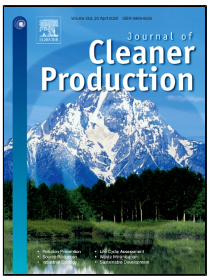

Circular Supply Chain Management: A State-of-art review and future opportunities

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Circular Supply Chain Management: A State-of-art review and future opportunities

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Circular Supply Chain Management: A State-of-art review and future opportunities

Abstract:

The notion of circular economy (CE) has gained considerable attention recently among researchers, practitioners, and policymakers due to the enormous waste generation at all phases of a product life cycle. CE acts as alternative solutions to the dominant linear economic model of production and consumption. The incorporation of the CE into supply chain management is known as circular supply chain management (CSCM). The objective of this study is to conduct a state-of-art review of CSCM using content analysis methodology. This review covers the available circular supply chain literature, highlights the research trends, gaps and set up the potential research directions for future studies. Total 125 CSCM articles published in journals covering the span of last one decade (2010 to July 2019) are selected. The CSCM research articles are evaluated and segregated in 13 pre-defined structural dimensions and analytics. The result shows that there exist ample scope and open doors for the growth of CSCM which should be investigated with the help of advanced quantitative modeling approaches, highly developed optimization techniques, integrated multi-criteria decision making techniques, and proficient algorithms. Also, CSCM research needs to recognize enablers/drivers/critical success factors, barriers/obstacles, new circular business models and innovative frameworks. Therefore, this examination will prop up new opportunities for researchers to figure out the novel dimensions in the field of CSCM.

Keywords: Circular economy; Circular supply chain; CSCM; Content analysis; Sustainability

1. Introduction

In today's global competitive environment, every organization wants its supply chain to be more sustainable towards the economical, environmental and social point of view (Nosratabadi et al., 2019). The traditional industrial production and consumption system is based on the linear economy (take-make-consume-dispose) model (Goyal et al., 2018). It is also known as cradle-to-grave approach of production and consumption (Gregson et al., 2015). However, the linear economy model does not fit to be sustainable as it generates a huge amount of waste. Also, it depletes the available natural resources which causes natural resource scarcity and pollutes the environment enormously (Genovese et al., 2017). The world's urban community produces about 1.3 billion tons of solid waste every year which will rise to 2.2 billion tons by 2025 (Masi et al., 2017). This is a challenging situation for every manufacturing organization to mitigate the waste generation and environmental degradations problems (Braun et al., 2018). Hence, to tackle these issues, there is an urgent need to shifts towards a more sustainable mode of production in the supply chain, which is the concept of CE (Homrich et al., 2018).

The CE is emerging as a sustainable development strategy which requires a complete reform of the whole system of human activities. It includes both production processes and consumptions activities of the supply chain (Sehnem et al., 2019). This novel CE strategy is based on 6R's principles namely reuses, reduce, recycle, redesign, remanufacturing and repair operations of utilized products, by-products, and services (Ludeke-Freund et al., 2019). To empower such principles, supply chains are thought to be a basic unit of activity for the CE implementation (Ripanti and Tjahjono, 2019). Hence, a new domain of sustainability has been brought into the supply chain known as Circular supply chain management (CSCM) (Farooque et al., 2019). In transitions from CE to circular supply chain (CSC), the various aspects of sustainability such as design for circularity and CSC collaboration (Farooque et al., 2019), regenerative design (Franco, 2017), reverse logistic (Bernon et al., 2018), closed-loop supply chain (Ponte et al., 2019), green

supply chain (Liu et al., 2018), industrial symbiosis (Patricio et al., 2018), producers liabilities and responsibility (Farooque et al., 2019), cradle-to-cradle approach (Kalmykova et al., 2018), packaging recovery ecosystems (Batista et al., 2018a), eco-industrial park (Zeng et al., 2017), industry 4.0 and artificial intelligence (Dau et al., 2019) have been brought into consideration. CSCM can be defined in several ways by considering the role of CE in the supply chain. Batista et al. (2018b) defines CSCM as, harmonized forward and reverse supply chains through the incorporation of value creation aspects from products, by-products, and useful waste flows through prolonged life cycle that improves the three dimensions of organizational sustainability. CSCM is focused to restore and regenerate natural resources to maximize its utilization and captures the values of sources in a better way (Bernon et al., 2018). Further, MacArthur et al. (2015) defines CE with respect to supply chain as an industrial system that is restorative or regenerative by intention and design. There are numerous benefits due to adoption of CE in supply chain which includes improved availability of resources (Goyal et al., 2018), improved end of life strategies (de Sousa Jabbour et al., 2019), enhanced value propositions (Mishra et al., 2018), reduced waste generation rate (Herczeg et al., 2018), improved sustainability (Winkler, 2011), improved social benefits (Despeisse et al., 2017) etc. These CSCM benefits encourage the researchers and practioners to revisit their supply chain for possible integration with CE. These are few prominent reasons for tremendous growth of CSCM articles in last 2-3 years. A structural analysis is required to explore the diverse aspects of CSCM research articles. Hence, the present study focuses on a state-of-art review of CSCM literature using content analysis methodology to highlight the research trends, gaps and setting up the future research directions.

This research critically investigates the selected 125 research articles on CSCM over the span of last one decade (2010 to July 2019). This study classifies the CSCM research into two categories namely descriptive analysis and categorical analysis. The descriptive analysis includes the category namely number of published articles year-wise, journal wise, publisher wise,

universities wise, author wise and author's geographical location wise. The categorical analysis includes the category like research designs, research methods, data analysis techniques, algorithm and OR/mathematical tool, theories, MCDM techniques, practicing industries, level of analysis, ReSOLVE framework, circular business models, research fields, enablers / drivers /critical success factors and barriers / obstacles for the purpose to examine the CSCM field.

2. Previous literature review on CSCM

This section aims to summarize the existing literature review in the field of CSCM for elucidating the need for present study. The CSCM articles were retrieved from Scopus database. The CSCM research is growing continuously as it provides a prospect to promote sustainable production and utilization. This is evident from the number of literature published in the last few years. Till date, 14 significant review articles have been published on CSCM. Further, to carry out the structural review and justify the need of current review, a comparison of previously published review articles on CSCM is being organized based on criteria like country, review focus area, search engine used, time period, number of review articles considered, categories and brief outcomes (Table1).

←-------Table 1----------→

Majority of previous review articles are focused on a CE and its related concepts in context of supply chain. It is found that only 3 out of 14 articles are focused on the comprehensive issues of CSCM. These 11 previously published articles are focused on issues like waste to energy supply chain (Pan et al., 2015); integration of green supply chain and closed loop supply chain with respect to industrial ecology (Masi et al., 2017), industrial symbiosis and regenerative designs of supply chain for circular integration (Homrich et al., 2018), reverse supply chain and closed loop supply chain with respect to waste electrical electronics equipments (Islam and Huda, 2018), linking the closed loop supply chain and reverse logistics (Larsen et al., 2018), green supply

chain management and industrial symbiosis (Liu et al., 2018), green human resource management framework (Jabbour et al., 2019), business models in supply chain (Ludeke-Freund et al., 2019), Industry 4.0, CE and sustainable supply chain (Nascimento et al., 2019), sustainable business model in healthcare industry (Nosratabadi et al., 2019) and reverse logistics and closed loop supply chain (Ripanti and Tjahjono, 2019).

Other 03 review articles are focused on the compressive issues of CSCM. Farooque et al. (2019) considered 261 articles to define the concept of CSCM and integrated various terms related to value propositions aspects in CSCM. Further, this structured review provides the research directions for practitioners to operationalize the CE at various levels of the supply chain. It also highlights the novel concept such as design for circularity, regenerative design, remanufacturing, products liability and producer's responsibility and advanced technologies in CSCM. Taghikhah et al. (2019) reviewed the conceptual framework models based on CSCM to explain the sustainability issues in the SC with respects to the economic-socio-ecological performance by motivating consumer's behavior towards green consumption patterns to optimize the various process of the supply chain in manufacturing organizations. Batista et al. (2018b) considered 49 CSCM articles using content-based literature review methodology to understand the concept of restorative and regenerative principles in value creation and value proposition perspectives. These 3 articles on comprehensive CSCM lacks systematic literature review methodology which provides a comprehensive and exhaustive summary of current literature. Also, they have either limited focus on categories or number of articles selection.

