



**POLITECNICO**  
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE  
E DELL'INFORMAZIONE

# Bibliometric Analysis on the Importance of Green Manufacturing in Operations Management

TESI DI LAUREA MAGISTRALE IN  
MANAGEMENT ENGINEERING

**Author: Alberto Monforte Gomez**

Student ID: 10915681

Advisor: Federica Costa

Academic Year: 2022-23



# Abstract

This thesis presents a bibliometric analysis investigating the significance of green manufacturing within operations management. As sustainability concerns continue to rise globally, organisations increasingly recognise the need to adopt environmentally friendly practices in their manufacturing processes. This research aims to identify and analyse the key works, research trends, and thematic patterns related to green manufacturing in operations management.

Through bibliometric analysis, this study examines a wide range of academic publications, focusing on journal articles from the Web of Science. The analysis focuses on parameters such as publication output, citation patterns, collaboration networks, and keyword co-occurrence. This research identifies influential authors, leading journals, and prominent research clusters by employing advanced bibliometric techniques, including citation analysis, co-citation analysis, and co-word analysis.

The findings of this bibliometric analysis shed light on the evolution of green manufacturing research within operations management over time. It reveals the most influential research works and provides insights into the field's intellectual structure and thematic landscape. Additionally, this study uncovers emerging research trends, knowledge gaps, and potential future research directions for scholars and practitioners interested in green manufacturing and operations management.

The results of this research contribute to the growing body of knowledge on green manufacturing in operations management by providing a comprehensive overview of the existing literature and research landscape. The insights gained from this study can help researchers identify fruitful areas for further investigation, inform policymakers about the importance of promoting sustainable manufacturing practices, and guide practitioners in implementing environmentally friendly strategies in their operational processes.

**Keywords:** bibliometric analysis, green manufacturing, operations management, sustainability, citation analysis, co-citation analysis, co-word analysis.



# Contents

|   |            |
|---|------------|
| <b>Abstract</b> .....   | <b>i</b>   |
| <b>Contents</b> .....   | <b>iii</b> |
| <b>List of Tables</b> .....                                   | <b>v</b>   |
| <b>List of Figures</b> .....                                  | <b>v</b>   |
| <b>Introduction</b> .....                                     | <b>1</b>   |
| <b>1 Material and methods</b> .....                           | <b>2</b>   |
| 1.1 Data collection .....                                     | 2          |
| 1.2 Bibliometric analysis.....                                | 3          |
| <b>2 Results</b> .....  | <b>6</b>   |
| 2.1 Basic indicators .....                                    | 6          |
| 2.1.1 Years.....  | 7          |
| 2.1.2 Authors .....   | 7          |
| 2.1.3 Institutions .....                                      | 9          |
| 2.1.4 Countries .....   | 10         |
| 2.1.5 Journals .....  | 12         |
| 2.2 Co-citation analysis.....                                 | 13         |
| 2.2.1 Co-authorship .....                                     | 13         |
| 2.2.2 Collaborations between countries .....                  | 13         |
| 2.3 Thematic analysis .....                                   | 14         |
| 2.3.1 Bibliographic coupling for documents and keywords ..... | 14         |
| 2.3.2 Strategic thematic analysis.....                        | 44         |
| 2.4 Analysis of the main results .....                        | 46         |
| <b>3 Discussion and future research</b> .....                 | <b>48</b>  |
| <b>4 Conclusion</b> .....                                     | <b>51</b>  |
| <b>5 References</b> .....                                     | <b>52</b>  |



## List of Tables

|  |    |
|--|----|
| Table 1: Main information.....   | 6  |
| Table 2: Authors with most publications ( $\geq 3$ Recs).....                  | 8  |
| Table 3: Authors with most Total Global Citation Score ( $\geq 323$ TGCS)..... | 8  |
| Table 4: Journals with most publications ( $\geq 3$ RECS).....                 | 12 |
| Table 5: Journals with most TGCS ( $\geq 166$ TGCS).....                       | 12 |

## List of Figures

|  |    |
|--|----|
| Figure 1: Articles published by year.....  | 7  |
| Figure 2: Publications per research field.....   | 9  |
| Figure 3: Institutions with the most recs ( $\geq 3$ Recs).....                                      | 9  |
| Figure 4: Institutions with the most TGCS( $\geq 241$ TGCS).....                                     | 10 |
| Figure 5: Countries with the most recs ( $\geq 5$ ).....   | 11 |
| Figure 6: Countries with the most TGCS ( $\geq 257$ TGCS).....                                       | 11 |
| Figure 7: Co-authorship networks ( $\geq 1$ collaboration).....                                      | 13 |
| Figure 8: Country collaboration world map .....  | 14 |
| Figure 9: Bibliographic coupling analysis for documents ( $\geq 40$ citations per publication) ..... | 15 |
| Figure 10: Bibliographic coupling analysis for co-word networks ( $\geq 5$ co-word networks).....    | 44 |





# Introduction

This document presents a comprehensive analysis of the importance of green manufacturing in operations management, along with the bibliometric analysis conducted to support this thesis. With growing concerns regarding environmental sustainability, the need for sustainable manufacturing practices has become more pressing. As a result, the concept of green manufacturing has emerged as a critical area of interest in the field of operations management.

The document begins with an introduction that provides an overview of the research goals and objectives. It highlights the importance of green manufacturing, its impact on the environment and society, and the need for sustainable manufacturing practices. The introduction also outlines the various bibliometric tools and approaches used in the analysis, including fundamental indicators, co-citation analysis, and thematic analysis.

The material and methods section of the document provides a detailed description of the research methodology used in the analysis. The section outlines the various data sources, the search terms employed, and the selection criteria for identifying relevant studies. It also describes the various bibliometric tools and approaches used in the analysis, including fundamental indicators, co-citation analysis, and thematic analysis.

The results section of the document presents the findings of the bibliometric analysis. It provides a detailed overview of the primary indicators, including publication trends, authors, journals, and citations. The co-citation analysis section presents a map of the co-citation network, highlighting the field's most influential studies and authors and providing a detailed review of the articles. The thematic analysis section presents a strategic diagram of the thematic area analysed, highlighting the driving, niche/specialised, core, and emerging or disappearing themes.

Overall, this thesis offers valuable insights into the importance of green manufacturing in operations management and provides a comprehensive analysis of the research field. The analysis highlights the critical role of green manufacturing in addressing environmental sustainability concerns and provides a roadmap for future research in this area. The analysis results can be helpful for policymakers, practitioners, and researchers interested in sustainable manufacturing practices and operations management.

# 1 Material and methods

## 1.1 Data collection

This bibliometric study analyses the importance of green manufacturing in operations management. The research was conducted on seven April 2023, using the Web of Science database to search for relevant literature. The following search string was used:

"Operation management" (Topic) AND "environmental sustainability" (Topic) AND "green manufacturing" (Topic) AND 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022 OR 2023 (Publication Years) AND Article (Document Types)

This search string combines key terms related to the research question, including "Operation management," "environmental sustainability," and "green manufacturing." Including these terms helps narrow the search results to papers specifically addressing the intersection of these topics. The publication years are set from 2013 to 2023, covering 11 years. This range allows for including recent research while also capturing earlier contributions. Additionally, the search is limited to articles as the document type. This ensures that only articles are included in the search results, filtering out other types of publications, such as conference papers or book chapters.

During the research process, it was found that there were many articles retrieved from the initial search conducted using the specified search string. A further filter was applied to refine the search and focus on the most relevant articles using specific investigation fields. The following filter string was used to exclude certain Web of Science categories from the search results:

"Green Sustainable Science Technology", OR "Environmental Sciences" OR "Engineering Environmental" OR "Environmental Studies" OR "Business" OR "Economics" OR "Engineering Electrical Electronic" OR "Multidisciplinary Sciences" OR "Computer Science Interdisciplinary Applications" OR "Engineering Mechanical" OR "Regional Urban Planning" OR "Computer Science Information Systems" OR "Development Studies" OR "Ecology" OR "Engineering Civil" OR "Information Science Library Science" OR "Materials Science Multidisciplinary" OR "Sport Sciences" OR "Telecommunications" OR "Transportation" OR "Transportation Science Technology" (Exclude – Web of Science Categories) AND "Automation Control Systems" OR "Computer Science Cybernetics" OR "Energy Fuels" OR "Engineering Chemical" OR "Industrial Relations Labor" OR "Psychology Multidisciplinary" OR "Social Issues" OR "Social Sciences Interdisciplinary" (Exclude – Web of Science Categories)

This filter string excludes specific categories within the Web of Science database to narrow the search results to articles more closely aligned with green manufacturing in operations management. By excluding these categories, the search focuses more on the desired research field.

Applying this additional filter helps to refine the search results. It ensures that the analysis is based on articles directly relevant to the investigation of green manufacturing in operations management while excluding articles from unrelated fields.

After applying the additional filter using the specified exclusion string, the final research yielded 56 articles. These 56 articles represent a more refined and focused literature on the importance of green manufacturing in operations management. With this smaller set of articles, the subsequent steps of the bibliometric analysis can be conducted more effectively.

## 1.2 Bibliometric analysis

**HistCite:** HistCite is a powerful software tool for bibliometric analysis and citation network visualisation. It provides researchers, scholars, and information professionals with a comprehensive set of features to explore and understand scientific literature's citation patterns and intellectual structure.

This software offers a user-friendly interface that enables users to import bibliographic data from various sources, such as citation databases, reference management software, or custom datasets. Once the data is loaded, the software employs advanced algorithms to generate citation maps, co-citation networks, and bibliometric indicators.

In summary, HistCite is a valuable software tool for researchers seeking to conduct comprehensive bibliometric analyses and visualise citation networks. By harnessing its features, researchers can gain valuable insights into the intellectual structure of a research field, identify key contributors and influential works, and make informed decisions in their scholarly pursuits.

**Vosviewer:** VOSviewer is a versatile and user-friendly software tool for visualising and analysing bibliometric networks. It enables researchers and information professionals to explore and understand the complex relationships among scientific publications, authors, institutions, and keywords.

The bibliometric analysis involves quantifying and analysing the patterns of scholarly publications and their associated citations. It offers a range of powerful features that help researchers gain insights into research fields' structure, impact, and dynamics.

The software also provides advanced analysis tools for bibliometric studies. It offers various metrics and indicators, such as citation counts, co-occurrence frequencies, and collaboration strength, allowing researchers to quantify the impact and relationships within a network. Additionally, the software supports clustering algorithms, which automatically group related items based on their similarity, facilitating the identification of research themes and subfields.

In conclusion, VOSviewer is a powerful software tool that facilitates the visualisation and analysis of bibliometric networks. Its features and capabilities enable researchers to gain valuable insights into the structure and dynamics of research fields, identify critical contributors and collaborations, and explore emerging trends. With its user-friendly interface and customisable options, VOSviewer has become an essential tool for researchers seeking to harness the power of bibliometric analysis.

**Rstudio:** R, a widely used open-source programming language and software environment, has emerged as a powerful tool for conducting bibliometric analysis. With its extensive collection of packages and libraries specifically designed for handling bibliographic data, R provides researchers with a flexible and customisable platform to explore and analyse scholarly literature.

Bibliometric analysis involves quantitatively examining publications and citations, enabling researchers to uncover patterns, trends, and relationships within a field of study. R offers a range of packages, such as bibliometrix, which provides specialised functions and algorithms for processing bibliographic data, constructing citation networks, and calculating various bibliometric indicators.

One of the key advantages of using R for bibliometric analysis is its ability to handle large and complex datasets. Researchers can import bibliographic data from different sources, such as Web of Science, Scopus, or PubMed, and leverage R's data manipulation and cleaning capabilities to preprocess the data for analysis. R's programming capabilities allow for efficient data wrangling, filtering, and merging, ensuring researchers fully control the data preparation process.

R's vast collection of statistical and analytical functions empowers researchers to perform various bibliometric calculations. From calculating citation counts and impact factors to conducting co-citation and co-authorship analyses, R provides researchers with the tools to quantify and assess the influence and interconnectedness of scholarly literature.

In conclusion, R has become an invaluable tool for conducting bibliometric analysis. Its versatility, extensive package ecosystem, and statistical capabilities make it a go-to platform for researchers interested in exploring and understanding the structure and impact of scholarly literature. By harnessing the power of R, researchers can gain valuable insights into research networks, track research trends, and contribute to the growing field of bibliometrics.

## 2 Results

After all the documents were reviewed, the search in the WoS database retrieved a total of 56 articles published in 21 journals by 183 authors. The average number of citations per document is 43.3. A total of 240 keywords and 230 author's keywords were found. Finally, the number of authors per paper is around 3, with an international collaboration rate of 41.67%. This information can be seen in Table 1.

| <b>MAIN INFORMATION ABOUT THE DATA</b> |           |
|--|-----------|
| Timespan                               | 2014:2023 |
| Sources (Journals, Books, etc.)        | 21        |
| Documents                              | 60        |
| Annual Growth Rate %                   | -7.41     |
| Document Average Age                   | 4.3       |
| Average citations per doc              | 43.3      |
| References                             | 3882      |
| <b>DOCUMENT CONTENTS</b>               |           |
| Keywords Plus (ID)                     | 240       |
| Author's Keywords (DE)                 | 230       |
| <b>AUTHORS</b>                         |           |
| Authors                                | 183       |
| Authors of single-authored docs        | 5         |
| <b>AUTHORS COLLABORATION</b>           |           |
| Single-authored docs                   | 5         |
| Co-Authors per Doc                     | 3.45      |
| International co-authorships %         | 41.67     |
| <b>DOCUMENT TYPES</b>                  |           |
| article                                | 56        |
| article; early access                  | 3         |
| article; proceedings paper             | 1         |

Table 1: Main information

### 2.1 Basic indicators

This first section of the results presents the fundamental indicators, giving details of the papers and citations per year, the number of papers and citations per author, institution and country. Likewise, the journals that published at least one article, the number of publications, citations and the impact factor are listed. Finally, the authors' keywords are presented according to the year of publication.

### 2.1.1 Years

The number of published articles is 56, published from 2014 to 2023. The publications per year range from two to 10, with a mean of 5.7 and a standard deviation of 2.36 ( $n = 56$ ; range = 2-10; mean = 5.7; SD = 2.36). The first article was published in 2014, with six publications ( $n = 6$ ). In the next two years, the number of publications remains constant ( $n=6$ ) until 2017, when these numbers decrease significantly ( $n=2$ ). We can observe slow growth at 10 publications in 2022 in the following years. Furthermore, the annual growth rate percentage is negative and equals -7.41%, as shown in Table 1.

