suppliers,  Government | General | (Balasubramanian, 2012), (Beitzen-Heineke et al., 2017), (Chen et al., 2021), (Govindan et al., 2014) and (Long and Young, 2016) |
| 1. Packaging Cost | Higher cost of eco-friendly packaging | Internal | Organization | General | (Balasubramanian, 2012) and (Govindan et al., 2014) |
| 1. Fear of failure | Failure in advancement of technology | Internal | Organization | General | (Balasubramanian, 2012) (Govindan et al., 2014) and (Mathiyazhagan et al., 2013) |
| 1. Environmental KPIs | Lack of effective monitoring of environmental KPIs | External | Organization, Government, suppliers | General | (Balasubramanian, 2012) and (Govindan et al., 2014), (Mathiyazhagan et al., 2013), (Moktadir et al., 2018) and (Rissman et al., 2020) |
| 1. Transforming Action | Difficulty in converting environmentally friendly ideas into actions | External | Organization, suppliers,  Government | General | (Balasubramanian, 2012) and (Govindan et al., 2014) |
| 1. Innovative Technology | In manufacturing and construction, there is a lack of technological innovation | Internal | Organization, suppliers | General | (Balasubramanian, 2012), (Bataille, 2018), (Bloom et al., 2019), (Govindan et al., 2014), (Li et al., 2015) and (Mathiyazhagan et al., 2013) |
| 1. IT Infrastructure | In organizations, there is a lack of IT support systems, such as environmental monitoring system (EMS) | Internal | Organization, suppliers | General | (Balasubramanian, 2012) and (Govindan et al., 2014), (Kim and Rhee, 2012), (Kirchherr et al., 2018), (Li et al., 2015) , (Long and Young, 2016) and (Mathiyazhagan et al., 2013) |
| 1. Return on Investments | Because of smaller profit margins, there is a slower return on investments (ROI) using GSCM | Internal | Organization, suppliers | General | (Balasubramanian, 2012) (Baranikumar et al., 2021), (Beitzen-Heineke et al., 2017), (Govindan et al., 2014) and (Jabbour and de Sousa Jabbour, 2016) |
| 1. Capital Investment | Initial capital investment is higher for implementing GSCM | Internal | Organization, suppliers,  Government | General | (Balasubramanian, 2012) (Baranikumar et al., 2021), (Beitzen-Heineke et al., 2017), (Govindan et al., 2014), (Li et al., 2015), (Long and Young, 2016) and (Mathiyazhagan et al., 2013) |
| 1. Inadequate Management Capacity | Lack of initiatives of top-level management in adopting GSCM | Internal | Organization | General | (Balasubramanian, 2012), (Govindan et al., 2014), (Jabbour and de Sousa Jabbour, 2016), (Kim and Rhee, 2012) and (Teixeira et al., 2016) |
| 1. Addressing Complexities | Stakeholders' perception of GSCM implementation is "too complex". | External | Organization, suppliers,  Government | General | (Balasubramanian, 2012), (Govindan et al., 2014), (Jabbour and de Sousa Jabbour, 2016), (Long and Young, 2016) and (Mathiyazhagan et al., 2013) |
| 1. Training | There aren't enough training courses, consultants or institutions to train, oversee and advise people on GSCM | External | Organization, suppliers,  Government | General | (Balasubramanian, 2012), (Chen et al., 2021), (Govindan et al., 2014), (Teixeira et al., 2016) |
| 1. Skilled Professionals | Lack of qualified professionals such as green architects, consultants, green developers and contractors for sustainability in GSCM implementation | External | Organization, suppliers,  Government | General | (Balasubramanian, 2012), (Govindan et al., 2014), (Mathiyazhagan et al., 2013) and (Teixeira et al., 2016) |
| 1. Business Environmental consciousness | Lack of understanding of how business practices impact on environment | Internal | Organization, suppliers | General | (Balasubramanian, 2012), (Govindan and Sivakumar, 2016), (Jabbour and de Sousa Jabbour, 2016), (Khan et al., 2018), (Kirchherr et al., 2018) (Teixeira et al., 2016) |
| 1. Consumer Awareness | Lack of awareness and/or readiness to actively engage in sustainable SC | External | Community | General | (Balasubramanian, 2012), (Baranikumar et al., 2021), (Beitzen-Heineke et al., 2017), (Govindan et al., 2014), (Govindan and Sivakumar, 2016), (Jabbour and de Sousa Jabbour, 2016), (Kirchherr et al., 2018) and (Mathiyazhagan et al., 2013) |
| 1. Strategic Information Flow | Communication and information sharing amongst supply chain stakeholders are lacking. | Internal | Organization, suppliers | India, UAE | (Balasubramanian, 2012), (Govindan et al., 2014), (Kim and Rhee, 2012) and (Kirchherr et al., 2018) |
| 1. Visionary Thinking | Organizations lack a 'long term' vision and are focused only short term | Internal | Organization, suppliers | General | (Balasubramanian, 2012), (Govindan et al., 2014), (Kim and Rhee, 2012) and (Sachs et al., 2019) |