It is evident from Table 1 that the 14 review articles have used different databases for the selection of article available on CSCM. Most of them have used more than one database and few of them have used only one database for the article selection process. These databases are Scopus, Web of Science, Google Scholar, ProQuest and EBSCO. Publisher's database such as Science Direct/ Elsevier and Springer are also used in few of the articles. Out of 14 review

articles, 3 articles have not disclosed the database chosen for their review (Table 1). Based on above discussion, there is a need for systematic literature review of CSCM articles to explore the research trend, gaps, and set up for potential research directions for future studies.

3. Research Methodology

This research study is driven by the content analysis methodology using the Systematic Literature Review (SLR) approach (Seuring and Muller, 2008). SLR is usually aimed at two purposes. Firstly, it recapitulates the existing research by identifying the various issues, patterns and themes of the relevant research field. Secondly, it helps to identify the conceptual content of the research in terms of theory. Hence, this study uses the SLR approach to meet the objectives of the research. This review adopts a six-step SLR model with a few modifications (Prajapati et al., 2019). The proposed research methodology framework for CSCM is shown in figure 1.

←-------Figure. 1---------→

3.1 Material collection

The first phase of material collection is selection of database and selection of keywords to find the CSCM articles. The material to be gathered is detailed and delimited with units of analysis (Prajapati et al., 2019). There are multiple databases available for selection of articles. These are Scopus, Web of science, Google scholar etc. The Scopus and Web of science constitutes of 95% of research articles published (de Oliveira et al., 2018). In this study, Scopus database is selected for articles selection, as it very exhaustive coverage. The data were collected in July, 2019 using search criteria in the article title, abstract and keywords over the span of last one decade. Total 1075 articles resulted in the initial search (Table 2).

3.2 Material refinement

Material refinement is a rigorous approach to refine the selected CSCM research articles. Articles found in the initial search were refined based on inclusion and exclusion criteria to eliminate articles that were not linked to CSCM research. The first filter excludes the articles based on document types: thesis, technical reports, technical papers, PPT's, white papers, technical reports, technical papers, competition announcements, project deliverables, magazines, editorial, erratum, and poster publication. Further, it excludes articles based on source type: conference proceedings book series and trade publications. A total of 736 articles were left with the first refinement of the initial articles. The second filter was to exclude articles that didn't use the English language. A total of 650 articles were left after the second filter. The third filter was to exclude articles based on duplicate publications via title wise. A total of 305 articles were left after the third refinement of the 650 articles. The fourth filter was to include the articles that strictly address the CSCM issues via abstract analysis. After meticulous analysis of 305 articles through their abstracts, 125 CSCM research articles were finally selected for this study (Table 2).

←-------Table 2----------→

3.3 Descriptive study

The descriptive study provides the background for subsequent content analysis. The selected 125 CSCM research articles are examined according to the frequency of published articles into categories like publication year wise, journal wise, publisher wise, university wise, author wise and author's geographical location wise.

3.4 Selection of categories

In this step, categories are derived based on the inductive and deductive approach to achieve the research objectives. In a deductive approach, articles are selected before the material is analyzed, while in inductive approach, categories are derived from the articles under examination itself by

process of generalization (Seuring and Muller, 2008). This research employs the categories from the inductive approach of selection. These structural dimensions are adopted from the previous literature review articles with additions of few dimensions (Merli et al., 2018; Ansari and Kant, 2017). This study considers thirteen structural dimensions namely research designs, research methods, data analysis techniques, algorithm and OR/mathematical tool, theories, MCDM techniques, practicing industries, level of analysis, ReSOLVE framework, circular business model, research fields, enablers / drivers/ critical success factors and barriers / obstacles of the CSCM. Table 3 illustrates the comprehensive categorical classification of study.

←----------Table 3----------→

3.5 Categorical analysis

This step consists of an assessment of selected 125 CSCM research articles based on its contents as per structural dimension (Table 3). The 13 predefined categories are described in section 4.2.

3.6 Result & conclusions

The last step discuss the outcomes i.e. research findings, gaps, and future research directions of CSCM research.

4. Findings

4.1 Descriptive analysis

In the first step of the evaluation, selected 125 CSCM research articles were categorized based on descriptive dimensions. Further, the content of these CSCM research articles was assessed using descriptive analysis. The following sub-sections describe the descriptive analysis:

4.1.1 Year wise distribution

The purpose of time span review is to examine the year-by-year development of CSCM research. It has been observed that CSCM has become extremely interesting research field among the academicians and practitioners in the recent past (Figure 2). The selected 125 CSCM research articles for the period 2010-2019 are arranged in a chronological order as per the year of publications (Figure 2). The CSCM research was limited during the period of 2010–2016 as published articles on CSCM research was at a stable rate with 1, 2 or 3 articles every year. The publication shows a steep rise after the year 2016 with around 83% of the research articles being published from 2017 onwards. This shows that CSCM is an emerging research field due to the increased awareness among researchers and practioners.

←----------Figure. 2----------→

4.1.2 Journal wise distribution

The purpose of journal wise distribution is to examine the existing journals which are publishing the CSCM research articles. The selected 125 articles on CSCM research are published across 41 journals. The broad range of journal coverage indicates the expansion of the CSCM research field. Table 4 lists out the major journals covering the CSCM research. It is observed that the Journal of Cleaner Production (35 articles) is the leading journal publishing research on CSCM. The other leading journals publishing CSCM research articles are: International Journal of Production Research (10 articles), Sustainability (10 articles), Production Planning and Control (9 articles), Resources, Conservation and Recycling (6 articles), Management Decision (5 articles), and Business Strategy and the Environment (4 articles).

←----------Table 4----------→

4.1.3 Publisher wise distribution

It is found that 11 publishers publish CSCM research articles in their prominent journals (Table 5). Out of the 125 CSCM research articles, almost 45% of the articles are published by Elsevier. This is followed by Taylor & Francis (16.80%), Emerald Insight (13.6%), MDPI (10.40%) and

Wiley (5.6%). These are the well established and renowned publishers which are actively involved in publishing the peer-reviewed CSCM research articles.

←----------Table 5----------→

4.1.4 University wise distribution

The statistics shows that 97 universities/ institutions are actively involved in CSCM research. The university affiliated to first author of publication is considered for this analysis. Table 6 shows the most active universities involved in the CSCM research. The University of Technology, Australia and Montpellier Business School, France (5 articles each) emerges as the topmost university/ institute to publish CSCM research. Further, University of Exeter, England, Chalmers University of Technology, Sweden and Dalian University of Technology, China has published 3 articles each. There were 14 other universities/ institutions with 2 articles each and 78 universities/ institutions with 1 article each. Such type of analysis helps to collaborate with the universities working on CSCM research.

←----------Table 6----------→

4.1.5 Author wise distribution

The author wise distribution examines the dynamic involvement of the authors in CSCM research and helps to promote the possible collaboration. It is established from the analysis of selected 125 CSCM research articles that 114 prominent researchers did research on CSCM. Table 7 provides the list of the researchers who are involved in the CSCM research. The frequency of listed researchers is the first authors of their publication. Batista L. and Van Loon P. (3 articles each) are the most prolific researchers in the area of CSCM. Others contributors are 7 researchers with 2 publications each and 105 researchers with 1 publication each.

←----------Table 7----------→

4.1.6 Geography of scholar wise distribution

The geographical analysis of scholars for selected 125 research articles shows that the CSCM research widely covers 32 countries around the globe. Table 8 presents the frequency of collected data for geographical locations of the scholars. The major research on CSCM is being carried out by United Kingdom (24 articles) followed by China (10 articles), France (9 articles), Brazil (8 articles), Netherlands and United States (7 articles each), and India and Australia (6 articles each). The result indicates that the majority of the study is conducted and published by countries which are well aware of the negative environmental impact and are progressively performing environmental practices to diminish the same. This analysis helps to collaborate with the researchers and practioners of nearby geographical locations.

←----------Table 8----------→

4.2 Categorical analysis

In this analysis, selected CSCM research articles are analyzed for its content aligned with each of the structural dimensions (Table 3). Further, these selected CSCM research articles are assigned a suitable subcategory. The following sub-sections present the complete categorical analysis and its outcomes.