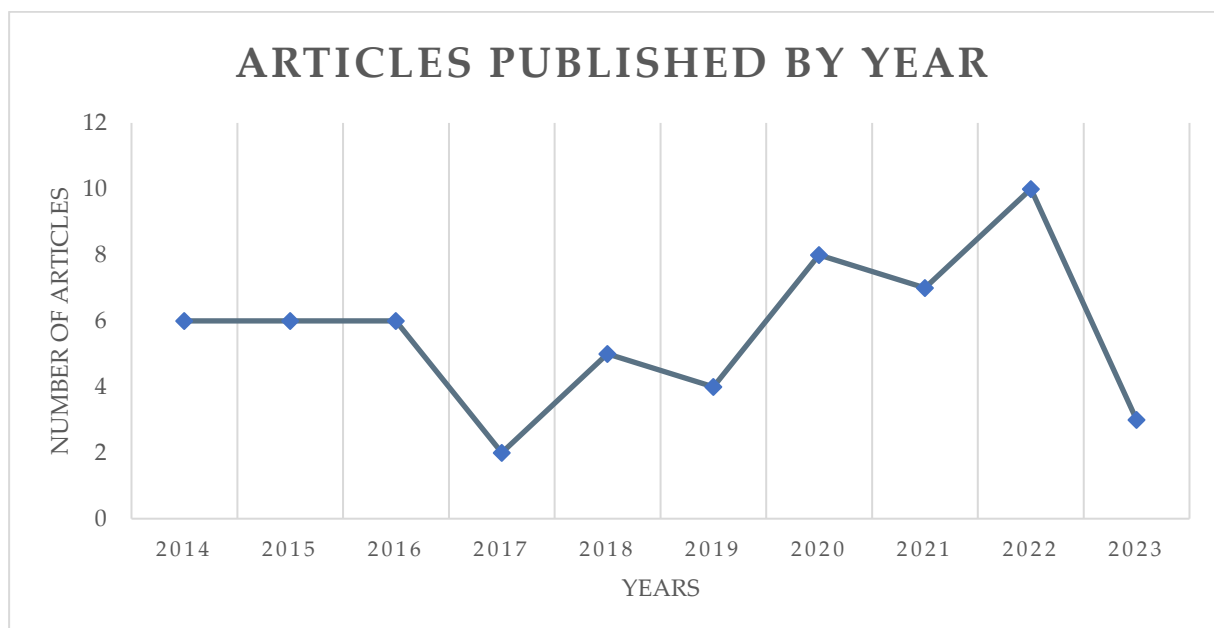


Figure 1: Articles published by year.

### 2.1.2 Authors

183 researchers have published at least one article on Operation management, environmental sustainability, and green manufacturing. The publications ranged from one to three, with a mean of 1.13 and a standard deviation of 0.42 (range = 1–3; Mean = 1.13; SD = 0.42). The researchers with the most publications on this subject were Afum E, Agyabeng-Mensah Y, Cagliano R, Khan SAR, Lai KH, and Longoni A, with three papers each, as shown in Table 2.

| <b>Author</b>     | <b>Recs</b> | <b>TGCS</b> |
|-------------------|-------------|-------------|
| Afum E            | 3           | 74          |
| Agyabeng-Mensah Y | 3           | 74          |
| Cagliano R        | 3           | 241         |
| Khan SAR          | 3           | 203         |
| Lai KH            | 3           | 178         |
| Longoni A         | 3           | 241         |

Table 2: Authors with most publications ( $\geq 3$  Recs)

Likewise, Garza-Reyes JA had the most overall citations with 362, followed by Alencastro V, Caiado RGG, Lona LR, Nascimento DLM, Quelhas OLG and Tortorella G with 323, as shown in Table 3.

| <b>Author</b>  | <b>Recs</b> | <b>TGCS</b> |
|----------------|-------------|-------------|
| Garza-Reyes JA | 2           | 362         |
| Alencastro V   | 1           | 323         |
| Caiado RGG     | 1           | 323         |
| Lona LR        | 1           | 323         |
| Nascimento DLM | 1           | 323         |
| Quelhas OLG    | 1           | 323         |
| Tortorella G   | 1           | 323         |

Table 3: Authors with most Total Global Citation Score ( $\geq 323$  TGCS)

These authors work in different research fields. The most common is “Engineering Industrial” and “Management”, with 34 authors each, followed by “Engineering Manufacturing”, with 33 authors and “Operations Research Management Science,” with 26 authors. The results are shown in Figure 2.



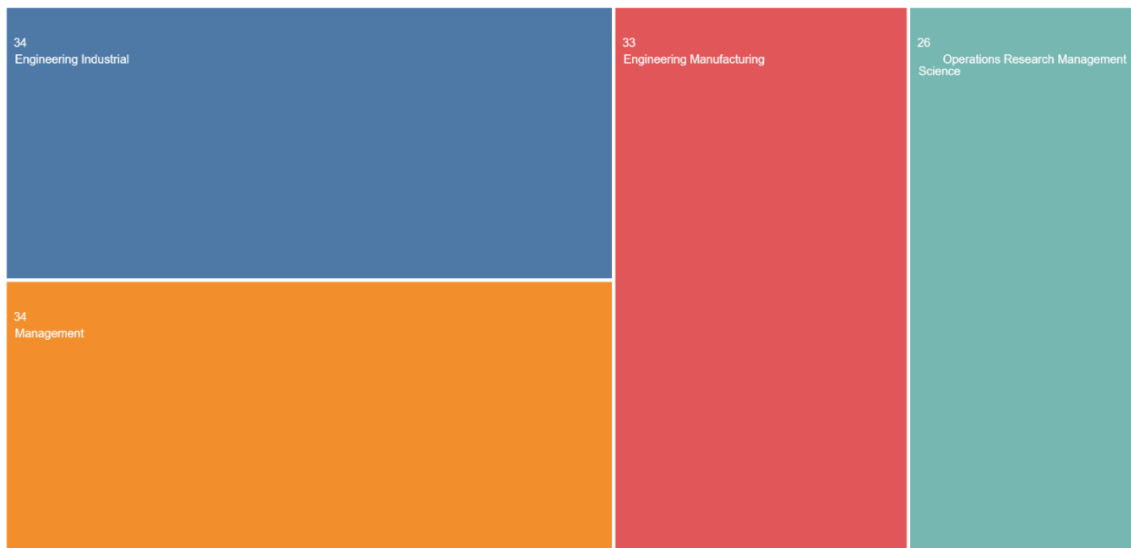


Figure 2: Publications per research field

### 2.1.3 Institutions

The number of institutions with publications is 118. The number of publications ranges from one to 3, with a mean of 1.21 and a standard deviation of 0.54 (range = 1–3; Mean = 1.21; SD = 0.54). Seven of them have three articles, eleven of them have two, and the rest have one article. As can be seen in Figure 3 and establishing three publications as the cut-off point ( $\geq 3$ ), Abu Dhabi University, Dalian Maritime University, Hong Kong Polytechnic University, Politecnico Milan, Tsinghua University, University Bergamo, and University Derby are the universities with the most published papers with three papers each.

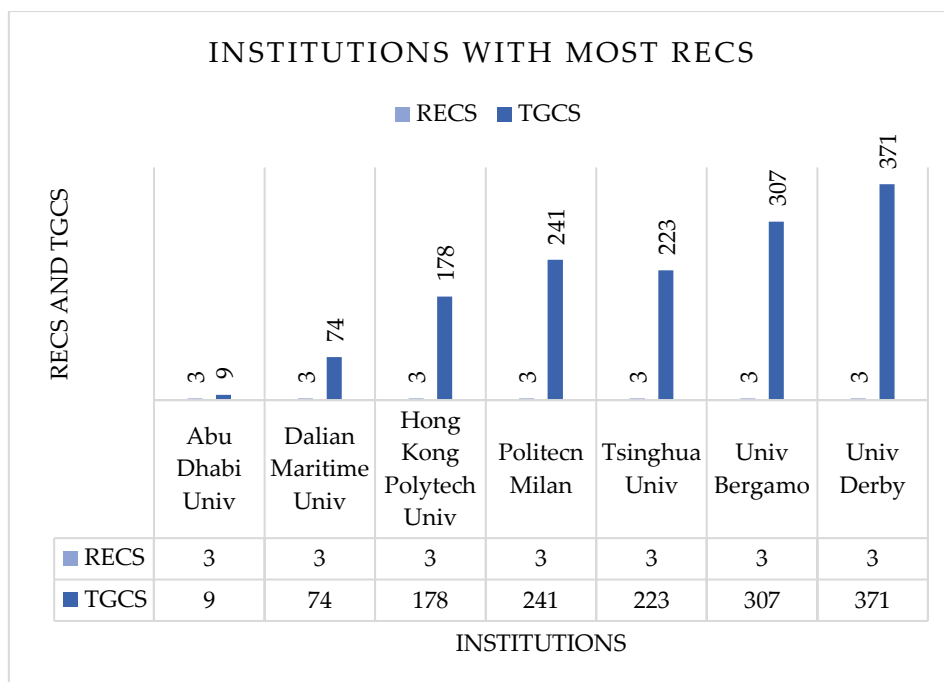


Figure 3: Institutions with the most recs ( $\geq 3$  Recs)

However, there are a total of 2598 global citations, ranging from 0 to 371, with a mean of 58.83 and a standard deviation of 81 (range = 0–371; mean = 58.84; SD = 81), with 241 citations as the cut-off point ( $\geq 241$ ) and the University Derby has the most global citations, with a total of 371, followed by Cinvestav, Fed Fluminense University, Pontifical Catholic University Rio De Janeiro, University Fed Santa Catarina with 323, University of Bergamo and Politecnico Milan, respectively with 307 and 241 total global citations as shown on figure 4.

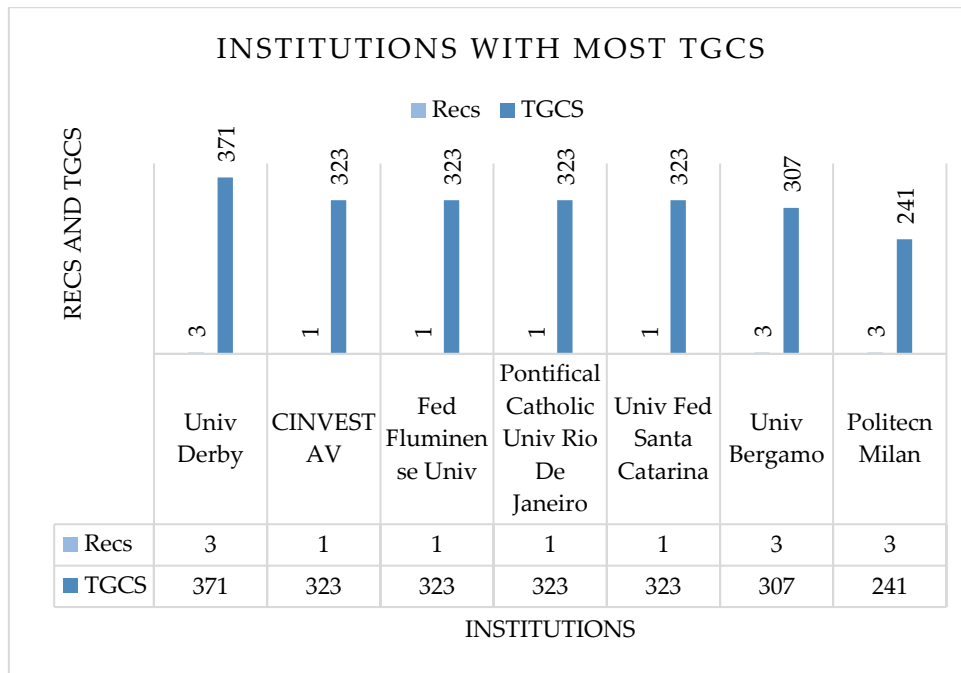


Figure 4: Institutions with the most TGCS( $\geq 241$  TGCS)

### 2.1.4 Countries

Researchers from 27 countries have published at least one article on this Research Topic. The total number of articles is 56. The number of publications ranges from one to 17, with a mean of 3,44 and a standard deviation of 3,83 ( $N = 56$ ; range = 1–17; mean = 3,44; SD = 3,83). Establishing three articles ( $\geq 5$ ) as the cut-off point, the country with the most publications is the Peoples R China ( $n = 17$ ), followed by the United Kingdom ( $n=11$ ), India ( $n=9$ ), Italy ( $n=7$ ), Pakistan ( $n=6$ ) and finally, Brazil, United Arab Emirates and USA( $n = 5$ ). This can be seen in Figure 5 below.

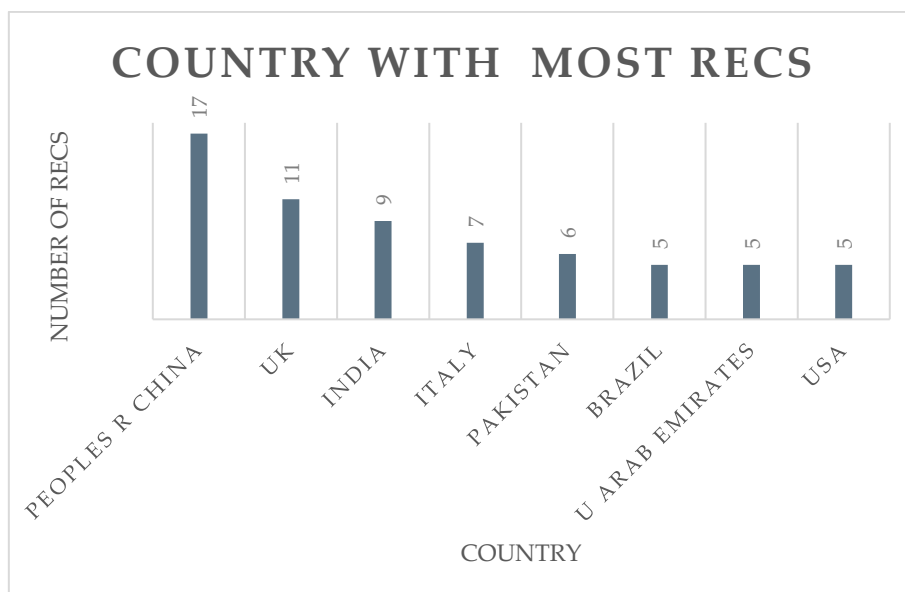


Figure 5: Countries with the most recs ( $\geq 5$ )

The number of citations ranged from 3 to 803, with a mean of 172.7 and a standard deviation of 222.9 (range = 0–803; Mean = 172.7; SD = 222.9). The countries that have received the most citations in the WoS as a whole, with a cut-off point of more than 257 articles, are the following: United Kingdom (n = 803), Peoples R China (n = 758), Italy (n = 546), Brazil (n = 393), Mexico (n=323), India (n=292), USA (n= 268) and finally Taiwan (n=257) (see Figure 6).