The study also analyzed the status of the barriers of NZE based on the number of times it appeared in existing and shortlisted articles. This will help researchers and managers to identify the most studied and top identified barriers of NZE. Figure 6 displays a snapshot of the popularity of barriers of NZE.

Chart, bar chart

Description automatically generated

**Figure 6:** Barriers of net zero economy

* 1. **Practices to Net Zero Economy**

The following is a systematic review of articles to analyze the practices of NZE. Table 6 indicates that there are 10 major initiatives or practices that have been addressed by various authors to promote net zero economy in SCM. These practices include government regulations, product quality maintenance, economic risk assessment and support, as well as the internal infrastructure of the organization and technological implementations. Factors of both an internal and external nature have also been identified, indicating the organization’s ability to promote SSCM practices. These practices have thus been identified from selected articles as effective, practical and sustainable. Based on their meaning and similarities, these practices have been grouped into categories. These practices are identified and classified into internal or external practices based on the thorough review of shortlisted articles. The content of the articles was thoroughly evaluated and based on this, we identified and classified them into internal or external practices (as mentioned in Table 6). The categorization of practices into internal and external is based on the practices that operate inside or outside a firm for adoption in a SC.

The selected practices were then classified into clusters based on the classification schemes of existing literature and on the functional aspect of these practices. Figure 7 summarises a representation of practices in NZE with classification made into 5 clusters.

**Practices**

**Governance Initiative**

**Economic Initiative**

**Product Development**

**Management Support**

**Infrastructure**

Enhancement of job position (P 30)

Enhancement of attractive marketing policies (P 20)

Infrastructural modifications and training upper management for accommodating new policies in supply chain in net zero economy (P 30, P 31, P 50)

Promoting Prospect of economic growth (P 21, P 41)

Practice promoting accountability among organizations for preserving the environment (P 45)

Tax benefits and external tax regulations (P 22, P 25)

Promotion of low-risk policies among corporations for sustainable supply chain practices in net zero economy

(P 1, P 15)

Cooperation and collaboration (P46)

Advanced technological support (P 26, P 34, P 49)

Government implementation of policies (P 10, P 23, P 48)