4.2.1 Research design categorization

This section of analysis focuses on the bifurcation of selected 125 CSCM research articles according to research design mainly empirical research and desk research. Empirical research design is divided into three sub-groups namely Empirical qualitative, Empirical quantitative and Empirical triangulation. Further, the Desk research design is divided into two sub-groups namely Desk qualitative and Desk quantitative (Ansari and Kant, 2017). Table 9 depicts the division of CSCM research articles as per the research design. It is observed that desk qualitative (31 articles) is the most accepted research design amongst CSCM researchers. Empirical triangulation (28 articles), empirical qualitative (27 articles), empirical quantitative (18 articles)

and desk quantitative (7 articles) are the next preferred research design in literature. The other category (14 articles) includes review articles. Further, the results indicate that the CSCM research field is more inclined towards a qualitative approach (58 articles) rather than quantitative approach (26 articles).

←----------**Table 9**----------→

4.2.2 Research methods categorization

The statistics shows that 11 research methods are used by the CSCM researchers in the past, which includes individual and hybrid category (Table 10). It is observed that the conceptual model (31 articles) is the frequently used research method in CSCM. This is followed by a case study (27 articles), case study and interview (15 articles), survey (11 articles) and interview (7 articles). Mathematical modeling (2 articles) is the least preferred method. Only 2 articles on mathematical modeling indicate that there are ample of scope to apply mathematical modeling techniques to CSCM research. Hybrid research methodology like case study and survey, case study, survey and interview need to be applied to screen out the issues related to CSCM implementation.

←----------**Table 10**----------→

4.2.3 Data analysis techniques categorization

A data analysis technique helps to convert the existing raw data into valuable information using statistical or logical operations useful for decision-making (Prajapati et al., 2019). It assists researchers to collect random data, outlines the outcome of variables and allows them to gauge the impacts of alternative potential situations (Sachan and Datta, 2005). Data are collected and analyzed to answer research questions, test hypotheses or disprove theories. Table 11 depicts the distribution of CSCM research article based on diverse data analysis techniques. The content analysis (23 articles) is the most established data analysis technique and reports highest in the

selected CSCM research articles followed by statistical analysis (16 articles), Life cycle analysis (14 articles) and sensitivity analysis (8 articles). Other major data analysis techniques are Thematic analysis, Cross-case analysis (7 articles each), SEM (4 articles). The data analysis techniques like regression analysis, discriminate analysis, MANOVA, correlation analysis, etc. reported limited application in selected CSCM research articles.

←----------**Table 11**----------→

4.2.4 Algorithm and OR/ Mathematical tools categorization

This section focuses on reviewing the selected 125 articles to find out different algorithm and OR/ mathematical tools used in the CSCM research. Table 12 shows the statistics of the algorithm and OR/ mathematical tools employed in CSCM research. Mixed-integer linear programming model (5 articles) is found to be leading tool. This is followed by simulation (4 articles), input-output model (3 articles), and game theory and Markov chain model (2 articles each). Other tools used in CSCM research includes: artificial neural network, goal programming, graph theory and matrix approach, heuristic model, and k means clustering algorithm (1 article each). The analysis shows that there are limited applications of Algorithm and OR/Mathematical tools in CSCM research.

.←----------**Table 12**----------→

4.2.5 Theories categorization

"*A theory is a thoughtful and unbiased kind of abstract or comprehensive thinking or the consequences of such analysis for understanding and guiding any phenomenon. It is developed from experience, experimentation, innovative and social thinking*" (Prajapati et al., 2019 pg. 514). Table 13 presents the theories used by researchers in the CSCM field. Grounded Theory (4 articles) is most used theory in CSCM research. It is based on the systematic generation of theoretical aspects from qualitative data that contains both inductive and deductive thinking

(Kalverkamp and Young, 2019). Dynamic capabilities theory, ecological modernization theory, institutional theory, and resource-based view theory (3 articles each) are second-most used theory followed by prospects theory, stakeholder theory, system theory, upper echelon theory and theory of planned behavior (2 articles each) in CSCM research. Other 13 theories are used only once in the selected 125 CSCM research articles.

←----------Table 13----------→

4.2.6 Multi criteria decision making techniques categorization

MCDM techniques are applicable when the decision is to be made between various conflicting situations. MCDM considerably used over the last few years by the supply chain managers and researchers. Table 14 lists the MCDM techniques used in the selected 125 CSCM research articles. It is found that only 2 articles have implemented MCDM techniques in CSCM research. Both these articles used integrated MCDM techniques. These are mainly ISM - MICMAC (Mangla et al., 2018) and SWARA - EDAS (Yazdani et al., 2019).

←----------Table 14----------→

4.2.7 Major industries categorization

The selected CSCM articles are classified into three basic types of industries i.e. manufacturing, process and service to understand the adoption of CSCM practices. Table 15 provides the list of industries which have implemented CSCM concepts. The majority of the selected CSCM articles are from the manufacturing industries. The manufacturing industries are sub-classified into seven different industrial sectors as WEEE (23 articles), automobile and electronic (18 articles each), remanufacturing (11 articles) and electrical, defence and aerospace (1 each). The second group consists of process industries which include metallurgy (7 articles), food (4 articles), and chemical (3 articles each). Other process industries are cement, plastic, composites, leather, textiles, pharmaceutical, pulp and paper, and bioenergy (1 article each). The second group

consists of service industries which include healthcare, household, packaging, and logistics industries (1 article each). One article is also available on the construction supply chain. The few authors considered more than one industry for their research on CSCM is classified under multisector industries (12 articles).

←----------**Table 15**----------→

4.2.8 Level of analysis categorization

The level of analysis aims to carry out sustainable development across different level pertinent to economical prosperity, environmental quality and societal equity viewpoint (Merli et al., 2018). This analysis employs in CSCM research based on social science perspectives to point out the location, size or scale of research. The CSCM practices can be classified into three levels based on its application across the industry. Table 16 shows the frequency of selected articles based on the level of analysis. Macro (51 articles) is the topmost used level of analysis followed by supply chain (49 articles), Micro (13 articles) and Meso (4 articles) level of analysis. This approach of analysis leads to a more advanced evaluation system that gives the information to decision-makers on future strategies formulation based on sustainability.

←----------**Table 16**----------→

4.2.9 ReSOLVE framework categorization

CSCM requires complex efforts to focus on 6's actions of ReSOLVE framework to capture the economic benefits. This analysis aims to identify and categorize the CSCM research according to ReSOLVE framework to support practitioners in the transition process from the linear economy model to the CE model. ReSOLVE framework includes six business operational activities namely regenerate, share, optimise loop, virtualise, and exchange. Table 17 presents the distribution of 121 CSCM articles out of selected 125 articles based on ReSOLVE framework. Loop (56 articles) is a topmost business operational activity followed by optimise (31 articles).

Others business operational activities of ReSOLVE framework found in the literature are: regenerate (25 articles), exchange (4 articles), share (3 articles) and virtualize (2 articles). 4 articles don't contain any type of ReSOLVE framework.

←----------**Table 17**----------→

4.2.10 Circular business models categorization

The circular business model at one side focuses to reduce the extraction and use of natural resources and on the other side, it controls the generation of industrial and consumer wastes. CSCM research articles are categorized based on two business models namely slowing resource loops and closing resource loops (Bocken et al., 2016). The slowing resource loops are further divided into 4 sub-categories namely access and performance, extending product value, classic long life, and encourage sufficiency. Table 18 shows the frequency of business models found in CSCM research. The finding depicts that only 94 articles out of 125 selected CSCM articles employed business models strategy for their study. Researchers are more inclined towards closing resource loops circular business model (50 articles). But at the same time slowing loops circular business model (44 articles) is also critical to take the upsides of CSCM. Research on extending resource value (46 articles) is more popular as compared to industrial symbiosis (4 articles) in closing resource loops circular business model. On the other hand, extending the product value (20 articles) is the most examined category in slowing loops circular business model followed by classic long life model (17 articles), access and performance model (5 articles), and encourage sufficiency (2 articles).

←---------**Table 18**----------→

4.2.11 CSCM Research fields

This section aims to examine the core areas within the CSCM research fields. Table 19 shows the distribution of selected CSCM research articles according to the various research fields. The

finding suggests that diversified research fields are associated with the CSCM domain. It is evident from table 19 that environmental sustainability (15 articles) is the most preferred research area among researchers. This is followed by remanufacturing (14 articles), reverse logistics network design (13 articles), sustainable supply chain network design (10 articles), design for circularity (9 articles), industrial ecology (7 articles) and waste disposal (6 articles).