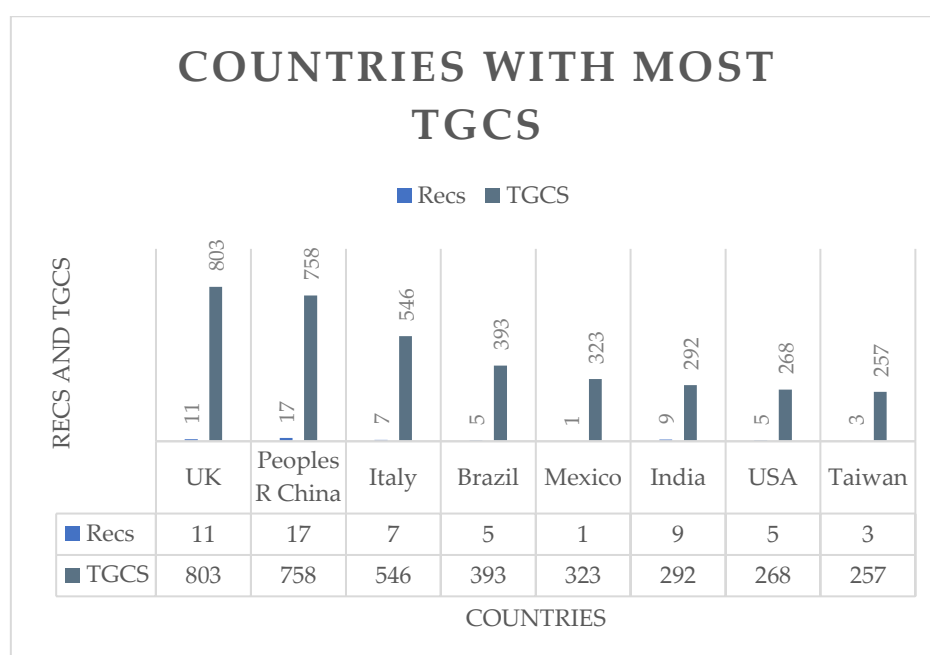


Figure 6: Countries with the most TGCS ( $\geq 257$  TGCS)

We see variations between the countries with the most publication and the countries with the most total global citation score. On the side of the countries with the most total global citations score, two new countries appear, Mexico with 1 publication but 323 TGCS and Taiwan with 3 publications but 257 TGCS

### 2.1.5 Journals

A total of 21 journals have published at least one article on this topic. Establishing the cut-off point in three or more publications ( $n \geq 3$ ), we obtain the following information (Table 4). The journals with the most articles published are *International Journal Of Production Economics* ( $n=15$ ), *Journal Of Manufacturing Technology Management* ( $n=7$ ), *International Journal Of Production Research* ( $n=6$ ), *International Journal Of Operations & Production Management* ( $n=4$ ), *Production Planning & Control* ( $n=4$ ), *International Journal Of Logistics-Research And Applications* ( $n=3$ ).

| Journals   | Recs |
|--|------|
| INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS                | 15   |
| JOURNAL OF MANUFACTURING TECHNOLOGY MANAGEMENT               | 7    |
| INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH                 | 6    |
| INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT  | 4    |
| PRODUCTION PLANNING & CONTROL                                | 4    |
| INTERNATIONAL JOURNAL OF LOGISTICS-RESEARCH AND APPLICATIONS | 3    |

Table 4: Journals with most publications ( $\geq 3$  RECS)

There is a relevant link between the articles published and the total global citations received by each journal. Table 5, shown below, shows the journals with the most total global citations, ordered from highest to lowest, with a cut-off set at TGCS = 166. The order of relevance is barely changed, except for the *International Journal Of Production Research*, which was in the third position but has scaled to the second position with a 535 total global citation score and in the last place, it appears *Journal Of Purchasing And Supply Management* with only two publication but a total global citation score of 166.

| Journals   | Recs | TGCS |
|--|------|------|
| INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS                | 15   | 718  |
| INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH                 | 6    | 535  |
| JOURNAL OF MANUFACTURING TECHNOLOGY MANAGEMENT               | 7    | 421  |
| INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT  | 4    | 285  |
| INTERNATIONAL JOURNAL OF LOGISTICS-RESEARCH AND APPLICATIONS | 3    | 208  |
| JOURNAL OF PURCHASING AND SUPPLY MANAGEMENT                  | 2    | 166  |

Table 5: Journals with most TGCS ( $\geq 166$  TGCS)

## 2.2 Co-citation analysis

This section presents the analysis of the co-citations. First, the co-authorship network is represented, followed by the cross-country collaboration networks, and finally, the keyword networks are presented. All these results are shown in the maps below.

### 2.2.1 Co-authorship

Of the 183 authors, only collaborations between authors who have written one or more articles are presented. The 10 co-authorship networks involving 31 researchers who have published a joint article on this topic are presented. There is one network of six collaborators, one network of five collaborators, one network of four collaborators, two networks of three collaborators and four networks of two collaborators. Figure 7 shows the various collaborative networks.

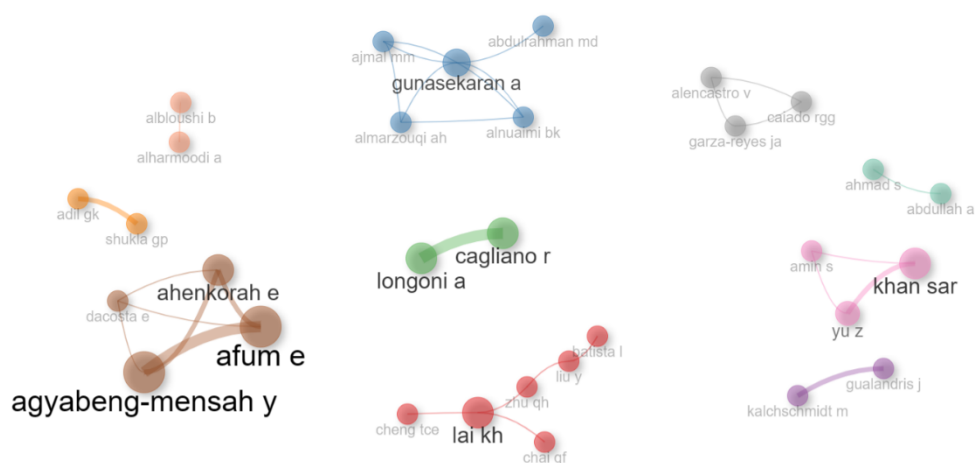


Figure 7: Co-authorship networks ( $\geq 1$  collaboration)

### 2.2.2 Collaborations between countries

Figure 8 shows that China is the most collaborative country regarding cross-country collaborations, followed by the United States and Brazil. There are also strong collaboration networks with Australia, Canada and India.

## Country Collaboration Map

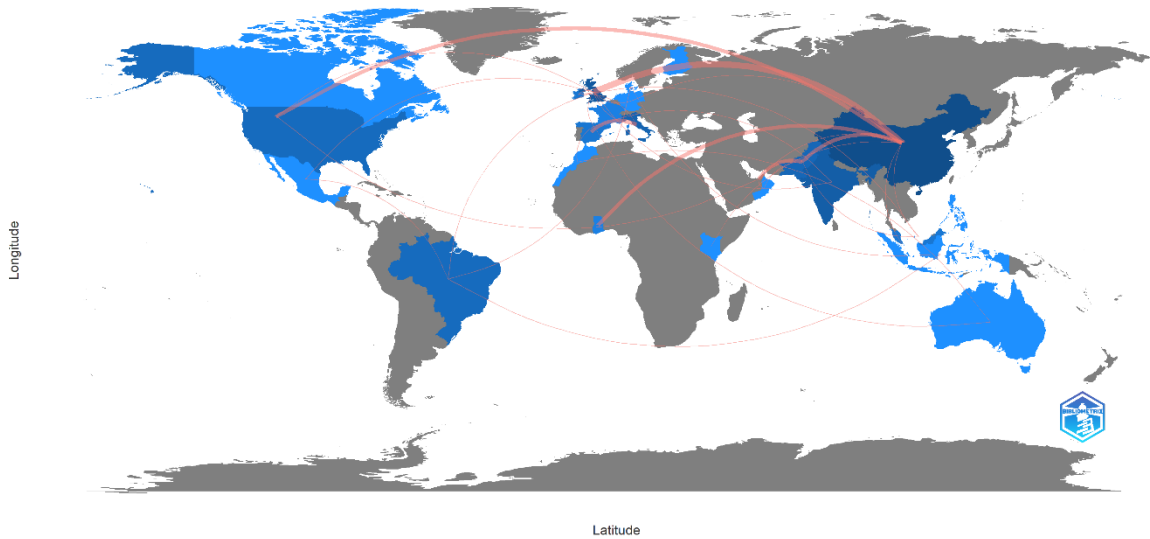


Figure 8: Country collaboration world map

## 2.3 Thematic analysis

Finally, this third section presents the results of the thematic analysis. First, we show the bibliographic coupling analyses by documents and words, and second, a strategic diagram of the various themes. Maps represent all these results.

### 2.3.1 Bibliographic coupling for documents and keywords

The bibliographic coupling for documents established a cut-off point of at least 40 citations per document ( $\geq 40$ ). Subsequently, only those connected were selected, leaving the final analysis with 23 documents distributed in five clusters (one colour per cluster). The size of the letter is proportional to the number of citations and the frequency of connections between them. These clusters are shown in Figure 9. A thematic review of each cluster with the number of papers, citations and most prominent authors is provided below.

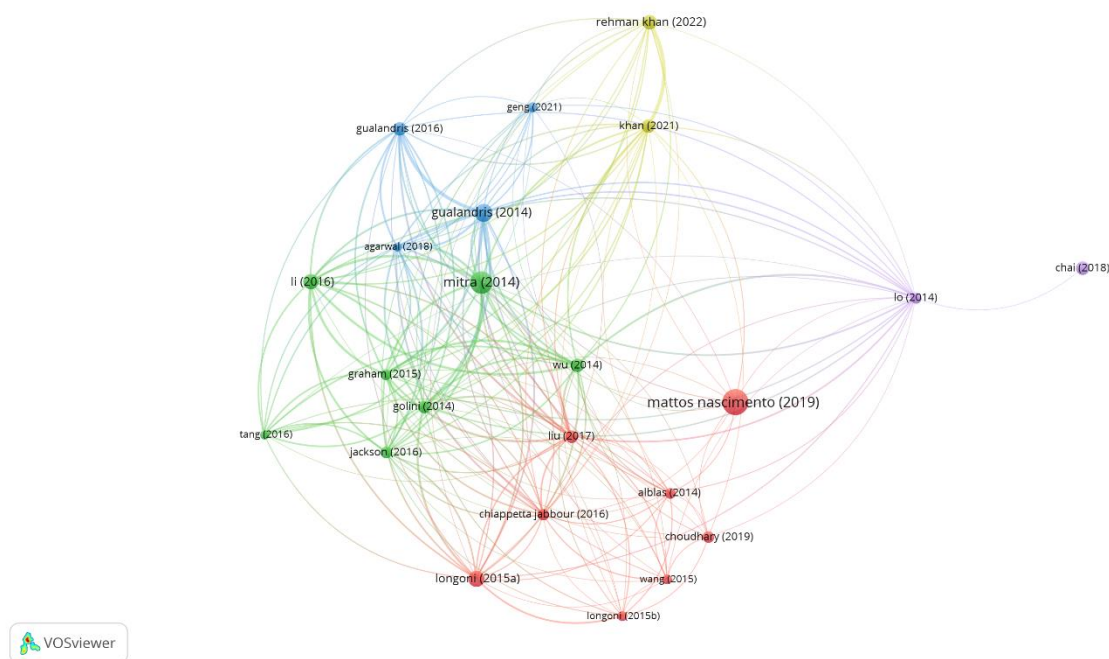


Figure 9: Bibliographic coupling analysis for documents ( $\geq 40$  citations per publication)

### 2.3.1.1 Cluster 1

#### 2.3.1.1.1 Zhen Wang's article "Composite Sustainable Manufacturing Practice and Performance Framework: Chinese Auto-Parts Suppliers' Perspective."

The author Zhen Wang in the article "Composite Sustainable Manufacturing Practice and Performance Framework: Chinese Auto-Parts Suppliers' Perspective", explores the implementation and effectiveness of composite sustainable manufacturing practices in the Chinese auto parts industry. The authors aim to examine the relationship between lean, green, and social responsibility practices and these companies' triple bottom line (3BL) performance.

The introduction highlights the growing importance of sustainability as a key objective for organisations. It emphasises the need for a comprehensive approach considering all three triple bottom-line dimensions (environmental, economic, and social sustainability) to achieve long-term sustainability. The authors also note the gaps in the literature regarding the implementation and effectiveness of composite sustainability practices, particularly in the Chinese automotive industry.

The study's objectives are clearly stated, focusing on examining the effectiveness of composite practices in improving sustainability performance in Chinese auto parts companies. The authors aim to minimise economic and environmental indicators while maximising the social welfare indicator, reflecting the 3BL perspective.

The research methodology employed a case study approach, suitable for investigating the "how" aspect of composite sustainable manufacturing practices and their impact on sustainability. The selection of two auto-parts companies in Ningbo, a coastal city known for its auto industry, provides a focused and in-depth investigation.

The study's findings highlight the importance of lean practices in the auto parts industry, with total productive maintenance and continuous improvement being the most widely practised. Reducing CO2 emissions and business wastage is emphasised for environmental reasons, technological advancements, and cost savings. The production manager for one of the companies mentioned the significant cost savings achieved through energy and materials elimination or reduction, along with improved product quality.

The study's contribution to the literature examines the combined effects of lean, green, and social practices on sustainability in the Chinese automotive industry. Previous studies have often focused on these practices in isolation, but this research fills a gap by considering all three aspects together. The higher implementation levels of 'health and safety' and 'employee education and training practices' compared to other social methods in the investigated companies indicate their commitment to social responsibility.

Overall, the findings underscore the importance of considering all three dimensions of sustainability (environmental, economic, and social) for long-term success. (Wang et al., 2015)

#### 2.3.1.1.2 Daniel C. Nascimento's article "Exploring Industry 4.0 Technologies to Enable Circular Economy Practices in a Manufacturing Context."

The author Daniel C. Nascimento in the article "Exploring Industry 4.0 Technologies to Enable Circular Economy Practices in a Manufacturing Context", delves into integrating Industry 4.0 technologies with circular economy (CE) practices. Industry 4.0, driven by advancements in information and communication technologies, encompasses various technologies such as the Internet of Things (IoT), augmented reality, additive manufacturing (AM), big data, cloud computing, simulation, industrial automation, and cybersecurity.

Previous studies have demonstrated that these technologies enable operational efficiency, improved data control, and reduced energy waste. Building upon this foundation, the paper aims to explore the integration of Industry 4.0 technologies with circular economy practices, particularly in establishing a business model that promotes the reuse and recycling of wasted materials, such as scrap metal or e-waste.



The study discusses the implications of Industry 4.0 technologies in facilitating the integration of circular economy practices. One specific technology highlighted is three-dimensional (3D) printing, which is vital in achieving the desired integration. The study presents a circular, smart production system (product life cycle, selective waste collection, waste sorting, waste treatment, product printing, product assembly if necessary, and product selling) model, which outlines the steps involved in the integration process.

During the discussion, certain stages of the circular, smart production system model, specifically stages 4 and 5, were frequently questioned and examined. The study proposes a solution for recycling cast iron through sorting, separating, and creating a mould using a 3D printer. The materials undergo a heating process, where the mould evaporates without leaving any residue.