**Figure 7:** Summary of Practices

**Table 6:** Systematic review of practices of net zero economy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Practices** | **Description of content** | **Internal/External** | **Stakeholder** | **Market** | **Source/s** |
| 1.Governmental implementation of policies promoting net zero economy practices in supply chain | Government support is regarded as an essential tool for promoting the practices related to environmentally friendly supply chain management. The government stands as an active propagator for the development of appropriate frameworks for addressing net zero economy, setting clear goals for organizations to follow. | External | Organization, Government | Pakistan, Australia, USA | (Bloom et al., 2019), (Ilyas et al., 2020) and (Wells et al., 2018) |
| 2. Enhancement of job position within the sustainable supply chain in net zero economy | Enhancing awareness among citizens and providing proper encouragement through the creation of job opportunities to promote net zero economy is regarded as an efficient practice for attaining net zero economy in supply chain management. Additionally, it will also help in the development of the local community, leading to the acquisition of further community support. | Internal | Organization, suppliers,  local community | Canada, Brazil, Indonesia, Colombia | (Alam et al., 2014) and (Godar et al., 2016) |
| 3. Enhancement of attractive marketing policies to support sales of recycled products in a net zero economy | Consumers need to be made aware of the high-quality of products. In many cases, myths of sustainably manufactured products have been associated with low quality and shorter life span of products. Attractive marketing policies with the incorporation of adequate information will help in changing consumer behaviour, aiding the process supply chain management in a net zero economy. | External | Organizations, consumers, suppliers | General | (Hunt, 2011) and (Jiang and Tian, 2018) |
| 4. Promoting prospect of economic growth in net zero economy for organizations | Promotion of adequate practices will enable organizations to participate in net zero economy while retaining profit. | Internal | Suppliers, organizations | Global | (Hickel and Kallis, 2020) and (Rockström et al., 2017) |
| 5. Practices promoting accountability among organizations to preserve the environment | Many organizations remain aloof and unaware of the consequences of industrial practices, especially related to a supply chain that damages the environment. Practices holding these organisations accountable for industrial practices will lead to net zero economy in supply chains. | External | Organizations, Government | Global | (Healey et al., 2021) |
| 6. Practices to ensure tax benefits; inadequate application of external tax regulations | Scope of tax benefits can be regarded as a positive motivator for the development of sustainable practices among organizations. Government may impose more external taxes to ensure that organizations are motivated to attain tax benefits through indirectly promoting net zero economy. | External | Organizations, Government | General | (Khan et al., 2018), (Madani and Rasti-Barzoki, 2017) and (Zhang and Yousaf, 2020) |
| 7. Promotion of low-risk policies among corporations for sustainable supply chain practices in net zero economy | Apprehensions regarding the high level of risk for implementing modifying policies can be amended by proper financial support from government and investors. | External | Organizations, Government, investors, shareholders | General | (Stern and Valero, 2021) |
| 8. Cooperation and collaboration for sustainable practices in supply chain | Organizations are expected to benefit from cooperation and collaboration with other organizations within the same industry to ensure a sustainable and profitable supply chain while attaining support and effective implementation of modified policies. | Internal | Organizations, suppliers | Malaysia | (Suryanto et al., 2018) |
| 9. Infrastructural modifications and training upper management to accommodate new policies in supply chain in net zero economy | The internal infrastructure of an organization and support of the management team is essential to ensure net zero economy practices in supply chain management. Enhancement of infrastructural stability and adaptability is essential for overall modification of practices and change management policies in the supply chain. | Internal | Organization, Managers | Global, Korea, China | (Kim and Rhee, 2012), (Laosirihongthong et al., 2013) and (Zhu et al., 2012) |
| 10. Advanced technological support for retaining product value or quality in cleaner and sustainable supply chain practices | Practices to retain product quality along with the implementation of advanced technology to ensure that supply chain management is being conducted cost-effectively and in a time-efficient manner. The aim of modified practices is to ensure that organizations are able to generate profit and create value among consumers. | Internal | Suppliers, organization | General | (Kumar and Chandrakar, 2012) |

The study also analyzed the status of the practices of NZE based on the number of times it appeared in existing and shortlisted articles. This will help researchers and managers to identify the most studied and top identified practices of NZE. Figure 8 shows a snapshot of the popularity of practices of NZE.

Chart, bar chart

Description automatically generated

**Figure 8:** Practices of net zero economy

* 1. **A Multi-Stakeholder Supply Chain Perspective Framework**

There are various internal and external factors that contribute to the development of a NZE in the supply chain. As mentioned by Rizet et al. (2012), the recent carbon footprint in traditional supply chain methods reveals the inability to preserve an environmental balance. Hence, severe damage to the ecosystem and biodiversity have been witnessed; this can be mitigated by the employment of practices in the supply chain leading to a NZE. In this regard, Martins et al. (2019) stressed that knowledge management can be used as the basis of practices concerning sustainable development. The above content analysis of the selected articles has indicated that in terms of drivers, barriers and practices for NZE in the SC, the organization and suppliers remain the main stakeholders. According to Nejati et al. (2017), SCM following a green supply chain methodology has been emphasized to create a positive impact on the climate. As seen above, the drivers identified for NZE in the SC are able to enhance the performance capacity of the SC.