←---------Table 19 ----------→

4.2.12 CSCM Enablers

CSCM implementation requires structural change within organizations. Enablers/critical success factors/drivers are the key factors for the implementation of any activities in the organization (Ansari and Kant, 2017). The various studies on enablers for CSCM implementation are listed in Table 20. The various enablers are identified in the perspective of business applications and countries. The major CSCM enablers include government support and legislation, economic benefits, scarcity of resources, consumer environmental awareness, top management support, industrial collaboration, innovative strategies, environmental policy, regulatory practices etc., are some of the important enablers of CSCM implementation. Agyemang et al. (2019) considered Chinese automobile industry to identify the enablers of CSCM. CSCM enablers are also identified for the manufacturing industries in Finland and Denmark (Tura et al., 2019; Govindan and Hasanagic, 2018).

←----------Table 20----------→

4.2.13 Barriers of CSCM

The transition from linear to CE business models is not easy task for any manufacturing organizations. There are numerous variables which hinder the CSCM implementation at industries levels are known as obstacles/barriers. These obstacles/barriers need to be resolved for the smooth CSCM implementation. The organizations must come out with the solutions to

mitigate the impact of these obstacles/ barriers. Table 21 lists out the major studies on obstacles/barriers of CSCM research. The major CSCM barriers include lack of environmental laws and regulations, lack of financial resources, lack of government support, lack of information and knowledge, lack of top management support, lack of supply chain integration, lack of circular design aspects, lack of market for remanufactured products etc. are commonly occurred barriers to the CSCM implementation. The majority of studies on the CSCM barriers are focused on the manufacturing sectors of European countries except one study on Indian manufacturing industries by Govindan and Hasanagic, (2018).

←-------Table 21----------→

5. Discussion on classified analysis result

The finding of the categorical analysis facilitates to discover more relevant research trends, gaps and develops future research opportunities. This section emphasizes the significant findings, research gaps, and future research scope.

5.1. Significant findings

The following are the finding from the content analysis of CSCM literature-

- CSCM research has gained impetus from the last few years which is evident from the abrupt increase in the number of publications during 2018 and 2019 (Figure 2). Out of selected 125 articles, 104 articles were published after 2017 showing significant interest towards CSCM research. The growing social and ecological relevance of the CSCM has created a pressure among the stakeholders to look for possible solutions for unsustainable development. CSCM implementation helps to improve supply chain resiliency, resource efficiency, process design, competitiveness, cost saving and end of life management strategies. It also focuses on waste minimization at source and enhances SC efficiency and productivity. Hence, researchers and practioners are paying more attentions towards CSCM implementation.

- A total of 11 publishers published CSCM research articles in their prominent journals. 28% of the selected articles on CSCM research are published in the Journal of Cleaner Production. It is an international and inter-disciplinary journal focusing on cleaner production, environmental, and sustainability practices. Elsevier emerged out to be a largest publisher of CSCM researches with almost 45% of articles are published by them.
- CSCM research is diversified across 97 universities of 32 countries covers 114 affiliated authors around the globe. The University of Technology, Australia and Montpellier Business School, France emerges as the top university/ institute to publish CSCM research. Most of the research on CSCM is being carried out by United Kingdom (19 %) followed by China (8 %), France (7.2 %), and Brazil (6.4 %), Netherlands and United States (7.6 % articles each). Most of the studies are carried out by the countries whose aim is to reduce the carbon footprint in the coming years. These countries already developed action plans and started its execution. Many countries around the globe are either unaware of the CSCM facts or do not have proper finance and facilities to carry out environmentally friendly practices.
- The Desk qualitative (24.8 %) is the most recognized research design in CSCM researchers. Desk research is based on the gathering of required information from available resources and mostly carries out by sitting at work area or desk with low cost. It is performed based on theoretical or conceptual aspects of CSCM. Empirical research is carried at any organizations by field survey with a comparatively higher cost than desk research. This review study demonstrates that nearly 60% of studies on CSCM are based on empirical research, whereas nearly 30% of CSCM studies are based on desk research. The statistic information shows that the field of CSCM is dominated by the field research.
- The research methods like conceptual model, case study, interview etc. are popularly used in CSCM research. Nearly 25% of the articles are based on conceptual models. The conceptual models help to know and understand the subject based on theoretical constructs. The case

study (21.6 %) is the preferred methodology amongst researchers as it acts as a foundation to develop a new hypothesis when there is no prior hypothesis available for future researches.

- Content analysis (23 articles) is the most accepted data analysis technique considered by the researchers in the CSCM field. This technique helps the researchers to understand the overall themes, patterns, and issues of the CSCM research. The top four techniques i.e. content analysis, statistical analysis, life cycle analysis, and sensitivity analysis constitute nearly 50% of the selected CSCM articles for this study. Statistical analysis helps to know the recent trends in the field (Merli et al., 2018) whereas the Life cycle analysis evaluates ecological impacts associated with all the stages of a product's lifecycle. Sensitivity analysis is generally performed to check and improve the robustness of the significant results (Shen et al., 2019).
- The literature depicts that a limited number of algorithms and OR/mathematical tool is used by researchers to solve complex CSCM problems. These modeling approaches transform real-world decision problems into an operation research model to achieve a desired set of objectives. Mixed-integer linear programming (5 articles) is the most used OR tool for solving multifaceted mathematical optimization problems such as optimizing output or cost in the area of CSCM research.
- Only four MCDM techniques are employed by researchers in CSCM, namely ISM, MICMAC, SWARA, and EDAS. ISM is used to develop a structural relationship among distinct variables and MICMAC is used to identify the driving and dependence power among them (Mangla et al., 2018). SWARA is used to find the criteria weight and EDAS is used to rank the alternatives in an MCDM problem (Yazdani et al., 2019).
- This analysis indicates that research on CSCM is not restricted to a few prominent industries but has a wide range of applicability in all type of industry segments. The majority of the studies are carried out in the manufacturing industries (73 articles) followed by process

industries (22 articles) and service industries (4 articles). Manufacturing industry offer an enormous potential to impact the sustainability issues in CSCM.

- Most of the CSCM articles are analyzed based on the Macro level (51 articles). This analysis considers several firms activities based on the local and national level. The micro-level analysis is based on single business activities or consumer (Vimal et al., 2019). Meso level usually emphases on inter-firm level activities based on industrial symbiosis concepts (Herczeg et al., 2018). Supply chain level analysis incorporates all the level of analysis. i.e. (Macro, Micro and Meso). It aims on the interactions among firms involved within a supply chains across the globe.
- ReSOLVE framework offers significance opportunities for manufacturing industries of developing countries as a tool for generating circular strategies and economic growth initiatives for CSCM implementation. Most of the ReSOLVE framework analysis is conducted on Loop action (56 articles) which restores the value of used/second-hand products through recycling, remanufacturing, repair, reuse activities of CSCM. Loop action acts as the main backbone of CSCM implementation (Mishra et al., 2018). The action optimise (31 articles) uses advanced manufacturing technologies such as sensors, automation, big data, and remote sensing to reduce the waste in production systems and supply chains (Aguilar-Hernandez et al., 2018). Regenerate, exchange, share, and virtualise actions were found in the least number of CSCM literature.
- Circular business model keeps products and materials in use, by design, for as long as possible to gain utmost value from them. The slowing resource loops model (44 articles) is focused on extended use and reuse of products and material over time through the design of long lifetime and lifetime extension activities (Ponte et al., 2019). Majority of articles are categorized in the closing the resource loop business model (50 articles) which significantly reduces greenhouse gas emissions through better circular waste management practices such

as extending resource value and industrial symbiosis to gain the advantages of value propositions (Braun et al., 2018). A circular business model leads to offer new commercial opportunities for manufacturing industries and contributes to the sustainable business growth. A circular business model protects the economy against resource shortages and the cost rise of materials.

- The CSCM research area is broadly classified in 26 core topics. Majority of the article are focused on environmental sustainability (15 articles) which deals with the ecologically sustainable development of supply chain to mitigate the negative/ hazardous impacts on the environment. Remanufacturing (14 articles) mainly emphases on second-hand products or components to gain the benefits of value proposition principle and keep the products in closed-loop as long as possible. Reverse logistics network design (13 articles) determines the recovery center locations and optimize the products flow between the processes at the various locations to gain the economic value of return products at minimal costs while complying with environmental legislation. Sustainable supply chain network design (10 articles) incorporates all three dimensions of sustainability in supply chains. Design for circularity (9 articles) focuses on circular aspects of products design for restorative and regenerative perspectives in CSCM research.
- The study of enablers/critical success factors/drivers and barriers/obstacles of CSCM implementation is mainly focused to the manufacturing, automobile, leather and remanufacturing industry. These studies are mostly carried out in the European countries like Denmark, Finland, England, Netherland etc. The evidences are also available from the Asian countries like China, India and Bangladesh.