In conclusion, the study explores the integration of Industry 4.0 technologies with CE practices and proposes a circular business model that reduces resource consumption and optimises natural resources. The model focuses on recycling electronic scrap and incorporates web technologies, reverse logistics, and additive manufacturing as a technological platform. Adopting this circular business model has broad environmental, sociotechnical, and economic implications for society. Furthermore, integrating Industry 4.0 technologies in CE practices allows stakeholders to shift their focus from technical aspects to research, development, and innovation, as many processes become automated. (Nascimento et al., 2019)

#### 2.3.1.1.3 Annachiara Longoni's article "Cross-functional Executive Involvement and Worker Involvement in Lean Manufacturing and Sustainability Alignment."

Annachiara Longoni's article "Cross-functional Executive Involvement and Worker Involvement in Lean Manufacturing and Sustainability Alignment" explores the strategic alignment between lean manufacturing and environmental and social sustainability. Sustainability has become an essential element of company strategies, and integrating sustainability goals and practices into lean manufacturing operations presents challenges.

While lean manufacturing has been traditionally viewed positively, there has been a growing debate about its potential negative impact on environmental and social sustainability. Social networks and online platforms have seen discussions about the environmental and social effects of lean manufacturing.

The study aims to understand how cross-functional executive and worker involvement contribute to the strategic alignment of lean manufacturing and sustainability. The aim is to examine whether and how lean manufacturing can be aligned with environmental and social sustainability goals.

The research methodology involves ten case studies of companies that have adopted lean manufacturing and have environmental and social sustainability goals. The authors selected leading companies based on lean manufacturing awards and secondary sources. The sample population was limited to companies with sustainability goals at both the company and operations levels, confirmed through sustainability reports and interviews.

The results highlight different organisational models and their impact on strategic alignment between lean manufacturing and environmental and social sustainability. Companies characterised by an advanced corporate model, with high cross-functional executive involvement and worker involvement, exhibit higher levels of alignment and overall sustainability performance. On the other hand, companies with less involvement demonstrate lower alignment and below-average sustainability performance.

The findings suggest that companies with an advanced organisational model can enhance the positive links between lean manufacturing and sustainability while avoiding negative associations. These companies achieve higher financial performance, cash flow, and material usage reduction than the sample average.

In conclusion, the study contributes to understanding the strategic alignment between lean manufacturing and environmental and social sustainability. The results emphasise the importance of cross-functional executive and worker involvement in achieving alignment and driving sustainability performance. (Longoni & Cagliano, 2015a)

#### 2.3.1.1.4 Annachiara Longoni's article "Environmental and social sustainability priorities: Their integration in operations strategies."

The author Annachiara Longoni once more, with another article called "Environmental and Social Sustainability Priorities", explores the integration of environmental and social sustainability into operations strategy configuration models. Sustainability has become increasingly important for companies as they recognise the need to ensure long-term success for both people and the planet. The competitive landscape is transforming due to the quest for sustainability, which necessitates product, technology, process, and business model changes. A McKinsey survey indicates that more companies actively incorporate sustainability priorities into their business strategies. Despite recognising the relevance of operations processes to sustainability, companies face challenges in implementing environmental and social sustainability in their operations strategies.

The study's objectives are to determine whether existing operations strategy configuration models can be modified to include environmental and social priorities and to evaluate the success of different operations strategy configuration models in the short and long term.

The research methodology employs a survey-based approach using data from the fifth release of the International Manufacturing Strategy Survey (IMSS) collected in 2009. The sample consists primarily of European and American companies in the assembly industry, chosen to replicate and extend previous studies on operations strategy configuration models.

The results involve replicating traditional operations strategy configuration models and identifying new models incorporating environmental and social priorities. The analysis reveals four standard configurations and similar models when sustainability priorities are included. No specific configuration models primarily characterised by environmental and social stresses emerged.

The discussion focuses on analysing the research propositions, particularly identifying configuration models and their relationship with traditional and sustainability priorities. The study finds that companies integrate environmental and social sustainability into existing operations strategies rather than developing entirely new approaches. The "new caretakers" and "new innovators" configuration models are most similar to traditional models but also consider sustainability priorities. It suggests that sustainability is integrated into conventional operations strategies, enriching and expanding them. Among the market-oriented configuration models, "new servers" are firmly committed to sustainability, indicating its growing priority for companies competing in after-sales and customer service.

In conclusion, this research enhances the understanding of how companies integrate environmental and social sustainability priorities into their operations strategies. The findings emphasise the integration of sustainability into existing models rather than the development of separate models. This has implications for the strategic management of sustainability and the incorporation of sustainability principles into operations management practices. (Longoni & Cagliano, 2015b)

#### 2.3.1.1.5 Yang Liu's article "Linking Capabilities to Green Operations Strategies: The Moderating Role of Corporate Environmental Proactivity."

Yang Liu, the author of the article "Linking Capabilities to Green Operations Strategies: The Moderating Role of Corporate Environmental Proactivity", explores the role of supply chain capabilities in implementing green operations strategies. The need to address environmental issues in business operations has gained significant attention, leading to various green operations strategies such as green design, green purchasing, green supply chains, and green manufacturing.

The authors highlight leading multinational companies, including PUMA, Unilever, and Mazda, that have invested in green operations strategies to demonstrate the increasing importance of sustainability initiatives in the business landscape.

The study's objective is to investigate the specific role of supply chain capabilities in implementing green operations strategies. The authors interviewed academics and industrial managers in logistics, supply chain, and environmental management to gather preliminary insights. They developed a questionnaire based on the findings from the interviews and literature and pre-tested it with relevant professionals. They conducted a pilot test with supply chain/logistics managers in the automotive industry.

The study results indicate that firm size has a significant positive effect on all dependent variables. The authors discuss the implications of their findings, emphasising the role of supplier appraisal and supply chain management skills and knowledge in supporting green design. They highlight the increasing importance of suppliers in the product development process and how a strong supplier appraisal capability, combined with supply chain management skills and knowledge, facilitates the adoption of green design strategies.

Drawing on the theoretical models of the Resource-Based View, the study argues that adopting green operations strategies requires developing and deploying specific supply chain capabilities. The findings contribute to understanding the importance of firm-level conditions in leveraging resources and capabilities to achieve a competitive advantage.

While the study provides valuable insights into green operations strategy implementation, it has limitations. The multidimensional nature of supply chain flexibility represents a challenge in accurately assessing its effects on green operations strategies. This limitation opens avenues for future research. Additionally, longitudinal data would allow for exploring causal relationships beyond mere associations.

In conclusion, this study sheds light on the role of supply chain capabilities in implementing green operations strategies. It highlights the importance of supplier appraisal and supply chain management skills and knowledge in supporting green design. It emphasises the significance of firm-level conditions in leveraging resources and capabilities for competitive advantage. (Liu et al., 2017)

#### 2.3.1.1.6 Sonal Choudhary article "An Integrated Lean and Green Approach for Improving Sustainability Performance: A Case Study of a Packaging Manufacturing SME in the U.K."

The author Sonal Choudhary in the article "An Integrated Lean and Green Approach for Improving Sustainability Performance: A Case Study of a Packaging Manufacturing SME in the U.K.", focuses on the increasing pressures faced by manufacturing organisations, especially small- and medium-sized enterprises (SMEs), to improve their environmental performance due to factors such as climate change, depleting natural resources, population growth, and stricter government regulations.

The authors highlight the importance of aligning business strategies and operations to improve financial and environmental performance in response to the competitive landscape and informed customers. They reference previous research that emphasises the need for industries, regardless of size, to incorporate lean and green strategies to achieve operational excellence and enhance environmental performance.

The research aims to develop a simple tool to measure and improve operational and green performance without requiring significant capital expenses or solid technical knowledge.

The methods employed in the study involve examining the production strategy of the packaging manufacturing SME in the U.K. The need for advanced production strategies in the company, such as lean practices and visual control systems, is identified. The absence of a robust quality assurance process is also noted. The findings indicate the company's reliance on weekly batch schedules and inefficient cooling mechanisms, which result in prolonged cycle times and high carbon emissions.

The discussion highlights SMEs' challenges in adopting complex calculations or various indicators to measure and improve their environmental impact. The authors argue that it is essential to have easy-to-measure and implement ecological measures for practical relevance, in line with previous recommendations. It emphasises the scarcity of empirical research that successfully integrates lean and green approaches for continuous improvement while considering operational efficiency and environmental performance. A research gap is identified in successfully integrating lean and green paradigms, particularly within SMEs.

In conclusion, the study documents a case study of a packaging manufacturing SME in the U.K., proposing a systematic methodology and a novel tool called the Green Integrated Value Stream Mapping (GIVSM). The GIVSM allows for the simultaneous deployment of lean and green initiatives to improve operational and environmental performance. The authors highlight the practical contribution of this tool for SMEs and its potential to address the research gap in integrating lean and green paradigms.(Choudhary et al., 2019)

### 2.3.1.1.7 Charbel José Chiappetta Jabbour's article "Barriers to the Adoption of Green Operational Practices at Brazilian Companies: Effects on Green and Operational Performance."

The author Charbel José Chiappetta Jabbour, in the article "Barriers to the Adoption of Green Operational Practices at Brazilian Companies: Effects on Green and Operational Performance", explores the impact of internal barriers (IBs) and external barriers (EBs) to environmental management on the adoption of green operational practices (GOPs) within Brazilian industrial companies. It also examines how these barriers influence the firms' operational performance (OP) and green performance (GP) indicators.

The introduction highlights the inhibitory role of internal and external barriers in implementing green management practices within organisations. The research aims to understand how these barriers affect the adoption of GOPs and their influence on operational and green performance indicators in Brazilian companies.

The literature review reveals a need for more studies focusing on the effects of green barriers and GOPs on firms' operational and green indicators. Most existing studies primarily concentrate on planning and organisational practices, particularly environmental management systems.

The paper's objectives are to investigate the impact of IBs and EBs on adopting GOPs and determine their influence on firms' operational and green performance. The study is based on ecological modernisation and natural resource-based view theories. It aims to establish direct and indirect relationships between internal and external green barriers and the adoption of GOPs and firms' performance indicators.

The findings indicate no statistically significant differences, suggesting no systematic non-response bias that could affect the results. The discussion emphasises that internal barriers (IBs) are more relevant than external barriers (EBs) when adopting GOPs. This implies that companies should focus on addressing IBs and increasing the green awareness of managers through training initiatives to build competitive advantages and improve performance.

Human skills, such as green training and awareness, are essential to overcome internal barriers. The conclusion emphasises combining ecological modernisation issues and the natural resource-based view to connect new green laws, overcome IBs, and enhance performance.

Overall, this article sheds light on the barriers to adopting green operational practices in Brazilian companies and their impact on operational and green performance. The findings underscore the significance of internal barriers and the need to prioritise strategies that enhance green awareness and offer sufficient green training to managers. (Jabbour et al., 2016)

#### 2.3.1.1.8 A.A. Alblas's article "Fuzzy Sustainability Incentives in New Product Development."

A.A. Alblas 's article "Fuzzy Sustainability Incentives in New Product Development" focuses on manufacturing companies' challenges in managing their products' sustainability. The introduction highlights the increasing interest of manufacturing organisations in sustainability management and the wide range of theories and studies available in the academic literature.

The paper's objectives are to improve understanding of the difficulties in managing sustainability from an organisational perspective and to investigate the challenges and opportunities in driving sustainability in new product development (NPD). The research design involves conducting an in-depth exploratory study using homogenous and variation sampling strategies to select cases from manufacturing firms.

The results section presents the initial assessment of sustainability issues and reports the findings from two rounds of interviews with representatives from six case companies. The data collected through workshops and interviews are structured and interpreted using the systems theory of control.

Overall, this article provides insights into the difficulties manufacturing companies face in managing sustainability in the context of new product development. Exploring the challenges and opportunities in this area contributes to a better understanding of the complexities involved. It offers potential directions for future research in the field of sustainable product development.((Alex) Alblas et al., 2014)

#### 2.3.1.1.9 Cluster 1 discussion

The articles examined in this literature review highlight the growing importance of sustainability in various manufacturing contexts. The studies explore different aspects of sustainability, including environmental, economic, and social dimensions, and propose strategies for integrating sustainable practices into manufacturing operations. Besides the overarching theme of sustainability and manufacturing practices, the articles also focus on specific industries or contexts. All writing in this cluster has in common four main topics. The first is industry-specific focus; some articles concentrate on industries or sectors. For example, Zhen Wang focuses on the Chinese auto parts industry(Wang et al., 2015), while Sonal Choudhary presents a case study of a packaging manufacturing SME in the U.K(Choudhary et al., 2019). This industry-specific approach allows for a more tailored examination of sustainability challenges and opportunities within those contexts. Secondly, we have technological integration; many articles discuss integrating advanced technologies with sustainability practices. Daniel C. Nascimento explores the integration of Industry 4.0 technologies, such as the Internet of Things and additive manufacturing(Nascimento et al., 2019), while Yang Liu highlights the role of technology adoption in achieving sustainability goals(Liu et al., 2017). This focus on technology underscores the potential for technological

advancements to support sustainable manufacturing practices. Thirdly, they talk about organisational involvement and collaboration; several articles emphasise the importance of organisational participation and cross-functional collaboration. Annachiara Longoni discusses the role of cross-functional executive and worker involvement in achieving sustainability goals (Longoni & Cagliano, 2015a), while Sonal Choudhary proposes a tool that combines lean and green initiatives, highlighting the need for collaboration between different departments within an organisation (Choudhary et al., 2019). Finally, the last common focus is measurement and improvement; the articles are also interested in practical tools and methodologies to measure and improve sustainability performance. Sonal Choudhary, for example, proposes the Green Integrated Value Stream Mapping (GIVSM) tool to improve operational and environmental performance. This focus on measurement and improvement reflects the importance of tracking progress and implementing effective strategies for sustainable manufacturing. (Choudhary et al., 2019)

### 2.3.1.2 Cluster 2

#### 2.3.1.2.1 Tienhua Wu's article "Aligning supply chain strategy with corporate environmental strategy: A contingency approach."

The author Tienhua Wu in his article "Aligning supply chain strategy with corporate environmental strategy: A contingency approach", explores the relationship between supply chain strategy and corporate environmental strategy and the impact on firm performance. The study considered the alignment of these strategies as a means to achieve sustainable supply chain management. Alignment is introduced as adjusting one component to another to achieve optimal outcomes. Previous studies have examined alignment in the context of green and reverse supply chain management but from a bivariate perspective. The authors propose a holistic approach that aligns four supply chain strategies and four corporate environmental strategies.

The article categorises supply chains into efficient, responsive, and agile based on the type of product and the degree of demand and supply uncertainty. Corporate environmental strategies are classified as reactive, defensive, and proactive based on the level of commitment and capabilities. The authors argue that the degree of alignment between these strategies impacts firm performance.

The study collected data from export-oriented manufacturing firms in Taiwan through questionnaires. The reliability and validity of the measurement items were assessed. The authors then used a three-step alignment analytic process to compute the level of alignment between the supply chain and corporate environmental strategies.