The barriers identified above create issues in the process of implementation. The external issues are generally related to a lack of proper support and aid while internal factors relate to barriers that are developed within the organization. As stated by Arroyo et al. (2016), NZE has gained importance in recent years; however fundamental practices that lead to NZE are yet to reach adequate recognition. In essence, many organizations on a global scale are aware of the practical implications of a NZE. Organizational authorities need to be made aware of the scope of economic growth that is related to NZE. As per Korhonen et al. (2018), development of NZE is closely related to a circular economy, a more practical application of environmentally sustainable industrial practices. An organization naturally seeks to gain large-scale profit, yet sustainable practices, on the surface, may seem to hold the opposing principles to competitive advantages. Maintenance of a SC, in accordance with the green supply chain framework, also requires implementation of advanced technological equipment, tools and techniques in the initial states. Ilyas et al. (2020) have recognized that financial support from the government and investors is an essential requirement for green supply chain management. In essence, the suppliers and organizations may feel pressurised without the active support and cooperation of the stakeholders. In addition, consumer behaviour and market demands have also been defined as external factors that create limitations for an environmental SSCM. Propagators of NZE, in essence, are required to support the suppliers and organisation through proper practices to promote NZE. The major practices that have been identified for NZE revolve around these barriers and drivers. A framework for sustainable practices should include the careful strategic implementation of policies that will be able to benefit the stakeholders as well as fulfil the business objectives. As demonstrated by Rogelj et al. (2015), the aim of developing sustainable practices in SCM is to protect human society as well. Society, as one of the key stakeholders of NZE, benefits from the development of green supply chain management. Decarbonisation, electrification of transport, use of renewable energy and increments in local supply distribution are the general practices that are highlighted to attain supply chain sustainability. Hence, consideration of these factors for the development of a framework (Figure 9) for NZE in the knowledge-based supply chain indicates the requirement of establishing a balanced structure between the internal and external factors of drivers, barriers and practices.

**External**

**Internal**

1. Implementation of government laws and regulations for changing industrial SC policies.
2. Insufficient support of the government and lack of adequate KPI for achieving NZE in SC
3. Government implementation of policies for defining NZE framework
4. Practice to ensure tax benefits inadequate application of external tax regulations
5. NZE still remain unclear as a vision for various organisation around the globe while government fails to introduce adequate frameworks
6. Public Health Protection
7. Health Prevention for the Animals
8. Rising population and the necessity to provide a sustain future for the succeeding generation
9. Preserving the resources and other environmental materials to protect the earth
10. Rising Social Awareness regarding consumption of environmentally sustainable industrial practice to protect the environment
11. Product quality may be enhanced as sustainable material usage
12. Price calculations faces barriers in supply chain
13. Enhancement of attractive marketing policies for supporting the sales of recycled products in net zero economy
14. Green Supply chain management and other procedures leading to the creation of job in supply chain
15. The creation of job opportunities to promote net zero economy

**Organization**

**&**

**Suppliers**

1. Prospect of Economic Growth Government Laws
2. Public Health Protection
3. Health Prevention for the Animals
4. Demands of Rising Population
5. Preserving the Resources
6. Rising Social Awareness
7. Creation of Job
8. Product Quality Enhancement
9. Policy Structure
10. Insufficient governmental contracts
11. Cost (Packaging, Adoption, Disposal)
12. Suppliers' environmental practices
13. Consumer Demand
14. Product Quality
15. Market Uncertainty/Competition
16. Fear of failure
17. Environmental Measures
18. Transforming Action
19. Innovative Technology
20. IT infrastructure
21. Return on Investments
22. Capital Investment
23. Infrastructural Issue
24. Inadequate management capacity
25. Addressing Complexities
26. Stakeholder’s knowledge
27. Training& Skilled Professionals
28. Ownership
29. Business Environmental conscious
30. Supplier Commitment Consumer Awareness
31. Strategic Information Flow
32. Visionary Thinking
33. Government implementation of policies
34. Enhancement of job position
35. Enhancement of attractive marketing policies
36. Promoting prospect of economic growth
37. Practices promoting accountability among organizations for preserving the environment
38. Tax benefits and external tax regulations
39. Promotion of low-risk policies among corporations for sustainable supply chain practices in net zero economy
40. Cooperation and collaboration
41. Infrastructural modifications and training upper management for accommodating new policies in supply chain in net zero economy
42. Advanced technological support

**Drivers**

**Practices**

**Barriers**

**Government Aspect**

**Society, Community and Environment**

**Society, Community and Environment**

**Consumer Behavior**

**and Awareness**

**Figure 9:** A Knowledge Based Supply Chain Multi-Stakeholder Perspective Framework of Net Zero Economy Implementing Drivers, Barriers and Practices

1. **Discussion**
   1. **Discussion of Drivers in Net Zero Economy**

The drivers of NZE are those factors that may encourage or support the procedures of SSCM in order to attain NZE. The key drivers of NZE may also be evaluated to assess the nature and implications of these drivers in practice.