5.2. Gaps identified

- Most of the studies on CSCM research are focused on the case study, conceptual and theoretical aspects. The research in the CSCM is at the beginning stage and lacks the application of quantitative research methodology.
- The majority of the CSCM research is based on content analysis, statistical analysis, and life-cycle analysis. But, the research is limited to other credible data analysis techniques such as structural equation modeling, factor analysis, regression analysis, and ANOVA, etc. Also, methods such as data envelopment analysis, parametric analysis, Bayesian analysis, Shapiro-Wilk's test, path analysis and chi-square analysis etc. are not reported in CSCM research.
- Multi-objective OR tools such as mixed-integer programming, mixed-integer non-linear programming, dynamic programming, system dynamics, genetic algorithm, etc. are not reported in a single article of CSCM research. These modeling approaches help to solve both linear as well as non-linear optimization functions. The application of MCDM techniques in CSCM research is limited. The traditional and advanced MCDM techniques are very powerful tools to handle the conflicts arises during CSCM implementation.
- Most of the studies are based on WEEE, automobile, and electronics industries. Other industries such as mining, cement, defense, oil and gas, resin, wine, plastic, composites, electrical, computer, leather, textiles, construction, pharmaceutical, pulp and paper, aerospace, agri-food, bioenergy, healthcare, household, packaging, and logistics have a lot of scope for CSCM implementation but still not given due attention so far.
- Enablers/critical success factors/drivers and barriers/obstacles of CSCM implementation need to focus with respect to the specific set of industries for effective CSCM adoption. The best practices need to be developed and benchmarked for better CSCM implementation. Although there are many articles available on sustainable business models in the CSCM literatures, but it lacks the implementation plan at industries to achieve the sustainable growth. Despite of

many studies conducted in the field of CE and CSCM, but focus is limited on applicability of different supply chain management theories.

- Previous studies on CSCM reveals that a number of framework and tools are available for evaluation of circular business models but still they are not adapted for the assessment of different value creation and proposition dimensions of CBMs. Most of the CSCM research articles are focused on cleaner production practices with respect to sustainability. To reshape the socio-economic growth of organizations, CSCM need attention and active participation from the research community, Further, risk assement of CSCM implementation is completely missing and need greater attention.

5.3. Future research direction

Based on the gaps indentified, future research of CSCM may include the following, but not limited to the points below.

- It is observed that most of the previous studies on CSCM are biased towards the quantitative research and mostly conducted the studies based on qualitative research. The CSCM researches should focus on quantitative research methodology such as questionnaires, interviews, observations, records, online surveys, longitudinal surveys, web-based surveys, e-mail based, etc. For collection of large amount of data in efficient manner and for getting feedback, survey research plays an important role in the field of CSCM. The main purpose of these methods is to verify the reliability and legitimacy of the theory developed.
- There is a need to use advanced simulation and mathematical modeling techniques. To overcome the inadequacy in CSCM research, the use of mathematical/simulation modeling becomes necessary to optimize the various operations of industries. These methods help the academicians and practioners to predict the behavior of a system (both linear and non-linear), examine the multifarious systems and give an idea of significant inputs and outputs results.

- Use of non-linear programming models such as response surface modeling, goal programming, dynamic programming, graph theory, interpolation algorithm, etc. to solve the complex and complicated real case problems is highly recommended.
- There is need to employ the advanced data analysis techniques such as data envelopment analysis (DEA), parametric analysis, Bayesian analysis, Shapiro-Wilk's test, path analysis, chi-square analysis, cost-benefits analysis, network analysis, correlation analysis, regression analysis, material flow analysis, input-output analysis, cluster analysis, Man-Whitney U-test etc.
- MCDM techniques in CSCM are under utilized. Hence, MCDM techniques such as Analytic hierarchy process (AHP), Complex proportional assessment of alternatives (COPRAS), The technique for order of preference by similarity to ideal solution (TOPSIS), Weighted aggregated sum product assessment (WASPAS), Elimination and choice expressing reality (ELECTRE), Preference ranking organization method for enrichment of evaluations (PROMETHEE), Measuring attractiveness by a categorical based evaluation technique (MACBETH), Operational competitiveness rating (OCRA), Organization, rangement et synthese de donnes relationnelles (ORESTRE), Multiobjective optimization on the basis of ratio analysis (MOORA), Decision making trial and evaluation laboratory (DEMATEL), etc. and the combination of these to be targeted in future CSCM studies. Also, using these methods with a fuzzy set theory is recommended to reduce the vagueness.
- The slowing and closing loops business models acts as a main driver for adoption of sustainable CE practices in supply chains of industry. These models serve to reduce the generation of hazards industrial and consumer wastes. Hence, future CSCM research is a need to explore the concept of slowing and closing material loops business models.
- The countries having higher gross domestic product growth rate such as Libya, Rwanda, Bangladesh, Ethiopia, etc. and the fastest growing economies of the world is focused on

increasing their production, which in turn leads to produce more waste if they follow the linear supply chain model. Therefore, there exist ample opportunities in such countries to focus on CSCM research for their economic, social and environmental growth.

- CSCM values creation and proposition research includes design for circularity, design for remanufacturing, regenerative design, industrial ecology, laws and policy implication, industrial symbiosis, industrial ecology, circular consumption, CSC collaboration and coordination, biodegradable packaging, producers liabilities and responsibilities, corporate social responsibility, product life cycle extensions, additive manufacturing, smart manufacturing, industry 4.0 with CE, supply chain procurement, circular and process integration and sharing economy should be further explored in future studies. These values creation and proposition research enhance the three dimensions of sustainability such as economical dimensions (i.e. cost saving, revenue generation by access to new market, risk reduction and reduce waste disposal cost), environmental dimensions (i.e. substitutions of virgin materials, extent of reuse or recycle of materials, reduced the use of toxic materials, waste mitigation, energy use reduction, integration of eco-design thinking and green certifications and standards) and social dimensions (i.e. customer satisfaction and loyalty, ease of access for the customer, reduced life cycle costs and health and safety practices).
- The industries such as mining, printing, wine, oil and gas, fashion, defense, maritime, steel and few other industries that have a major impact on the SC sustainability in terms of maximizing the use of non-renewable resources, improving the efficiency of supply chain operations and recover the values from waste generated across SC of industries, can offer considerable research opportunity in future.
- Research areas such as resource management, additive manufacturing, smart manufacturing, performance management, bio-waste management, societal sustainability, sustainable manufacturing, eco-design, e-waste management, just-in-time manufacturing, facility

location, government regulations and CE, consumer behavior have given very less attention so far in CSCM literature. Hence, these areas can provide abundance opportunities of research in future perspectives.

- The various production and business activities in CSCM linked with numerous types of risk factors. The occurrence of these risks factors would hinders the implementation of CSCM. Hence, there is need to identify, analyze and evaluates CSCM risks factors and its solution in future study.

- Applicability of various management practices such as end-of life management, sustainable supply chain management, reverse logistics management, green supply chain management, closed loop supply chain integration with CE, Products service system management are still to be discover with perspectives of CSCM. This has led to develop the wide variety of performance indicators. Hence there is need to develop the CSCM standards performance metrics for its evaluation prior to its implementation, during implementation and after implementation.

- It is also proposed that much research is needed to explore the different supply chain management theories such as value creation theory, resource based view theory, industrial network theory, organizational theory, supply chain management theory, cascading theory, supply network, governance theory, control theory, management theory, ecological modernization theory etc. These theories can be utilized to determine the strategic framework for effective adoption of CSCM practices in various industries to achieve the sustainable competitive advantage over its competitors.