The results of hierarchical regression analysis indicate that alignment is significantly associated with firm performance regarding revenue increase and cost reduction. The degree of alignment between different supply chains and corporate environmental strategy combinations affects strong performance. The control variable of geographic dispersion did not show significant statistical weight.

The discussion highlights the alignment concept's opportunities to holistically consider the organisational and strategy domains. The study emphasises the importance of adopting a systems approach to understand the complex relationships among environment, operations, supply chain, and performance. The authors suggest that recognising the alignment effects of supply chain and corporate environmental strategies can help firms make effective decisions on environmental resource allocation.

The implications for research include advancing the existing research on operations management, supply chains, sustainability, and performance. The study proposes a new stream of research that examines the multiple relationships between the supply chain and the environment using the alignment viewpoint. The methodology of profile deviation analysis provides a valuable starting point for exploring the relationships between business and the broader environment.

The article also has implications for practice. It suggests that firms should reposition the benefits of green initiatives into business goals and align operational efficiency with pollution reduction. The study provides guidelines for firms to align goals from a strategic alignment perspective rather than viewing tradeoffs as inevitable. The authors acknowledge that supply chains will continue to evolve, and alignment needs to be adaptable to process changes and external uncertainties. (Wu et al., 2014)

#### 2.3.1.2.2 Ailie K.Y. Tang's article "A Multi-research-method approach to studying environmental sustainability in retail operations."

The author Ailie K.Y. Tang in his article "A Multi-research-method approach to studying environmental sustainability in retail operations.", says that the concept of environmental sustainability is often associated with the "triple bottom line," highlights the interconnectedness of economic, environmental, and social factors (Gong, 2013). While manufacturers have embraced "greening" their activities, retailers operating in the service context face unique challenges. This study explores the practices of Green Retailing Operations (GROs) adopted by retailers and how they differ from those of manufacturers.

In the literature review, the World Business Council for Sustainable Development (2006) defines eco-efficiency as the delivery of competitively-priced goods and services that satisfy human needs while progressively reducing ecological impacts. Some scholars argue that superior environmental sustainability leads to a lower cost of capital and increased profitability, resulting from improved resource utilisation and increased efficiency.

In retail, replenishment policies are driven by demand forecasting, where orders are placed before customer demand. Previous studies have explored CSR practices in retail, including employee compensation, local sourcing, energy conservation, emissions and waste management, and labour relations. Innovations in products and processes within retail chains have been found to enhance competitiveness through cost reduction, improved reliability, and responsiveness to market needs.

The study employs a multi-research-method approach to overcome common method bias, combining quantitative and qualitative methods. This approach enables an examination of how GROs can address stakeholders' needs while contributing to financial gains in a real-world retail context. The research focuses initially on Japanese retailers, given their prominence globally, and expands to include the Hong Kong retail context for a comprehensive understanding of GROs.

Qualitative case studies highlight the significance of green store operations in improving efficiency within retail operations. Examples include sorting and repurposing unused clothes and implementing energy-efficient systems such as LED lighting. The study also acknowledges the trade-off between service improvement and cost reduction in stock replenishment and inventory holding areas.

In the study's second phase, a quantitative survey is conducted in the Hong Kong retail context, targeting retailers adopting green retailing practices. Perceptual performance measures are utilised to evaluate financial performance, with respondents assessing various measurement items. The survey findings reinforce the positive association between GROs and retailers' financial performance.

The study's findings have theoretical and practical implications for retailers. Integrating environmental protection measures into retail operations poses a challenge, but GROs can benefit retailers by improving financial performance and satisfying stakeholders. Government measures, such as sponsoring the purchase of environmentally friendly vehicles and promoting energy-efficient practices, can complement environmental regulations, especially in countries with weaker enforcement.

The study also uncovers noteworthy findings, including the significant contribution of retailers to plastic bag waste and the potential for reducing CO<sub>2</sub> emissions through energy-efficient logistics. Successful implementation of GROs by retailers like Lawson showcases practical examples.

In conclusion, adopting green operations in retail not only benefits stakeholders but also contributes to financial gains. The study provides actionable insights for retailers seeking to achieve the triple bottom line. Subrata Mitra's article "Adoption of green supply chain management practices and their impact on performance: an exploratory study of Indian manufacturing firms."

Over the past two decades, supply chain management has been extensively studied. Still, discussions on green supply chain management (GSCM) or sustainable supply chain management (SSCM) have only gained momentum in the early 2000s. SSCM is the strategic integration and achievement of an organisation's social, environmental, and economic goals in coordinating inter-organizational processes to improve long-term financial performance. SSCM is a natural extension of just-in-time (JIT), total quality management (TQM), and lean manufacturing approaches.

The research methodology involved surveying Indian manufacturing firms to assess the adoption of GSCM practices and their impact on firm performance. Convenience sampling was used due to the country's low GSCM awareness level. The sample size exceeded the minimum requirement for multivariate data analysis.

Descriptive statistics, factor analysis, confirmatory factor analysis, and structural equation modelling were employed to analyse the data. The findings showed that only some firms adopted GSCM practices to comply with regulations, suggesting that environmental norms in India are less stringent than in developed countries. This highlights the need for stricter environmental regulations to compel firms to adopt sustainable practices.

This study provides one of the earliest surveys on GSCM practices in India. The authors developed India-specific items for the survey based on relevant literature and corporate feedback. The study identified supplier collaboration, product design, and logistics for environmental sustainability as critical success factors (KSFs) that significantly impact firm performance. The findings contribute to the understanding of GSCM practices in Indian manufacturing firms and shed light on the issues faced in both developed and developing countries. The authors anticipate that the results will facilitate the development of a regulatory framework and increased adoption of GSCM practices in India's pursuit of emissions reduction and environmental sustainability. (Tang et al., 2016)

### 2.3.1.2.3 Shaorui Li's article "Proactive environmental strategies and performance: role of green supply chain processes and green product design in the Chinese high-tech industry."

Environmental issues have traditionally been seen as a threat to firm profitability due to the substantial investments required in ecological management. However, recent research suggests that organisations increasingly recognise the natural environment as a potential source of competitive advantage. Adopting a greener approach, including waste reduction, pollution reduction, and resource conservation, can improve performance. The concept of the triple bottom line, encompassing social, environmental, and economic considerations, is gaining importance and has significant implications for organisations.

This study collected data from high-tech companies in China, specifically those in the Chengdu High-tech Zone. The zone was selected because the Chinese environmental agency closely monitors it. The researchers used the maximum likelihood estimation method within LISREL 8.8 to test the hypothesised relationships.

The findings revealed statistically significant and expected relationships between environmental orientation and green supply chain constructs. Specifically, ecological orientation had a substantial direct effect on green product design and green supply chain processes. Additionally, environmental exposure significantly indirectly affected specific components of green supply chain processes, such as green purchasing, green manufacturing, and green information systems.

In conclusion, organisations in the high-tech industry recognise their role in achieving a sustainable ecosystem due to the environmental impact of their products and processes. This study empirically demonstrates that green supply chain capabilities can positively impact environmental and financial performance. However, the results also highlight the importance of translating environmental orientation into tangible product- and process-related capabilities, such as green product design and effective green supply chain processes, to achieve superior performance. There needs to be more than an environmental orientation to drive positive outcomes.

Overall, this research contributes to understanding proactive environmental strategies in the Chinese high-tech industry. The study emphasises the significance of integrating green practices into supply chain processes and product design to enhance environmental and financial performance. These findings have practical implications for firms seeking to improve their environmental sustainability and gain a competitive edge in the high-tech sector. (Li et al., 2016)

#### 2.3.1.2.4 Sherry Avery Jackson's article "Examining the impact of design for environment and the mediating effect of quality management innovation on firm performance".

The increasing focus on environmental responsibility in research and practice has highlighted the importance of sustainability for businesses. However, there is still a gap in understanding the specific elements of quality and sustainability that contribute to firm performance. This study addresses this gap by examining the impact of design for environment (DFE) and the mediating effect of quality management innovation (QMI) on firm performance.

The research design and methodology involve several tasks. The authors reviewed existing literature to operationalise the constructs and identify relevant scales. They developed a survey instrument based on validated scales and collected data through Amazon MTurk and Qualtrics, Inc. Separate analyses were conducted for the two survey populations. The survey instrument was validated in a pilot test using MBA students in an introductory operations management course.

The results indicate a significant positive relationship between DFE and environmental performance, and QMI positively mediates this effect. DFE also leads to better economic performance, judged by environmental performance. The findings suggest that implementing DFE and QMI can improve environmental and financial performance.

The study is grounded in the Natural Resource-Based View (NRBV) theory, and the authors found that QMI positively mediates the relationship between DFE and a firm's environmental and economic performance. Quality management innovation is defined as aspects of a quality management program that improve products and processes. The authors emphasise the importance of continuous improvement in supporting QMI.

Summarising the study provides empirical evidence that DFE and QMI strategically enhance environmental and economic performance. The findings support the existence of "win-win" opportunities for businesses. There is a strong relationship between DFE and financial performance, while QMI positively impacts environmental performance, which, in turn, tends to affect economic performance positively. (Jackson et al., 2016)

#### 2.3.1.2.5 Stephanie Graham's article "Environmental operations management and its links with proactivity and performance: A study of the UK food industry."

The article "Environmental operations management and its links with proactivity and performance: A study of the UK food industry" addresses the relationship between a firm's environmental orientation, environmental practices, and performance outcomes in the UK food industry. The study aims to fill the research gap in the literature regarding the connection between environmental management orientation and organisational performance.

The authors highlight the mixed results of previous studies on the link between environmental activity and performance outcomes. To address this gap, the study develops a theoretical framework grounded in the Natural Resource-Based View (NRBV) to examine the dimensions of environmental proactivity, practices, and performance.

The Natural Resource-Based View (NRBV) suggests that firms can gain a competitive advantage by incorporating proactive considerations for the natural environment in their production processes. Environmental proactivity is defined as going beyond compliance with legislation or industry standards. The study proposes that proactivity is linked to pollution prevention and process stewardship. The article presents hypotheses about the relationship between environmental proactivity and waste reduction practices, customer collaboration, and environmental performance.

The research methodology involved a survey of the UK food industry. Various scales were developed to measure environmental proactivity, pollution prevention, process stewardship, and performance variables. The data collected were analysed using exploratory factor analysis and multiple regression analysis.

The study's results support the hypotheses and provide evidence for the suggested links between environmental proactivity, pollution prevention, process stewardship, and performance outcomes. The findings indicate that firms with a proactive orientation towards environmental management are more likely to engage in pollution prevention practices and collaborate with suppliers to improve environmental performance. However, the study found a different positive relationship between environmental collaboration with customers and performance outcomes.

Overall, the study contributes to understanding the relationship between environmental orientation, practices, and performance in the UK food industry. It highlights the importance of environmental proactivity and provides insights into the specific practices that can improve environmental and cost performance. The findings suggest that firms should integrate proactive environmental management strategies to achieve competitive advantages and enhance their overall performance. (Graham & Potter, 2015)

#### 2.3.1.2.6 Ruggero Golini's article "Developing sustainability in global manufacturing networks: The role of site competence on sustainability performance."

The article "Developing sustainability in global manufacturing networks: The role of site competence on sustainability performance" explores the importance of sustainability in the business world and focuses explicitly on the role of site competence in achieving sustainability within global manufacturing networks.

The introduction highlights the growing recognition among companies that being successful in business is not enough, and they must also prioritise environmental protection, safety, and the well-being of current and future generations. The authors mention multinational companies like Nike, P&G, and Nissan Motors, which have successfully integrated sustainability into their manufacturing networks, gaining a competitive advantage through shared knowledge and skills across their global plants.

The study examines environmental and social sustainability from a plant-level perspective, addressing the need for integration and diffusion of sustainability practices within global manufacturing networks. The authors utilise data from the fifth edition of the International Manufacturing Strategy Survey (IMSS 5), a comprehensive research project conducted in 2009 that focuses on manufacturing and supply chain strategies in the assembly industry.

The results indicate a positive relationship between site competence and adopting sustainability programs and performance. Plants with higher competence demonstrate more significant improvements in environmental and social sustainability. The findings suggest that developing cross-functional and integrated competence at the plant level is crucial for achieving higher sustainability performance.

The discussion section emphasises the importance of site competence in achieving sustainability in global manufacturing networks. The authors highlight the need for managers to expect higher sustainability achievements from plants with more outstanding competencies, regardless of their home country. The regression model confirms the direct positive impact of site competence on environmental and social sustainability performance.

In conclusion, the article emphasises the global emergence of sustainability as a source of competitive advantage and reputational disaster if ignored. The complexity of sustainability development, especially when considering environmental and social issues, is acknowledged. The research provides insights into how multinational companies can effectively deploy sustainable strategies in their manufacturing networks, emphasising the role of site competence. The study underscores the significance of organisational capabilities in managing complex and evolving sustainability issues. (Golini et al., 2014)

### 2.3.1.2.7 Cluster 2 discussion

The common theme that emerges from these articles is the relationship between environmental sustainability practices and firm performance in various industries and contexts. Each article explores different aspects of this relationship and provides valuable insights into how organisations can align their supply chain strategies (Wu et al., 2014), retail operations, manufacturing practices, and product design with environmental sustainability goals to achieve improved financial and environmental outcomes. It is essential to mention that several of the articles share additional similarities. They are focused on performance outcomes, and many articles examine the impact of environmental sustainability practices on firm performance (Graham & Potter, 2015). They explore how green practices can improve financial performance, cost reduction, revenue increase, and competitive advantage. The studies aim to establish a positive relationship between environmental sustainability and various performance indicators. (Wu et al., 2014)

Regarding methodology, several articles employ quantitative research methods, such as surveys and statistical analysis, to collect and analyse data. They utilise established measurement scales and statistical techniques to examine the relationships between variables (Jackson et al., 2016). Some articles also use a multi-research-method approach, combining quantitative and qualitative methods to understand the research topic comprehensively. (Tang et al., 2016)

Many articles emphasise the significance of aligning different strategies, such as supply chain strategy with corporate environmental strategy or environmental orientation with green supply chain processes. They argue that aligning these strategies is essential for achieving optimal outcomes and superior performance. (Wu et al., 2014)

Industry-specific focus, some articles concentrate on specific industries or sectors. For example, there are studies on the high-tech industry in China, the UK food industry, and retail operations. These articles explore these sectors' unique challenges and opportunities for environmental sustainability. (Graham & Potter, 2015)

Talking about theoretical frameworks, many of the articles draw on established theoretical frameworks to guide their research. The Natural Resource-Based View (NRBV) is a commonly referenced theory that suggests firms can gain a competitive advantage by integrating proactive environmental considerations into their operations. Other approaches, such as contingency theory, are also used to explain the relationship between different variables and performance outcomes.



While these articles focus primarily on environmental sustainability practices, they also touch upon related topics such as performance outcomes, alignment, methodology, industry-specific issues, and theoretical frameworks. These commonalities provide a broader context for understanding and discussing the research findings within the field of environmental sustainability in operations and supply chains.