* + 1. *Organizational drivers and environmentally sustainable supply chains*

Organizations and suppliers can be regarded as the most important stakeholders for achieving the goals of a NZE. The collaborative effort of these two primary stakeholders helps in the development of a NZE that ultimately aims at the adoption of beneficial practices to create and maintain a sustainable and healthy balance between industrial practices and pollution reduction (Cherian and Jacob, 2012). Additionally, the process of decarbonisation, regarded as an essential part of NZE practice, is achieved through the adoption of strategies that help in reducing carbon footprint during the process of transportation.

As stated by Baranikumar et al. (2021), the suppliers in a green supply chain management net zero framework are required to maintain the quality of the products. However, preservation of quality in the supply chain in a NZE is highly dependent upon technological aid received by the organization. Furthermore, Khan et al. (2019) developed an integrated knowledge-based SC model to facilitate evaluation of overall SC performance to adapt with intensive SC digitalization. Advances in technology help companies to gather, examine, organize and evaluate data for effective decision making and better SC performance (Khan et al. 2018). Attia (2016) asserted that management of carbon footprint in the SC should be demonstrated by the ability of the suppliers as well as the organization to develop a modified manufacturing process with knowledge-based SC. In essence, from a supplier’s perspective, modification of the practices leading to enhanced quality of products will be a prime driver for NZE as enhanced quality in products will lead to cost-effective production and increased profitability.

* + 1. *Consumer behaviour as a driver of net zero economy in supply chains*

The positive behaviour of consumers is an important driver for promoting a sustainable supply chain. As suggested by Paul and Rana (2012), in recent years the development of environment conscious awareness has motivated various sectors to adopt green and sustainable supply chain management practices. Especially in the case of using recyclable materials and packaging, there has been support from fashion, food and other industries. According to Cherian and Jacob (2012), rising awareness of the environmental crisis has helped in holding industries accountable for their practices. Hence, consumer behaviour plays a vital part in a NZE.

* + 1. *Society, community and environmental factors*

The major drivers for society, community and the overall environment act as an important driver for NZE. Beitzen-Heineke et al. (2017) and Bonsu (2021) both have concluded that degradation of public health due to the environmental crisis is a critical factor that requires preventive and reformative measures. Manisalidis et al. (2020) has further opined that, along with the health hazards faced by humans, the natural habitat of animals is being endangered. On the other hand, Azevedo et al. (2012) states that with green supply chain management, the local community stands to benefit through the creation of various jobs. Hence, these vital factors increase the motivation of organizations to adopt practices for NZE in the SC.

* + 1. *Governmental factors*

Government support provides scope to businesses to gradually develop and integrate NZE in SCM and create a circular economy. Chen et al. (2021) advocated for the necessity of the government to set practical goals and introduce policies to help organizations to attain financial growth in a NZE. The Paris Agreement has been viewed by the governments of various countries as a directional guide for the formulation of sustainable industrial practices.

***Proposition 1:*** Future researchers can adopt the identified drivers of this study and develop an AI-enabled sustainable SC model to achieve NZE

***Proposition 2:*** To identify the role of various emerging technologies such as blockchain, robotics, internet of things, additive manufacturing etc. in enabling resilient SC and reducing carbon emissions

***Proposition 3:*** To analyze the significance of extensive technology adoption in achieving NZE

* 1. **Discussion on Barriers in Net Zero Economy**
     1. *Organizational and suppliers’ barriers*

It can be seen from previous research that organizations often face multiple barriers related to NZE. Financial restrictions can be regarded as one of these major barriers. As per the views of Govindan et al. (2014), a green supply chain management implementation requires widespread modification of existing policies. This often requires a significantly large amount of capital allocation and that can be a problem for small scale businesses. Coping with regulations and policies can also act as a barrier. According to the work of Rissman et al. (2020), existing government policies, laws and regulations can limit the scope of achievement for an organization. Our study has also found that suppliers’ environmental practices act as a major barrier in implementing NZE practices in an organization. To select sustainable suppliers, development of a knowledge-based AI-enabled framework will facilitate the decision making process in a company. In this regard, fuzzy logic, Bayesian networks, differential evolution techniques etc, could be used in supplier risk management (Hamd et al. 2018).