6. Research Conclusions

CSCM is an emerging research topic in recent years. It has great potential to improve the efficiency of manufacturing organizations in terms of the three dimensions of sustainability. It is an alternative solution to linear supply chain model (take, make, consume and dispose) of production. The implementation of CSCM enhances the effectiveness of supply chain operations. This state-of-art literature review is performed to examine the CSCM research published in the last decade (January 2010 till July 2019) using content analysis methodology. Based on its content, the articles were categorized in predefined structural dimensions and analytics. The implementation of the CSCM has several noteworthy benefits such as improving resource efficiency, supply chain efficiency, economic growth, value propositions, end of life strategy, competitiveness, etc. that an organization may achieve. The research on CSCM is in the initial phase and has numerous research opportunities in quantitative modeling and its application in real-life problems. Furthermore, research areas such as additive manufacturing, smart manufacturing, industrial ecology, resource management etc. have a huge potential to obtain the socio-economic growth in perspectives of sustainability. In addition, growing populations, scarcity of resources, complex socio-economic relationship, uncertainty in sustainability related factors, and nonlinearity amongst factors further demands to optimize the CSC network by developing efficient algorithms and programming tools. The recognized gaps and prospective opportunities provide a vision for researchers, practioners and policy makers to further expand the CSCM research. The limitation of this work exists in the selection of research articles. This research has selected articles only from the Scopus database, published in peer-reviewed English language journals. This restricts selection of relevant articles published in conferences, languages other than English, and not listed in the selected database.

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Declaration of interests

☒The authors declare that they have no known competing financialinterestsor personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

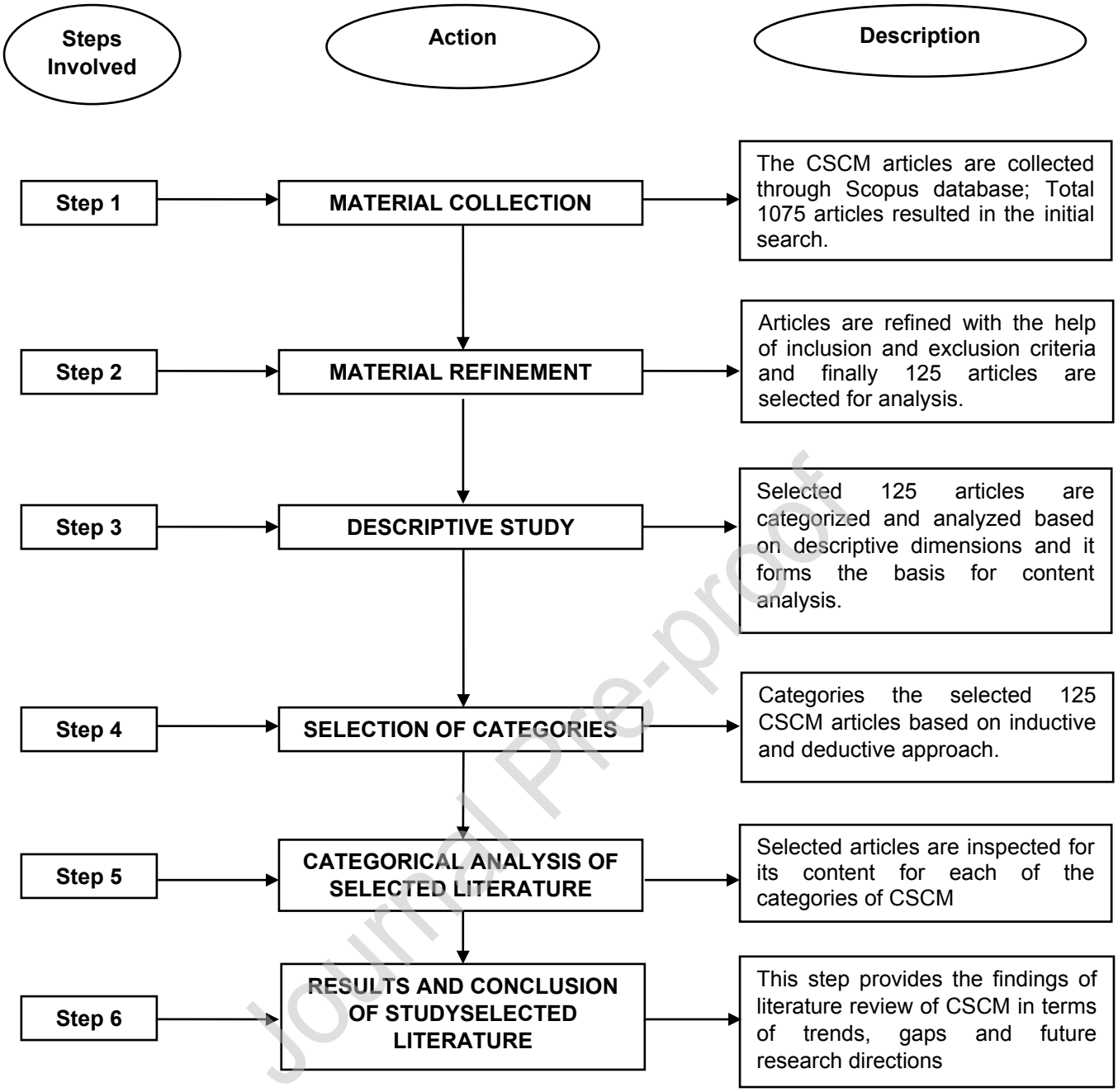

Fig.1. Research methodology framework for CSCM

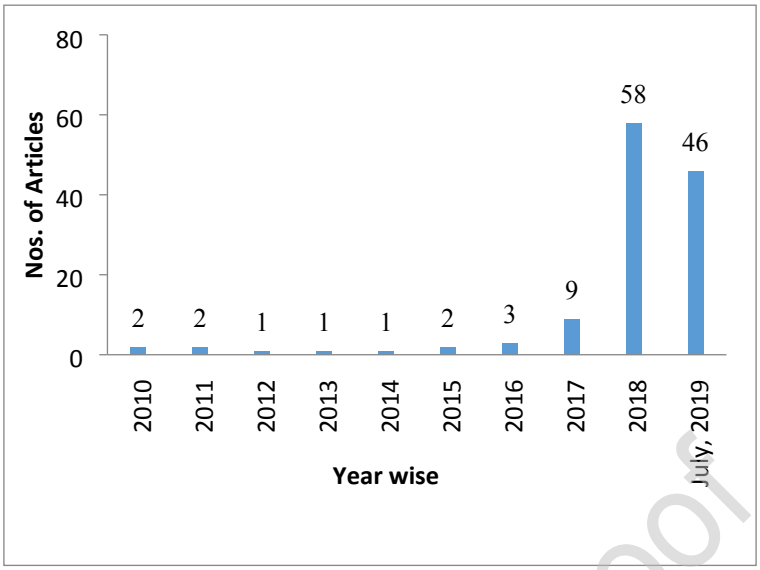

Fig.2. Time distribution of publication

Table 1 Existing literature review on CSCM

Sr. No.	References	Country*	Focus Area	Search Engine	Time period	No. of papers	Categories	Outcomes
1	Farooque et al. (2019)	New Zealand	CSCM	Scopus	2006-2018	261	Defines CSCM and Integrates terms such as value chain, products service system, drivers and barriers, indicators, logistic activities, End of Life management to CE.	Provides the research direction about how to introduce CE in supply chain context to enhance the field of sustainable and green supply chain
2	Jabbour et al. (2019)	France	Integrates GHRM framework in CE	NA	NA	NA	Circular economy, GHRM, Change management, Sustainable supply chain.	Develops the GHRM framework to links the concept of GHRM and ReSOLVE CE model.
3	Ludeke-Freund et al. (2019)	Germany	CBM, SC,CE	NA	Till 2018	NA	Interlink the industrial ecology terms such as industrial symbiosis, closed loop material system to circular economy business models.	Discusses the various design strategy which support the development of circular business models in supply chain context.
4	Nascimento et al. (2019)	Brazil	Industry 4.0, CE, SSC	Elsevier, Scopus and Springer	Till 2018	57	Additive manufacturing, Green operations in supply chain, Industry 4.0, Sustainable production system.	Presents the circular business model to reuse the E-waste in supply chain by incorporating the innovative technology to manufactured products.
5	Nosratabadi et al. (2019)	Hungary	CE, SBM's, Sustainability, Healthcare industries	Web-of-Science and Elsevier, Scopus	2002-2017	66	Circular economy, Sustainable supply chain, Innovation, Management and marketing, Entrepreneurship, fashion, Energy, Healthcare industries.	Develops the sustainable business model which acts as strategies to enhance the performance of circular supply chain.
6	Ripanti and Tjahjono (2019)	Indonesia	RL, CE, CLSC	Google Scholar, Scopus, and EBSCO	Till 2018	51	Reverse logistics, Sustainability, supply chain management, Product Recovery, Repair, Refurbishment, Remanufacturing and Cannibalization.	Identifies the various CE values in supply chain for the purpose to understand the design process of product recovery management in supply chain perspectives.