### 2.3.1.3 Cluster 3

#### 2.3.1.3.1 Jury Gualandris's article "Developing environmental and social performance: the role of suppliers' sustainability and buyer-supplier trust"

The article "Developing environmental and social performance: the role of suppliers' sustainability and buyer-supplier trust" addresses the growing concern for sustainability in firms, particularly in manufacturing sectors perceived to have significant social and environmental impacts. The study aims to contribute to understanding how manufacturing firms can improve their sustainability performance by examining the relationship between suppliers' sustainability, buyer-supplier trust, and sustainability performance.

The authors highlight the importance of sustainable supply chain management (SSCM) as a means for firms to reduce harm and regenerate natural and social systems. They argue that developing external practices that positively impact social and natural systems requires firms to build relational expertise, creating interdependencies and participation throughout the supply chain.

The study adopts an explanatory survey research design, utilising a conceptual framework and well-defined concepts, theories, and hypotheses. The authors provide methodological transparency by explaining how the conceptual model was operationalised, the sample selection and data collection procedures, and the absence of biases.

The study's findings are based on data collected from 86 participating firms, yielding a response rate of 17.2%. The study reveals that sustainability performance measurement (SPM) is positively and significantly related to sustainable supply management (SSM). SPM also shows a significant relationship with sustainability-specific (SS) practices, which, in turn, are positively and significantly associated with firm performance (FS).

Drawing upon resource-based theories and supply chain management literature, the authors propose a conceptual framework that positions SPM as a fundamental technical capability that drives initial improvements in sustainability performance. They suggest SSM, as a higher-order relational capability, influences SS and FS, particularly when combined with trust.

The article highlights the novelty of considering such a complex interaction to explain how manufacturing firms can enhance their environmental and social performance. Previous studies have yet to explore this intricate relationship in detail. The study concludes that SPM and SSM are crucial in driving firm performance.

The authors suggest further research directions, including investigating the impact of SS and trust in different industrial and cultural contexts and studying how SS influences a manufacturing firm's economic performance. They emphasise the importance of firms associating their success with their suppliers to gain full stakeholder support, as primary and societal stakeholders increasingly hold manufacturing firms accountable for sustainability. (Gualandris & Kalchschmidt, 2016)

#### 2.3.1.3.2 Jury Gualandris's article "Customer pressure and innovativeness: Their role in sustainable supply chain management."

The article "Customer pressure and innovativeness: Their role in sustainable supply chain management" addresses the development of sustainable supply chain management (SSCM) within companies, focusing on the transition from internal to external practices. The study aims to contribute to the literature by examining the driving and enabling factors influencing this process and shedding light on how firms can effectively respond to customer pressure and leverage innovativeness for sustainability.

The introduction highlights the importance of sustainability for firms and acknowledges the extensive body of literature on SSCM. However, there needs to be more understanding of how SSCM evolves within a company and the factors influencing its development. The authors emphasise the need to explore the link between internal and external practices and the role of driving and enabling factors in this context.

The study utilises a survey approach to collect data from 500 manufacturing firms randomly selected from the Aida database. The authors focused on manufacturing sectors, considering their direct and indirect impacts on economic wealth creation and the environment throughout the product life cycle. The sample selection aimed for high external validity by stratifying the sample based on the expected proportion of manufacturing firms in each industry.

The study's findings suggest that sustainable process management (SPM) forms the foundation for sustainable supply management (SSM) development. SPM is mediating in facilitating the transition from internal to external practices. The authors discuss how internal practices foster external practices, drawing upon existing literature in supply chain management and SSCM.

The study highlights the importance of environmental and social standards, such as ISO 14001 and SA8000, in driving firms to address relevant aspects and develop specific knowledge of sustainability issues. As firms advance in environmental and social management, supply managers can proactively seek opportunities upstream in their supply chains, supported by their organisations.

The authors argue that innovativeness is an essential enabling factor that helps firms anticipate and shape stakeholders' sustainability requirements. However, they emphasise that internal practices must be in place for these antecedents to translate into externally oriented sustainable practices. Duanyang Geng's article "Eco-innovation and its role for performance improvement among Chinese small and medium-sized manufacturing enterprises."

The article "Eco-innovation and its role for performance improvement among Chinese small and medium-sized manufacturing enterprises" focuses on implementing eco-innovation practices and their impact on performance improvement in the context of small and medium-sized manufacturing enterprises (SMMEs) in China. The study aims to understand the levels of eco-innovation implementation among SMMEs and identify the contingency factors that influence the relationship between eco-innovation practices and performance improvement.

The introduction highlights stakeholders' pressure on large enterprises for environmental protection, including governments, the general public, and non-governmental organisations (NGOs). However, SMMEs need more capabilities and resources to implement traditional environmental management practices. To remain as suppliers for large customers, SMMEs are motivated to implement eco-innovation practices, while conventional environmental management practices become necessary to comply with environmental regulations.

The objectives of the study are twofold. Firstly, the authors aim to understand the levels of eco-innovation practices implemented by SMMEs. Secondly, they seek to identify the contingency factors that affect the relationship between eco-innovation practices and performance improvement in SMME operations.

The study utilises a variety of methods. Measurement items for evaluating eco-innovation and performance were developed based on previous studies. For traditional environmental management practices, specific measurement items were designed considering the operating situations of SMMEs in China. A pilot questionnaire was developed and refined through interviews with 10 SMMEs to ensure the inclusion of essential measurement items and the relevance of constructs.

The study results revealed two clusters of SMMEs based on their levels of eco-innovation implementation: eco-innovation adopters and eco-innovation planners. A cluster analysis was performed to identify these clusters and examine differences in eco-innovation practices, traditional environmental management practices, and performance outcomes between the clusters. The study finds that the association between eco-innovation practices and performance varies depending on the level of implementation. Technology eco-innovation practices directly improve economic performance when implemented at a relatively higher level for eco-innovation adopters.

In conclusion, the study contributes to operations management research by identifying two firm clusters among SMMEs based on their levels of eco-innovation implementation. The study analyses the interaction effects of eco-innovation and traditional environmental management practices on performance improvements and finds that these effects vary between the two firm clusters. The results provide decision support for SMMEs and the government in identifying eco-innovation practices that can effectively improve environmental and economic performance. The study suggests that government officials can develop stricter standards mandating eco-innovation and traditional environmental management practices based on the successful implementation observed in leading SMMEs. (Gualandris & Kalchschmidt, 2014)

#### 2.3.1.3.3 Atul Agarwal's article "A mediation model of green supply chain management adoption: The role of internal impetus."

The article "A mediation model of green supply chain management adoption: The role of internal impetus" explores the drivers of green supply chain management (GSCM) adoption and their interrelationships. It addresses the gap in previous research that has focused on the direct impacts of drivers while ignoring their interrelationships. The study aims to understand the relationships among the drivers of GSCM and their influence on GSCM practices and performance outcomes.

The introduction highlights the growing acceptance of sustainability in society and business. It mentions a study which found that although 90% of companies considered sustainability important, only 60% had a sustainability strategy, and only 25% could link it to business benefits. The study suggests that focusing on material issues, such as integrating sustainability throughout the organisation and collaborating with stakeholders, is crucial to addressing this conundrum.

The study's objectives are to explore the relationships among the drivers of GSCM and examine their impact on GSCM practices and performance outcomes. The study aims to fill the research gap by considering the interrelationships among the drivers.

The study utilises a survey questionnaire with close-ended questions adopted from prior studies to ensure validity. The questionnaire is divided into three sections: pressures for adopting GSCM practices implemented GSCM practices and performance outcomes. The section on GSCM practices includes five dimensions: green purchasing, cooperation with customers, investment recovery, eco-design, and internal environmental management.

The study's findings indicate no significant difference between early and late respondents, suggesting no non-response bias. The study examines the industry's impact on various aspects, such as regulation, market, supplier, environmental, and economic performance. The results show significant effects of the industry on these aspects but not on internal impetus, GSCM adoption, or operational performance.

In conclusion, the authors discuss the implications of their findings. They highlight the multi-faceted and complex social and economic pressures for GSCM adoption. The study suggests that regulatory pressures may have a negligible effect on GSCM adoption for Midwest manufacturing companies, which contrasts with previous research. This could be because many existing regulations targeting manufacturing operations predate the emergence of GSCM or focus on clean energy rather than direct manufacturing operations. (Agarwal et al., 2018)

#### 2.3.1.3.4 Cluster 3 discussion

The four articles discussed in this cluster share a common theme: the role of various factors in driving and improving sustainable supply chain management (SSCM) practices in manufacturing firms. Each article offers unique insights into different aspects of SSCM, providing valuable perspectives on how firms can enhance their environmental and social performance. Apart from the common theme, the articles share a few other commonalities, like methodology; all four articles employ empirical research methods to gather data and analyse the relationships between variables (Gualandris & Kalchschmidt, 2014). They utilise survey questionnaires and measurement items adapted from previous studies to ensure the validity and reliability of the data collected. The articles provide transparency regarding their data collection procedures, sample selection, and analytical techniques.

Importance of internal practices, the articles recognise the significance of internal procedures within organisations for driving sustainable supply chain management. They highlight the role of internal impetus, sustainable process management, and internal environmental management in facilitating the adoption and implementation of sustainable practices throughout the supply chain. (Agarwal et al., 2018)

The studies consider performance outcomes as a result of implementing sustainable supply chain management practices. While the specific performance measures vary across the articles, they all acknowledge the importance of achieving positive economic, environmental, and social outcomes through sustainable practices. (Gualandris & Kalchschmidt, 2014)

Finally, recommendations for future research, In their conclusions, the articles suggest avenues for future research in sustainable supply chain management. They propose exploring the impact of contextual factors, industry differences, cultural contexts, and the interdependency among different SSCM practices.

#### 2.3.1.4 Cluster 4

##### 2.3.1.4.1 Syed Abdul Rehman Khan's article "The role of block chain technology in circular economy practices to improve organisational performance."

This paper aims to explore the role of blockchain technology (BCT) in enhancing organisational performance within the context of the China-Pakistan Economic Corridor (CPEC). The study investigates the applicability and functionality of BCT in the circular economy and examines its impact on environmental and economic performance.

The research identifies theoretical and empirical gaps in the literature regarding the potential of BCT in the circular economy. The study focuses on two perspectives: the applicability of BCT and its functionality within the circular economy. A conceptual model is developed, starting with the BCT-circular economy relationship, followed by the impact of the circular economy on environmental and economic performance, and finally, evaluating the influence of these performance measures on firm performance. The measurement model is tested for reliability, convergent validity, discriminant validity, and collinearity. Structural Equation Modeling (SEM) is used to analyse the hypothesised model.

The study collects primary cross-sectional data from Chinese and Pakistani manufacturing firms involved in cross-border green supply chain activities within the CPEC. The survey instrument and measurement model are validated through reliability and validity tests. The results show that blockchain technology has a significant positive impact on the circular economy. Furthermore, the circular economy significantly positively affects both environmental and economic performance. Environmental performance is positively associated with firm performance, indicating its impact on the organisation's financial health.

The study concludes that blockchain technology significantly promotes sustainable green supply chain practices within the circular economy, improving organisational performance. The findings highlight the positive influence of blockchain technology on the circular economy, as well as the significant impact of the circular economy on both environmental and economic performance. The study emphasises the importance of ecological performance in driving firm performance and underscores the potential benefits of adopting blockchain technology in circular economy practices. (Rehman Khan et al., 2022)

#### 2.3.1.4.2 Syed Abdul Rehman Khan's article "Assessing the eco-environmental performance: a PLS-SEM approach with a practice-based view".

This article investigates the impact of Green Supply Chain Practices (GSCPs) on competitive advantage, economic performance, environmental performance, and organisational performance. It also examines the influence of internal environmental management and green information systems on these relationships.

The study utilises Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CB-SEM) to assess the quality of the structural models. CB-SEM estimates the observed covariance matrix accurately, while PLS-SEM focuses on the variance explained in the endogenous variables. The study collects data from manufacturing firms in Pakistan.

The analysis demonstrates that the number of dependent and independent constructs in structural equation modelling is not restricted to one. Convergent validity is assessed to examine the degree of relationship between two theoretically related constructs. Reliability and convergent validity are evaluated using composite reliability (CR) and average variance extracted (AVE) scores. The acceptable CR values and AVE scores indicate robust convergent validity.

The study reveals the interconnectedness between internal environmental management, green information systems, and green practices, along with their impact on competitive advantage, economic performance, environmental performance, and organisational performance. The findings highlight the significance of senior management commitment and green information systems in GSCM. Implementing green practices positively influences competitive advantage, economic performance, and environmental performance, ultimately leading to improved organisational performance. The study emphasises the importance of integrating green practices into corporate strategies for achieving multi-dimensional advantages. (Rehman Khan & Yu, 2021)

#### 2.3.1.4.3 Cluster 4 discussion

The common theme that emerges from these articles is the emphasis on sustainable practices and their impact on organisational performance. The first article focuses on the role of blockchain technology in promoting sustainable green supply chain practices within the circular economy. It highlights the positive influence of blockchain technology on the circular economy, environmental performance, and economic performance. The second article examines the impact of GSCPs on various dimensions of performance, emphasising the importance of integrating green practices into corporate strategies for achieving multi-dimensional advantages. (Rehman Khan et al., 2022)

Methodologically, both articles employ rigorous approaches. They validate their measurement models through reliability and validity tests, ensuring the robustness of their findings. The first article demonstrates the positive impact of blockchain technology on the circular economy (Rehman Khan et al., 2022), while the second article highlights the interconnectedness of internal environmental management, green information systems, and green practices in driving competitive advantage and organisational performance. (Rehman Khan & Yu, 2021)

In conclusion, these two articles contribute to understanding how blockchain technology and green supply chain practices can enhance organisational performance. They provide valuable insights into the potential of blockchain technology in the circular economy context and shed light on the significance of GSCPs in driving competitive advantage and organisational performance.

#### 2.3.1.5 Cluster 5

##### 2.3.1.5.1 Sonia M. Lo's article "Effects of supply chain position on the motivation and practices of firms going green".

In pursuing sustainable economic and environmental development, using energy effectively and recycling resources have become global concerns. Several studies have explored different aspects of green supply chains, such as network design, product lifecycle management, and motivations of firms going green. However, there needs to be more research on how uncertainties and firm positions in the supply chain influence a firm's motivation and practices when adopting green strategies.

This study aims to understand the impact of a firm's position in the supply chain on its attitude towards green strategies. The research questions addressed are: Do environmental uncertainties differ based on a firm's role in the supply chain? Does the motivation for going green vary with the uncertainties faced in the supply chain? Do green-related practices differ depending on a firm's position in the supply chain?



A case study approach was adopted to collect qualitative data for this exploratory study. Taiwan's high-tech industry was divided into upstream, midstream, and downstream firms based on the literature review. Representative firms from each category, including raw material suppliers, ODM/OEMs, and brand companies, were selected for participation. Twelve cases were chosen to balance subjective results and excessive dispersion.