* + 1. *Barriers from consumer*

The main barrier that can be presented here from the perspective of the consumer is the modifications in pricing strategy. Trying to achieve a NZE can result in both an increase and decrease of overhead costs. As noted by Govindan and Sivakumar (2016), setting a price that is acceptable to customers can be difficult. The price needs to be aligned with the present market price and the organization also needs to ensure that they are not facing any type of losses. Therefore, it can be assumed that a price higher than the market average can result in less demand across the customer base. On the other hand, fulfilment of consumer demands is another barrier and a good inventory allocation model suggested by Wanke et al. (2017) can manage several decisions in meeting consumer demand and logistic plan. Hence, knowledge-based SC can help in decision making to mitigate the barriers associated with consumer demands and perceptions. In this regard, Kuo et al. (2021) used a hybrid 3.5 strategy based on knowledge sharing by developing a material resource management and distribution method to solve problems concerning consumer material fulfilment.

* + 1. *Governmental factors*

Evaluation of the entire scenario indicates that net zero implementation is a relatively new concept. Therefore, it is essential that the government provides a proper framework for this. As per the views of Sachs et al. (2019), absence of a proper framework can be observed even at governmental levels. This makes it tougher for organizations to implement a sustainable strategy towards the green supply chain scenario. The contradiction of the framework with existing regulations can also be considered as a barrier here.

* + 1. *Technological barriers*

Barriers due to insufficient exposure to technology for implementing green supply chain practices create a challenging environment for businesses. Bataille (2018) has stated that modifications of the SC require implementation of those specific technologies that are able to use recyclable materials, conserve energy and manufacture high quality products. Li et al. (2015b) also argued that, along with quality, production quantity must also be maintained in order to cater to the demands of the market. On the other hand, decarbonisation of transport in the SC is a large-scale modification agenda, especially in the case of the global SC. Jabbour and de Sousa Jabbour (2016) and Teixeira et al., (2016) demonstrate that such large-scale changes in management face barriers due to a lack of knowledge and experience among employees. Thus, without sufficient training and guidance, technological barriers cannot be removed from the root. In addition, Khan et al. (2019) asserted that existing SC models do not efficiently align with the SC intensive technological adoption and hence a knowledge-based SC performance evaluation system is required.

***Proposition 4:*** To develop a resilient SC model using emerging AI-technology to mitigate the barriers in NZE

***Proposition 5:*** To develop an AI-enabled SC model for supplier selection using various techniques such as analytical hierarchy process (AHP), Bayesian networks, fuzzy logic, artificial neural networks (ANN) etc.

***Proposition 6:*** To provide a technology adoption model which solves the issues associated with technological barriers in NZE

* 1. **Discussion on Practices to Net Zero Economy** 
     1. *Organizational and suppliers’ practices*

As the prime stakeholders of NZE are the organization and suppliers, the internal practices hold utmost significance to promote NZE in the SC. Rockström et al. (2017) demonstrated the requirement of promoting scope for economic growth for both organizations and suppliers to aid sustainable practices. On the other hand, Hickel and Kallis (2020) suggest that in a simultaneous manner, effective practices create the base for cost-effective manufacturing and distribution, resulting in economic growth. Stern and Valero (2021) demonstrate the necessary practices of the investors and other shareholders to encourage and support organizations. In essence, the prospect of proper collaboration with other companies in the same industry has been highlighted by Suryanto et al. (2018).

* + 1. *Government aid and support*

Government aid and support for promoting sustainable practices in the SC have been discussed widely. As evaluation shows, support from the government may be financial, political or technological. In essence, effective government policies help in the development of clear sustainable frameworks. Healey et al. (2021) further advocates for practices to hold organizations accountable for their role in environment preservation. Accountability to the government and consumers is to be practised. Zhou et al. (2016) also highlight governmental policies regarding external tax management and providing proper tax benefits to businesses. Hence, these practices by the government support a NZE.