7	Taghikhah et al. (2019)	Australia	CSCM	Scopus, Science Direct	Till 2019	NA	Encouraging consumer behavior toward green consumption patterns as a result supplier and producers change their operation in sustainable way.	Proposes a conceptual framework based on circular supply chain. This helps to optimize the various operations of supply chain.
8	Batista et al. (2018b)	England	CSCM	EBSCO and ProQuest	1992-2017	49	CE, Circular supply chain, sustainability viewpoint of supply chains, restorative processes	Presented literature review and understand the concept of restorative and regenerative principles in CSCM.
9	Homrich et al. (2018)	Brazil	CE, SC, IS, Regerative Design, Industrial ecology	Web of Science and Scopus	1990-2016	327	Cradle to cradle, Industrial ecology, Regenerative design, Industrial metabolism, Industrial symbiosis and Eco-parks. Social network analysis.	Provides the various definition of CBM's based on social network analysis and improve the in depth knowledge of CE in supply chain
10	Islam and Huda (2018)	Australia	RSC, CLSC, CE, WEEE	Web of Science and Scopus	1999-2017	157	Circular economy, CLSC, Reverse logistics, Sustainability, Waste Electrical and Electronic Equipment management.	Provides the deeper understanding of WEEE management activities based on RL/CLSC concept.
11	Larsen et al. (2018)	Denmark	Linked the notion of CLSC, RL in CE.	Web of Science and Scopus	1995-2017	112	Circular economy, CLSC, Reverse logistics, Factor network map for RSC. Recovery and resale of end-products.	Identifies the important factors which directly contribute to the firm's financial performance by adopting reverse supply chain.
12	Liu et al. (2018)	China	GSCM, CE, Industrial symbiosis in CE	Scopus and Web of Science	2000-2017	182	Circular economy, Green supply chain management, industrial symbiosis, Theories applied in GSCM and CE, Methodology.	Develops the mutual theory applications for in-depth understanding of GSCM and CE.
13	Masi et al. (2017)	England	Delve into GSC, CLSC and CE aspects in relation to SC, Industrial	Web of science, ProQuest, Scopus	2005-2017	77	Circular economy, Industrial ecology, Sustainable supply chains, Drivers, Enablers, Inhibitors to CE	Explores the various aspects of CE based on meso level supply chain such as drivers, inhibitors, enablers, Industrial symbiosis, Green supply chain and Closed loop supply

			ecology					chain
14	Pan et al. (2015)	Taiwan	CE, waste to energy supply chain	NA	NA	NA	Waste to energy supply chain, Circular economy system, Eco-industrial park, Business model.	Focuses on implementation of waste to energy supply chain based on sustainable bio-energy production.

Note: *This represents first author's country; CE: Circular economy; SC: Supply chain; GSC: Green supply chain; GSCM: Green supply chain management; SSC: Sustainable supply chain; SBM: Sustainable business model; CBM: Circular business model; CLSC: Closed loop supply chain; CSC: Circular supply chain; CSCM: Circular supply chain management; RSC: Reverse supply chain; RL: Reverse logistics; GHRM: Green human resource management; WEEE: Waste electrical electronic equipments; IS: Industrial symbiosis.

Table 2 Search Criteria's

Search terms	Initial Search	First Filter	Second Filter	Third Filter	Fourth Filter
	Initial number of articles searched from Scopus database	Articles left after exclusion criteria based on documents and source types	Articles left after exclusion of languages other than English.	Articles left after duplication via title wise	Articles left after meticulous analysis of abstract based on keyword CE and SC
Circular economy AND Supply Chain	364	263	235	107	43
Circular economy AND Sustainable supply chain	177	132	121	52	23
Circular economy AND Green supply chain	74	54	43	19	14
Circular economy AND Closed loop supply chain	62	48	39	13	10
Circular economy AND Environmental supply chain	166	122	115	54	14
Circular economy AND Reverse logistic	77	39	32	17	11
Circular economy AND Logistic	155	78	65	43	10
Total number of paper lefts	**1075**	**736**	**650**	**305**	125
Final number of papers selected for analysis					**125**

Table 3 Categorical classification

Structural Dimension	Analytical Categories		Descriptions
Research design	Desk qualitative		Conceptual and theoretical
	Empirical qualitative		Case study and action based research
	Empirical quantitative		Survey based research.
	Desk quantitative		Mathematical or simulation models, fuzzy logic etc.
	Empirical triangulation		Qualitative and quantitative based research
Research method	Case study		In-depth and detailed examination of a subject and its related contextual conditions
	Conceptual model		Theoretical aspects
	Mathematical model		Creating mathematical model to describe the behavior of a system.
	Simulation		Verify the validity and applicability of the proposed mathematical models
	Interview		Semi structural, structural, telephonic interview etc.
	Conceptual model+ Interview		Combination of conceptual model and interview
	Case study+ Interview		Combination of case study and interview
	Survey		Direct or mail based survey
	Survey + Interview		Combination of survey and interview
	Case study+ Survey		Combination of case study and survey
	Case Study+Survey+Interview		Combination of case study, survey, and interview
Data analysis technique	Content analysis, Life cycle analysis, Sensitivity analysis, etc.		Summarizations of the available data
Algorithm and OR/Mathematical tools	MILP, Simulation, Graph theory, Game theory, etc.		Optimization of existing resources, optimized network design and routine problems
Theories	Grounded theory, Dynamic capability theory etc.		Provides a framework for explaining observation based on social life aspects.
MCDM techniques	ISM, MICMAC, SWARA, EDAS		Structuring and solving the problems of multi criteria.
Industry sector	Sector of activities		Concern about implementation and adoption of core areas in the industries.
Level of analysis	Macro		Analysis of Industry based on city, province, region, country levels.
	Micro		Firm's level interactions such as single company or Consumer.
	Meso		Inter-firm's level activities.
	Supply chain		Supply chain level activities.
ReSOLVE framework	Regenerate		Shift to renewable energy source and materials.
	Share		Prolong life of products through maintenance, design for durability and upgradability.
	Optimize		Enhances the effectiveness and performance of a used product and eliminates the wastes.
	Loops		Keeps the products in closed loop as long as possible to take the advantage of value propagations.
	Virtualized		Dematerialize resource use by delivering utility virtually
	Exchange		Replaces old with advanced non-renewable materials, apply new technologies and choose new products or service.
Circular business model	Slowing loops model	Extending product value	Remanufacturing and refurbishment practices
		Classic long-life model	Extended product life based on durability and repair principle.

		Access and performance model	Providing the services to satisfy user needs without needing to own physical products
		Encourage sufficiency	Durability, upgradability and repair activities.
	Closing loops model	Extending resource value	Transformation of waste into a valuable resource
		Industrial symbiosis	Residual waste output of one industry becomes input for other industries.
Research fields	Environmental sustainability, Remanufacturing, Reverse logistic network design, etc		Various research area of CSCM has been explored so far.
Enablers			Variables that drive the CSCM implementation.
Barriers			Variables that obstruct the CSCM implementations.

Note: MILP: Mixed integer linear programming; SEM: Structural equation modeling; ISM: Interpretive structural modeling; SWARA: Step wise weight assessment ratio analysis; EDAS: The evaluation based on distance from average solution; MICMAC: Cross-impact matrix multiplication applied to classification.