Taiwan plays a significant role in the global production of integrated circuits (IC) and computer-related products. The country's output value accounts for a substantial portion of the worldwide market. This context provides a valuable backdrop for studying the effects of supply chain position on green practices in the high-tech industry.

The study examines the motivations and strategies of firms going green based on their positions in the supply chain. Brand companies, ODM/OEMs, and raw material suppliers face different uncertainties while implementing green practices. Consumer acceptance influences brand companies, while ODM/OEMs focus on the availability of suitable raw materials and fulfilling customer requirements. Raw material suppliers are concerned about market share and competitors' strategies. (M. Lo, 2013)

#### 2.3.1.5.2 Qiangfei Chai's article "Can carbon cap and trade mechanism be beneficial for remanufacturing?"

The article "Can carbon cap and trade mechanism be beneficial for remanufacturing?" explores the potential benefits of implementing a carbon cap and trade mechanism in the remanufacturing industry. The authors examine the impact of carbon emissions regulations on a monopolistic manufacturer producing new and remanufactured products. The study focuses on two market scenarios: remanufacturing without a carbon cap and trade and remanufacturing under a carbon cap and trade.

The authors analyse the manufacturer's optimal production quantity and pricing decisions in the ordinary market, where consumers perceive new products as more valuable than remanufactured products. They find that remanufacturing without carbon caps and trade can lead to profits, and they provide a mathematical model to determine the manufacturer's optimal decisions.

The authors investigate the effects of carbon caps and trade on the manufacturer's decisions in the green market, including ordinary consumers and green consumers who view remanufactured products as good as new ones. They propose different pricing strategies, namely keeping the price of remanufactured products low for all consumers or keeping it high to target green consumers specifically. The study concludes that remanufacturing under carbon cap and trade can result in lower carbon emissions than remanufacturing without such regulations, regardless of the chosen pricing strategy.

The article also analyses the influence of various carbon-related parameters on the manufacturer's optimal decisions, such as carbon trading prices and carbon emissions from remanufactured products. The authors show that higher carbon trading prices require manufacturers to increase product prices and reduce production quantities to offset increased carbon emissions costs. They also discuss the importance of improving ordinary consumers' acceptance of remanufactured products and investing in low-carbon production technology.

The findings of this study contribute to understanding how carbon emissions regulations can impact the profitability of remanufacturing operations. The research highlights the potential benefits of incorporating carbon caps and trade mechanisms in the remanufacturing industry, reducing environmental impact and generating manufacturer profits. The article suggests that policymakers and manufacturers should consider the influence of carbon trading prices, carbon emissions from remanufactured products, and the proportion of green consumers when implementing carbon caps and trade mechanisms. Cluster 5 discussion

In pursuit of sustainable economic and environmental development, adopting green strategies has become a global concern. The two articles" shed light on distinct but interconnected aspects of sustainability. Lo's article focuses on the influence of a firm's position in the supply chain on its motivation and practices when adopting green strategies, while Chai's article examines the potential benefits of implementing a carbon cap and trade mechanism in the remanufacturing industry.

The common theme that emerges from these articles is the importance of external factors in influencing firms' sustainability practices and profitability. Both studies recognise the significance of considering the contextual factors that shape firms' motivations and strategies. Lo's research emphasises the impact of a firm's position in the supply chain on its green practices, revealing how different uncertainties and responsibilities shape their motivations and methods. Chai's study highlights the role of carbon emissions regulations, particularly carbon caps and trade mechanisms, in shaping the profitability of remanufacturing operations. By incorporating environmental considerations and addressing consumer preferences, manufacturers can optimise their decision-making processes and reduce their environmental impact.

In conclusion, the articles by Sonia M. Lo and Qiangfei Chai provide valuable insights into the interplay between supply chain position, green practices, and remanufacturing profitability. Lo's research emphasises the influence of supply chain position on a firm's motivation and practices when adopting green strategies. At the same time, Chai's study highlights the potential benefits of implementing a carbon cap and trade mechanism in the remanufacturing industry.(Chai et al., 2018)

### 2.3.1.5.3 Cluster 5 discussion

In today's global context, the pursuit of sustainable economic and environmental development is paramount. Both articles address the imperative of adopting environmentally conscious strategies in various industries. Lo's work delves into the role of a firm's position within the supply chain and how it influences their motivation and practices when adopting green strategies (M. Lo, 2013). On the other hand, Chai's article explores the potential advantages of incorporating a carbon cap and trade mechanism within the remanufacturing industry. (Chai et al., 2018)

Despite their differences in focus, the articles converge on the idea that external factors significantly impact firms' approaches to sustainability and their overall profitability. The studies underscore the necessity of acknowledging contextual factors that mold firms' motivations and strategies for achieving sustainability.

A common thread that emerges from these articles is considering external influences in shaping firms' sustainability practices and overall success. Both studies advocate for a holistic approach to decision-making—one that acknowledges the wider environmental, economic, and social impacts of business operations.

In conclusion, Sonia M. Lo's examination of supply chain positions (M. Lo, 2013) and Qiangfei Chai's analysis of carbon cap and trade mechanisms provide valuable insights into the multifaceted landscape of sustainable business practices. (Chai et al., 2018) Lo's work demonstrates how a firm's position within the supply chain affects its willingness and capability to adopt green strategies. In parallel, Chai's study emphasizes the potential advantages of integrating carbon cap and trade mechanisms into the remanufacturing industry. These two articles underscore the critical nature of aligning business practices with broader sustainability goals, reflecting the contemporary imperative for businesses to balance environmental concerns with economic success.

### 2.3.1.6 Bibliographic coupling for keywords

A bibliographic coupling for co-word networks was then performed, and a group of four clusters of different colours is shown in Figure 10. The size of the letter is proportional to the frequency of occurrence of the keyword and the number of connections between them in both cases. The most common keywords used in the publications under study total 240. If the cut-off point is set at a frequency equal to or greater than five ( $\geq 5$ ), there are 22. Four main groups of keywords were found. The first cluster, coloured red, is composed of seven words, including "capabilities," "corporate social-responsibility," "resource-based view," "green," or "supply chain," and refers to the main subject investigated in this analysis, talking about green solutions on manufacturing and supply chain and the responsibility of the corporations on this field. The second cluster, coloured green, contains seven words, including "business performance," "impact," "implementation," and "management

practices”, “supply chain management”, “sustainability” It focuses on the results and performance of this new way of managing and what kind of impact it has. The third cluster, in dark blue, is composed of five words and focuses on how to apply this solution, wondering about integrations and strategies to transform the operation and fit the performance standards, with parameters including “operations,” “strategies,” “integration” and “performance.” The fourth one, in yellow, with three words, refers to the financial performance of the new management model. There are also connected concepts such as “financial performance”, “model”, and “management.”

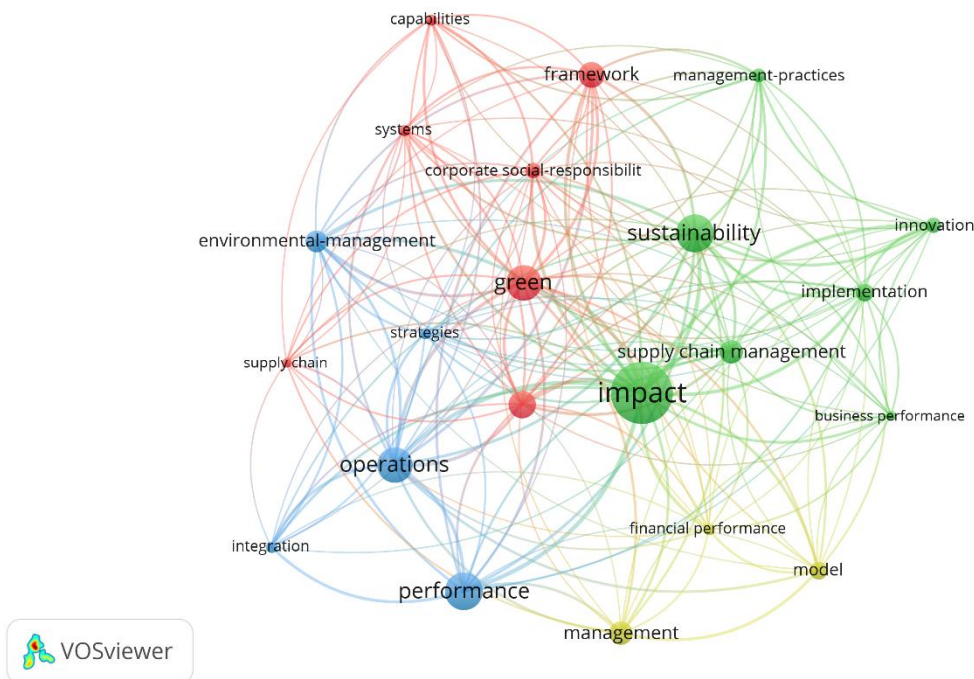


Figure 10: Bibliographic coupling analysis for co-word networks ( $\geq 5$  co-word networks).

### 2.3.2 Strategic thematic analysis

Finally, the strategic diagram of the thematic area analysed is presented below (Figure 11). The horizontal axis represents the relevance degree or centrality, indicating the frequency of a word appearing in publications. The vertical axis represents the development degree or density, reflecting how often a word is repeated. The size of the spheres corresponds to the number of occurrences of these keywords. The size of the spheres represents the number of occurrences of these keywords. The upper right quadrant shows driving themes, the upper left quadrant niche/very specialised themes, the lower right quadrant core themes and the lower left quadrant emerging or disappearing themes. The themes in the upper right quadrant are “corporate social-responsibility”, “sustainability”, “implementation”, “impact”, and “resource-based view”, all of which are relevant and well-developed for the structuring of this research field; we can conclude that the central part of the documents analysed is using this topic as a motor. The topics in the upper left quadrant, which are “performance”,

“supply chains”, and “challenges”, are relevant but underdeveloped and should therefore be researched further. We can see how the latter refers to challenges in supply chain performance, and this diagram thus shows the desirability of further research of this nature. The topics in the lower left quadrant are underdeveloped and represent emerging or disappearing topics. In this case, the terms “integration”, “strategies”, and “design” are undoubtedly emerging themes referring to the investigation and implementation of the new techniques, and its development will therefore increase considerably; without doubt, future studies should focus on integration strategies and design. The topics in the lower right quadrant are not entirely inside it, they are between the motor themes and the emerging themes, but we can see that they refer to the main focus of the study like “green operation”, “management model”, and “supply chain”. The thematic analysis shows that the terms “sustainability” and “corporate social-responsibility” are the main subject of the studies with the word “implementation”, which fit perfectly with emerging terms such as “integration”, “strategies”, and “design” referring to develop solutions to satisfy the main topics.

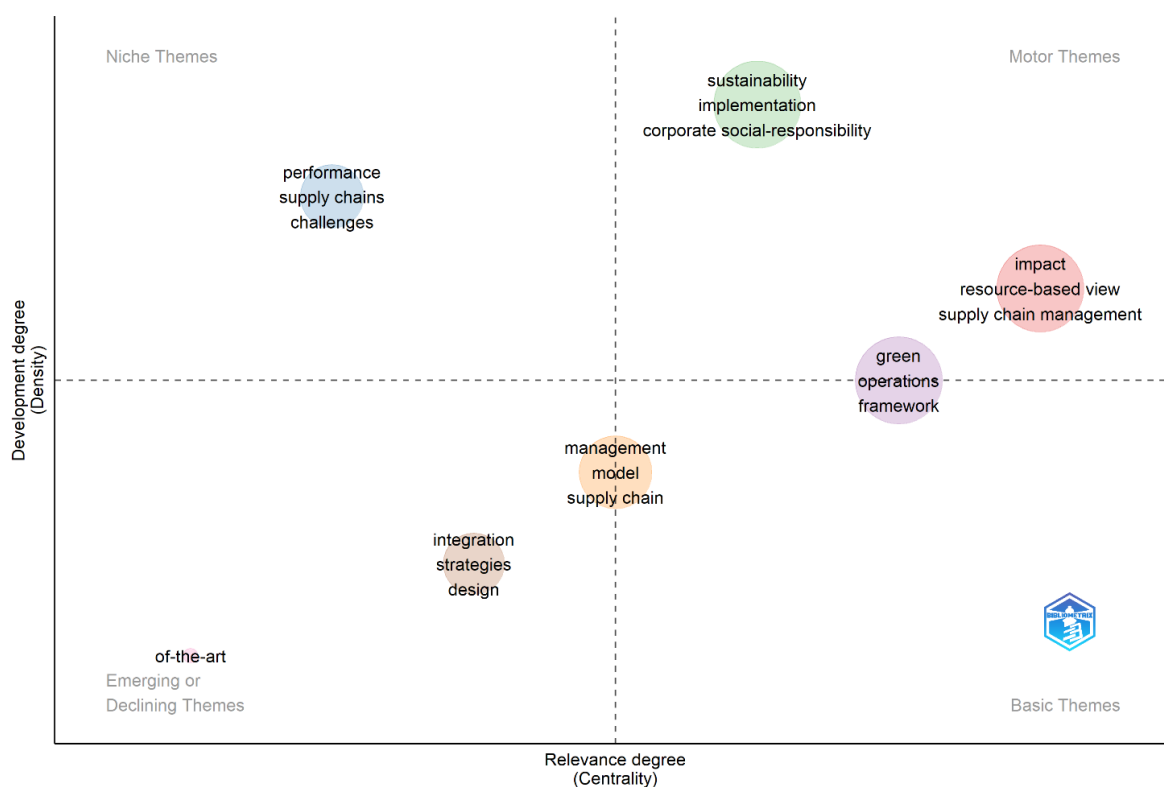


Figure 11: Strategic Diagram

## 2.4 Analysis of the main results

The bibliometric analysis retrieved 56 articles on green manufacturing in operations management published from 2014 to 2023 in 21 journals by 183 authors. The average number of citations per document is 43.3, and 240 keywords were found. The number of authors per paper is around 3, with an international collaboration rate of 41.67%. The countries with the most publications are the Peoples R China, the United Kingdom, and India. The journals with the most publications are the International Journal Of Production Economics, Journal Of Manufacturing Technology Management, and International Journal Of Production Research. The software tools used for bibliometric analysis include HistCite, VOSviewer, and RStudio. The primary indicators include annual publications, citations per author, institution, and country. The authors with the most publications are Afum E, Agyabeng-Mensah Y, Cagliano R, Khan SAR, Lai KH, and Longoni A. The institutions with the most publications are Abu Dhabi University, Dalian Maritime University, Hong Kong Polytechnic University, Politecnico Milan, Tsinghua University, University Bergamo, and University Derby. The authors with the most total global citation score are Garza-Reyes JA, Alencastro V, Caiado RGG, Lona LR, Nascimento DLM, Quelhas OLG, and Tortorella G. The countries with the most total global citation score are the United Kingdom, Peoples R China, Italy, Brazil, Mexico, India, USA, and Taiwan.

The overall thematic analysis provides valuable insights into the research field under examination. It reveals the dominant and well-developed themes that shape the literature and emerging areas that require further exploration. The strategic diagram offers a comprehensive overview of the thematic landscape by visualising the relationships between keywords.