* + 1. *Consumer support for sustainable practices*

Consumers need to be made aware of the requirement of NZE in SCM. Jiang and Tian (2018) and Hunt (2011) advocated the application of informative and effective marketing policies to attract the customer base. Kumar and Chandrakar (2012) also explain the importance of technological advancement in SCM that will enhance the quality of sustainable products. These practices are essential for reaching a wider consumer base and creating a positive impression. Technological assistance provides solutions for managing consumer knowledge and perception towards a product or practice. For instance, big data analytics enable managers to focus on sales history and consumer behavior which in turn, enhances demand forecast and promotions (Mena et al. 2011). Hence, emerging technological advancements will facilitate an efficient knowledge-based SC model to address the issues concerning sustainable practices of consumers and ultimately help an organization to remove this barrier in implementing practices of NZE.

* + 1. *Societal and community perspective*

Attaining community support is possible by simultaneously aiding the growth of the local community. Alam et al. (2014) explains the necessity of including the creation of job positions for local communities to acquire community support. Godar et al. (2016) discuss the current economic position of various underdeveloped communities and various modes of industrial practices to offer sustainability. In essence, the practices assumed by the market create a wider prospect of growth and development as well as environment preservation.

***Proposition 7:*** To develop an empirical study in evaluating the practices for NZE and provide a knowledge-based SC model incorporating those practices

***Proposition 8:*** To identify various AI-techniques which facilitate information and knowledge sharing in the entire SC to implement practices of NZE

***Proposition 9:*** To provide rank/weights to all identified practices to assess the hierarchical importance of these practices in achieving NZE by using multi-criteria techniques.

* 1. **Further Analysis**

Analysis and evaluation of 50 selected articles, in accordance with various perspectives and categories, has provided insightful knowledge pertaining to NZE in the SC. Administration of global SCM has often been recommended to be aligned with local SCs to reduce transport related pollution. As suggested by Plambeck (2012), the current issues of climate change and the further possibility of global warming may result in permanent damage to environmental resources. Hence, SSCM is regarded as a critical factor to create scope for NZE.

Apart from the above-mentioned articles, identification of certain other articles, such as Praene 2012, Zhou et al. 2016 and Deng 2014, on the topic of innovations in practices of NZE should be mentioned. Lack of innovative technology presents critical challenges in SCM. Hence, technological advancement and innovation can be regarded as essential practices to achieve the objectives of a NZE. Additionally, articles such as those by Berry and Marker 2015, Ilić and Nikolić 2016 and Bistline 2021 have also been identified on the topic of drivers of NZE. Further analysis of these additional articles portrays a critical connection between NZE and circular economy.

1. **Conclusion**

Regarding the current scenario of environmental change, there is a great necessity to incorporate SSCM protocols to attain NZE in the SC. It is regarded as an effective solution for balancing carbon emissions due to industrial activities. In this context, knowledge based SSCM can play a crucial role in maintaining resilience and sustainability in SC. However, being a fairly recent concept, practical implementation has been faced with delays. In this regard, this study has attempted to identify the role of knowledge-based SC in mitigating the factors which hinder the ways of achieving reduction in carbon emissions. For this purpose, this research has critically examined 50 articles and identified nine drivers that influence, eight barriers to eradicate and ten practices to implement NZE.

The main findings of the study suggest that economic growth, public health protection and government laws are the top three drivers of NZE which were highlighted and studied in the existing shortlisted articles. Hence, it is suggested that future research/studies can include these drivers in its knowledge-based SC model to develop an improved framework. On the other hand, the top three identified barriers of NZE are policy structure, capital investment and consumer awareness. However these major barriers can be mitigated through technological innovation and a knowledge-based SC model and by implementing the top three major practices of NZE identified in this study. Needed are government implementation of policies, infrastructural modification and training, together with tax benefits and external tax regulations. In addition, the findings of the research reveal that while organizations and suppliers remain the primary stakeholders in all cases, external factors also have a strong influence. Government, society, community and consumers are taken into account in order to develop effective change policies for SSCM. Organizations need to employ technologically advanced tools involved in knowledge-based SC to maintain the quality of products and fulfil market demands. Positive consumer behaviour is aided by the demonstration of quality products and proper marketing, especially for products manufactured with recyclable materials. Certain misconceptions regarding the quality of products have also been encountered as a barrier. Hence, all the barriers discussed in this paper can be resolved through the incorporation of practices that require development on evidence-based frameworks. However, this study has some limitations. For instance, it has only considered research articles on SC and NZE. Hence, future studies can include studies related to project management, consumer behavior and particular industries in relation to reduction of carbon emissions. Furthermore, as the scope of the subject is enormous, it can be concluded that future studies can be carried out using specific industries and geographical locations.

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