The upper right quadrant of the diagram showcases driving themes in the field. The presence of "corporate social responsibility," "sustainability," "implementation," "impact," and "resource-based view" indicates their significant role in shaping the research agenda. These themes have garnered considerable attention and are extensively studied, suggesting their relevance and impact. The prominence of these driving themes indicates that they serve as key focal points for researchers and practitioners.

In contrast, the upper left quadrant highlights niche or underdeveloped themes that remain relevant within the research domain. Keywords such as "performance," "supply chains," and "challenges" are recognised as essential topics but lack comprehensive exploration. This suggests an opportunity for future investigations to delve deeper into these areas and shed light on the specific challenges faced within supply chain performance.

The lower left quadrant captures emerging or disappearing themes characterised by their underdevelopment. The terms "integration," "strategies," and "design" represent topics that are on the rise, signifying a growing interest in exploring new techniques

and approaches. These emerging themes hold great potential for future research as they address the evolving needs and demands of the field. Investigating integration strategies and design can lead to innovative solutions and advancements in the research area.

Lastly, the lower right quadrant encompasses themes that lie between the driving themes and the emerging themes. Keywords such as "green operation," "management model," and "supply chain" are placed in this quadrant, indicating their alignment with the focus of the study. Although not entirely within the quadrant, these themes contribute to the central themes and serve as essential components of the research field.

Overall, the thematic analysis highlights the critical study subjects in the research field, emphasising the significance of "sustainability" and "corporate social responsibility." These driving themes, along with the concept of "implementation," form the foundation for most of the research in the field. Furthermore, the identification of emerging themes such as "integration," "strategies," and "design" indicates the evolving nature of the research area and the need for innovative approaches and solutions.

The strategic diagram provides a comprehensive overview of the thematic landscape, offering valuable insights for researchers, practitioners, and policymakers. It showcases the field's current state and identifies research gaps and areas for further investigation. By understanding the interplay between the driving themes, emerging topics, and underdeveloped areas, researchers can contribute to the advancement and development of the research field.

### 3 Discussion and future research

The articles presented in five clusters provide valuable insights into sustainable supply chain management practices in manufacturing firms (Choudhary et al., 2019). While the studies offer a comprehensive understanding of the subject matter, it is also interesting to suggest avenues for future research to advance knowledge in the field.

Cluster 1 focuses on the relationship between eco-innovation practices and small, medium, and micro-enterprises (SMMEs) performance improvement. The study identifies two groups of SMMEs based on their levels of eco-innovation implementation: eco-innovation adopters and eco-innovation planners (Nascimento et al., 2019). The authors find that the association between eco-innovation practices and performance varies depending on the level of implementation. The study concludes by providing decision support for SMMEs and the government in identifying eco-innovation patterns that can effectively improve environmental and economic performance. Future research for this cluster can investigate the impact of eco-innovation practices on performance improvement in different contexts, such as other sectors or regions. While the study identifies two sets of small, medium, and micro-enterprises (SMMEs) based on their levels of eco-innovation implementation, it is worth exploring how eco-innovation practices impact performance improvement in different contexts. For instance, the research could focus on the impact of eco-innovation practices on performance improvement in other sectors or regions.

Following the next group, cluster 2 discusses the drivers of green supply chain management (GSCM) adoption and their interrelationships (Graham & Potter, 2015). The study aims to fill the research gap by considering the interrelationships among the drivers. The authors highlight the multi-faceted and complex social and economic pressures for GSCM adoption. The study suggests that focusing on material issues, such as integrating sustainability throughout the organisation and collaborating with stakeholders, is crucial to addressing this conundrum (Wu et al., 2014). In this cluster, it is necessary to explore further the interrelationships among the drivers of green supply chain management (GSCM) adoption and the material issues that facilitate adoption. While the study recognises the multi-faceted and complex social and economic pressures for GSCM adoption, more research is necessary to understand the interrelationships among the drivers. Further exploration can help policymakers and firms identify and prioritise the most critical drivers of GSCM adoption.



For one thing, cluster 3 discusses the role of various factors in driving and improving sustainable supply chain management practices in manufacturing firms. Each article offers unique insights into different aspects of SSCM, providing valuable perspectives on how firms can enhance their environmental and social performance (Gualandris & Kalchschmidt, 2016). The articles share a few commonalities, like methodology; all four articles employ empirical research methods to gather data and analyse the relationships between variables. They utilise survey questionnaires and measurement items adapted from previous studies to ensure the validity and reliability of the data collected. The articles provide transparency regarding their data collection procedures, sample selection, and analytical techniques. Future investigation can explore the impact of contextual factors, industry differences, cultural contexts, and the interdependency among different SSCM practices (Agarwal et al., 2018). While the studies offer valuable insights into how firms can enhance their environmental and social performance, more research is necessary to understand how contextual factors, industry differences, and cultural contexts influence SSCM practices. Such analysis can help policymakers and firms tailor SSCM practices to specific contexts.

Furthermore, cluster 4 presents two articles that contribute to understanding how blockchain technology and green supply chain practices can enhance organisational performance. The first article focuses on the role of blockchain technology in promoting sustainable green supply chain practices within the circular economy (Rehman Khan & Yu, 2021). It highlights the positive influence of blockchain technology on the circular economy, environmental performance, and economic performance (Rehman Khan et al., 2022). The second article examines the impact of GSCPs on various dimensions of performance, emphasising the importance of integrating green practices into corporate strategies for achieving multi-dimensional advantages. This cluster needs to investigate further the relationship between sustainable practices and firm performance in diverse settings. The study recognises the significance of achieving positive economic, environmental, and social outcomes through sustainable practices. However, more research is necessary to understand how sustainable practices impact firm performance in diverse contexts. Further investigation can help policymakers and firms understand the trade-offs and synergies between sustainable practices and strong performance in different settings.

Finally, cluster 5 presents two articles that shed light on distinct but interconnected aspects of sustainability. The first article focuses on the influence of a firm's position in the supply chain on its motivation and practices when adopting green strategies (M. Lo, 2013). The second article examines the potential benefits of implementing a carbon cap and trade mechanism in remanufacturing (Chai et al., 2018). The common theme that emerges from these articles is the importance of external factors in influencing firms' sustainability practices and profitability. Both studies recognise the significance of considering the contextual factors that shape firms' motivations and strategies. Future research opportunities have been identified, such as investigating the influence of carbon trading prices, carbon emissions from remanufactured products, and the proportion of green consumers when implementing carbon caps and trade mechanisms. While the studies shed light on distinct but interconnected aspects of sustainability, more research is necessary to understand how external factors influence firms' sustainability practices and profitability. Such analysis can help policymakers and firms optimise their decision-making processes and reduce environmental impact.

In conclusion, the clusters provide diverse perspectives on sustainable supply chain management practices in manufacturing firms. The studies highlight the significance of internal procedures within organisations for driving sustainable supply chain management. They acknowledge the importance of achieving positive economic, environmental, and social outcomes through sustainable practices. The studies emphasise the importance of integrating green practices into corporate strategies for achieving multi-dimensional advantages. While the studies offer valuable insights into the subject matter, more research is necessary to advance knowledge in the field. The future research opportunities identified by the studies can help policymakers and firms tailor their decisions to specific contexts and achieve multi-dimensional advantages.

## 4 Conclusion

The research presented in this thesis provides valuable insights into sustainable supply chain management practices in manufacturing firms. The bibliometric and thematic analyses offer a comprehensive understanding of the research field, highlighting the driving themes, niche or underdeveloped areas, emerging topics, and interrelationships among keywords. The studies presented in the five clusters provide diverse perspectives on the subject matter, focusing on different aspects of sustainable supply chain management practices.

The findings suggest that firms should consider external factors, such as carbon trading prices, carbon emissions from remanufactured products, and the proportion of green consumers, when implementing sustainable practices. The studies acknowledge the importance of achieving positive economic, environmental, and social outcomes through sustainable practices and emphasise the significance of integrating green practices into corporate strategies for achieving multi-dimensional advantages.

Future research opportunities have been identified, such as investigating the impact of eco-innovation practices on performance improvement in different contexts, understanding the interrelationships among the drivers of green supply chain management adoption, and exploring the impact of contextual factors, industry differences, and cultural contexts on sustainable supply chain management practices. Other future research areas include investigating the relationship between sustainable practices and firm performance in diverse settings and exploring the potential benefits of implementing carbon cap and trade mechanisms in the remanufacturing industry.

Overall, the research presented in this thesis contributes to the advancement and development of the research field, offering valuable insights for researchers, practitioners, and policymakers. By understanding the interplay between driving themes, emerging topics, and underdeveloped areas, firms can optimise their decision-making processes and reduce their environmental impact. Policymakers can utilise the findings to tailor policies to specific contexts and achieve multi-dimensional advantages. By continuing to investigate and explore the subject matter, researchers can contribute to the advancement and development of the sustainable supply chain management practices in manufacturing firms.

## 5 References

- Agarwal, A., Giraud-Carrier, F. C., & Li, Y. (2018). A mediation model of green supply chain management adoption: The role of internal impetus. *International Journal of Production Economics*, 205, 342-358. <https://doi.org/10.1016/j.ijpe.2018.09.011>
- (Alex) Alblas, A. A., (Kristian) Peters, K., & (Hans) Wortmann, J. C. (2014). Fuzzy sustainability incentives in new product development: An empirical exploration of sustainability challenges in manufacturing companies. *International Journal of Operations & Production Management*, 34(4), 513-545. <https://doi.org/10.1108/IJOPM-10-2012-0461>
- Chai, Q., Xiao, Z., Lai, K., & Zhou, G. (2018). Can carbon cap and trade mechanism be beneficial for remanufacturing? *International Journal of Production Economics*, 203, 311-321. <https://doi.org/10.1016/j.ijpe.2018.07.004>
- Choudhary, S., Nayak, R., Dora, M., Mishra, N., & Ghadge, A. (2019). An integrated lean and green approach for improving sustainability performance: A case study of a packaging manufacturing SME in the U.K. *Production Planning & Control*, 30(5-6), 353-368. <https://doi.org/10.1080/09537287.2018.1501811>
- Golini, R., Longoni, A., & Cagliano, R. (2014). Developing sustainability in global manufacturing networks: The role of site competence on sustainability

- performance. *International Journal of Production Economics*, 147, 448-459.  
<https://doi.org/10.1016/j.ijpe.2013.06.010>
- Graham, S., & Potter, A. (2015). Environmental operations management and its links with proactivity and performance: A study of the UK food industry. *International Journal of Production Economics*, 170, 146-159.  
<https://doi.org/10.1016/j.ijpe.2015.09.021>
- Gualandris, J., & Kalchschmidt, M. (2014). Customer pressure and innovativeness: Their role in sustainable supply chain management. *Journal of Purchasing and Supply Management*, 20(2), 92-103. <https://doi.org/10.1016/j.pursup.2014.03.001>
- Gualandris, J., & Kalchschmidt, M. (2016). Developing environmental and social performance: The role of suppliers' sustainability and buyer-supplier trust. *International Journal of Production Research*, 54(8), 2470-2486.  
<https://doi.org/10.1080/00207543.2015.1106018>
- Jabbour, C. J. C., De Sousa Jabbour, A. B. L., Govindan, K., De Freitas, T. P., Soubihia, D. F., Kannan, D., & Latan, H. (2016). Barriers to the adoption of green operational practices at Brazilian companies: Effects on green and operational performance. *International Journal of Production Research*, 54(10), 3042-3058.  
<https://doi.org/10.1080/00207543.2016.1154997>
- Jackson, S. A., Gopalakrishna-Remani, V., Mishra, R., & Napier, R. (2016). Examining the impact of design for environment and the mediating effect of quality

- management innovation on firm performance. *International Journal of Production Economics*, 173, 142-152. <https://doi.org/10.1016/j.ijpe.2015.12.009>
- Li, S., Jayaraman, V., Paulraj, A., & Shang, K. (2016). Proactive environmental strategies and performance: Role of green supply chain processes and green product design in the Chinese high-tech industry. *International Journal of Production Research*, 54(7), 2136-2151. <https://doi.org/10.1080/00207543.2015.1111532>
- Liu, Y., Zhu, Q., & Seuring, S. (2017). Linking capabilities to green operations strategies: The moderating role of corporate environmental proactivity. *International Journal of Production Economics*, 187, 182-195. <https://doi.org/10.1016/j.ijpe.2017.03.007>
- Longoni, A., & Cagliano, R. (2015a). Cross-functional executive involvement and worker involvement in lean manufacturing and sustainability alignment. *International Journal of Operations & Production Management*, 35(9), 1332-1358. <https://doi.org/10.1108/IJOPM-02-2015-0113>
- Longoni, A., & Cagliano, R. (2015b). Environmental and social sustainability priorities: Their integration in operations strategies. *International Journal of Operations & Production Management*, 35(2), 216-245. <https://doi.org/10.1108/IJOPM-04-2013-0182>

- M. Lo, S. (2013). Effects of supply chain position on the motivation and practices of firms going green. *International Journal of Operations & Production Management*, 34(1), 93-114. <https://doi.org/10.1108/IJOPM-04-2012-0133>
- Nascimento, D. L. M., Alencastro, V., Quelhas, O. L. G., Caiado, R. G. G., Garza-Reyes, J. A., Rocha-Lona, L., & Tortorella, G. (2019). Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal. *Journal of Manufacturing Technology Management*, 30(3), 607-627. <https://doi.org/10.1108/JMTM-03-2018-0071>
- Rehman Khan, S. A., & Yu, Z. (2021). Assessing the eco-environmental performance: An PLS-SEM approach with practice-based view. *International Journal of Logistics Research and Applications*, 24(3), 303-321. <https://doi.org/10.1080/13675567.2020.1754773>
- Rehman Khan, S. A., Yu, Z., Sarwat, S., Godil, D. I., Amin, S., & Shujaat, S. (2022). The role of block chain technology in circular economy practices to improve organisational performance. *International Journal of Logistics Research and Applications*, 25(4-5), 605-622. <https://doi.org/10.1080/13675567.2021.1872512>
- Tang, A. K. Y., Lai, K., & Cheng, T. C. E. (2016). A Multi-research-method approach to studying environmental sustainability in retail operations. *International Journal of Production Economics*, 171, 394-404. <https://doi.org/10.1016/j.ijpe.2015.09.042>

- Wang, Z., Subramanian, N., Gunasekaran, A., Abdulrahman, M. D., & Liu, C. (2015). Composite sustainable manufacturing practice and performance framework: Chinese auto-parts suppliers' perspective. *International Journal of Production Economics*, 170, 219-233. <https://doi.org/10.1016/j.ijpe.2015.09.035>
- Wu, T., Jim Wu, Y.-C., Chen, Y. J., & Goh, M. (2014). Aligning supply chain strategy with corporate environmental strategy: A contingency approach. *International Journal of Production Economics*, 147, 220-229. <https://doi.org/10.1016/j.ijpe.2013.02.027>