Table 4 Journal wise distribution

Name of journals	No. of articles	Percentage (%)
Journal of Cleaner Production	35	28
International Journal of Production Research, Sustainability	10 each	8 each
Production Planning and Control	9	7.2
Resources Conservation and Recycling	6	4.8
Management Decision	5	4.0
Business Strategy and the Environment	4	3.2
Journal of Industrial Ecology, Journal of Manufacturing Technology Management	3 each	2.4 each
European Journal of Operational Research, International Journal of Production Economics, Journal of Environmental Management, Omega, Resources, International Journal of Physical Distribution & Logistics Management, Technological Forecasting and Social Change, Thunderbird International Business Review	2 each	1.6 each
Others (24 nos.)	1 each	0.8 each
Total	**125**	**100**

Table 5 Publisher wise distribution

Name of publishers	No. of articles	Percentage (%)
Elsevier	56	44.8
Taylor & Francis	21	16.8
Emerald Insight	17	13.6
MDPI	13	10.4
Wiley	7	5.6
Springer-Verlag	4	3.2
Blackwell Publishing	3	2.4
Others (4 nos.)	1 each	0.8 each
Total	**125**	**100**

Note: MDPI:Multidisciplinary Digital Publishing Institute

Table 6 University wise distribution

Name of university	No. of articles	Percentage (%)
University of Technology, Australia, Montpellier Business School, France	5 each	4.0 each
University of Exeter, England, Chalmers University of Technology, Sweden, Dalian University of Technology, China	3 each	2.4 each
Delft University of Technology, Netherlands, ESCP, Germany, INSEAD, France, KIIT University, India, KTH Royal Institute of Technology, Sweden, Prince Sultan University, Saudi Arabia, Rochester Institute of Technology, USA, Technical University of Denmark, Denmark, The Open University, England, University of Bradford, England, University of Cambridge, England, University of Northampton, England, University of Warwick, England, Utrecht University, Netherlands	2 each	1.6 each
Others (78 nos.)	1 each	0.8 each
Total	**125**	**100**

Table 7 Author wise distribution

Author	No. of articles
Batista L., Van Loon P.,	3 each
Alkhayyal B., Larsen S. B., Jabbour A.B.L.S., Masi D., Ponte B., Singhal D., Zhu Q.	2 each
Others (105 nos.)	1 each

Table 8 Geography of scholar wise distribution

Country's Name	No. of articles	Percentage (%)
United Kingdom	24	19.2
China	10	8.0
France	9	7.2
Brazil	8	6.4
Netherlands, United states of America	7 each	5.6 each
India, Australia	6 each	4.8 each
Denmark, Spain, Sweden, Italy	5 each	4.0 each
Germany	4	3.2
Austria, Belgium, Norway, Saudi Arabia, Turkey	2 each	1.6 each
Others (14 nos.)	1 each	0.8 each
Total	**125**	**100**

Table 9 Research design

Research design	No. of articles	Percentage (%)
Desk qualitative	31	24.8
Empirical triangulation	28	22.4
Empirical qualitative,	27	21.6
Empirical quantitative	18	14.4
Desk quantitative	7	5.6
Others	14	11.2
Total	**125**	**100**

Table 10 Research method

Research method	No. of articles	Percentage (%)
Conceptual model	31	24.8
Case study	27	21.6
Case study + Interview	15	12.0
Survey	11	8.8
Interview	7	5.6
Simulation modeling, Survey+ Interview	5 each	4.0 each
Case study + Survey, Case study + Survey+ Interview	3 each	2.4 each
Mathematical modeling, Conceptual model + Interview	2 each	1.6 each
Others	14	11.2
Total	**125**	**100**

Table 11 Data analysis techniques

Data analysis techniques	No. of articles
Content analysis	23
Statistical analysis	16
Life cycle analysis	14
Sensitivity analysis	8
Thematic analysis, Cross-case analysis	7 each
Structural equation modeling	4
Input-Output analysis, Descriptive analysis	3 each
Factor analysis, Regression analysis, Correlation analysis	2 each
ANOVA, Matrix analysis, Numerical analysis, MANOVA, Morphological approach, Multiscale analysis, Network analysis	1 each

Note: ANOVA: Analysis of variance; MANOVA: Multivariate analysis of variance

Table 12 Algorithm and OR/Mathematical tools

Types of Algorithms and OR/Mathematical tools	No. of articles
Mixed integer linear programming	5
Simulation	4
Input-Output model	3
Game theory, Markov chain model	2 each
Artificial neural network, Goal programming, Graph theory and matrix approach, Heuristic model, K-Means clustering algorithm	1 each

Table 13 Theories

Name of theory	No. of articles
Grounded theory	4
Dynamic capabilities theory, Ecological modernization theory, Institutional theory, Resource based view theory,	3 each
Prospects theory, Stakeholder theory, System theory, Theory of planned behavior, Upper echelon theory	2 each
Agency theory, Aligning theory, Cascading theory, Control theory, Game theory, Industrial network theory, Legitimacy theory, Management theory, Mutual theory, Organizational theory, Value creation theory, Supply network and governance theory, Supply chain management theory.	1 each

Table 14 MCDM methods

MCDM	No. of articles
ISM-MICMAC, SWARA-EDAS	1 each

Note: Interpretative structural modeling (ISM); Impact Matrix Cross-Reference Multiplication (MICMAC); Step Wise Weight Assessment Ratio Analysis (SWARA); The evaluation based on distance from average solution (EDAS)

Table 15 Industries

Major Industries	Sub-industries	No. of articles	Percentage (%)
Manufacturing	Waste electrical and electronic equipment's (WEEE)	23	18.4
	Automobile, Electronic	18 each	14.4 each
	Remanufacturing	11	8.8
	Electrical, Defence, Aerospace	1 each	0.8 each
Process	Metallurgical	7	5.6
	Food	4	3.2
	Chemical	3	2.4
	Cement, Plastic, Composites, Leather, Textiles, Pharmaceutical, Pulp and paper, Bioenergy	1 each	0.8 each
Service	Healthcare, Household, Packaging, Logistics	1 each	0.8 each
Construction		1	0.8
Multi-sector	(More than 1 industries)	12	9.6
Others		13	10.4
Total		**125**	**100**

Table 16 Level of analysis

Level of analysis	No. of articles
Macro	51
Supply Chain	49
Micro	13
Meso	4

Table 17 ReSOLVE framework

ReSOLVE framework	No. of articles
Loop	56
Optimize	31
Regenerate	25
Exchange	4
Share	3
Virtualize	2

Table 18 Slowing loops and Closing loops circular business model

Categories	Sub-Category	No. of articles
Slowing loops	Extending product value	20
	Classic long-life model	17
	Access and performance model	5
	Encourage sufficiency	2
Closing loops	Extending Resource Value	46
	Industrial Symbiosis	4

Table 19 CSCM Research field

Major research fields	No. of articles
Environmental sustainability	15
Remanufacturing	14
Reverse logistic network design	13
Sustainable supply chain network design	10
Design for circularity	9
Industrial ecology	7
Waste disposal	6
Enablers/ Drivers, Barriers, Recovery of second hand products, Circular business model, Industrial symbiosis	5 each
Resource management, Additive manufacturing, Smart manufacturing, Performance management, Circular supply chain collaboration and coordination, Bio-waste management, Societal sustainability	3 each
Sustainable manufacturing, Eco-design, E-waste management,	2 each
Just-In-Time Manufacturing, Facility Location, Government regulations and Circular economy, Consumer Behavior	1 each

Table 20 CSCM Enablers

Authors & Year	Enablers/Drivers/Critical success factors for CSCM Implementation	Application; Industry; Country
Agyemang et al. (2019)	Economic benefit, Unawareness towards CE, Cost reduction, Improved resource efficiency, Sustainable growth, Customer supplier relationship, environmental safety, Risk management issues, Improved quality of products, innovative strategies, Technological availability, Stability, Environmental regulations, Competitive advantage, Social responsibility, Organizational support, Stakeholder pressure.	CSCM; Automobile; China
Singhal et al. (2019)	Risk perception, Remanufactured product knowledge, Personal benefits, Green awareness, Market strategy, Attitude, Subjective norm, Perceived behavior control, Purchase intention,	CLSC; Remanufacturing; India
Tura et al. (2019)	Scarcity of resource, Concern about environmental negative impacts, Improve cost efficiency, Economic gain, Innovation, Increased awareness towards sustainability issues, Environmental regulations acts, Improved existing operations, New technologies, Improved information sharing, Reduced dependency on suppliers, Avoiding high and volatile prices, Improved availability of resources, Reverse network management, Improved organizational brand, Improved understanding to sustainable demands, company strategy and goals, Development of skills and capabilities.	CSCM; Manufacturing; Finland
Govindan and Hasanagic (2018)	Laws and policies, Economic growth, Climate change, Demand for renewable energy, Job creation potential, Consumers environmental awareness, Improved material and energy efficiency, Increased value of products with improve quality.	CSCM; Manufacturing; Denmark
Moktadir et al. (2018)	Training and education, Employee motivation, Knowledge sharing, Environmental impacts, Customer collaboration with environment, Global climate change, Scarcity of resources, Competitive advantage, Cleaner technology, Economic benefits, Government support and legislation, government funding, Reuse and recycling	CSCM; Leather industry; Bangladesh

	of materials, Suppliers collaboration with environment, Green environment, Industrial collaboration.

Table 21 CSCM Barriers

Authors & Year	Barriers/ Obstacles for CSCM Implementation	Application; Industry; Country
Agyemang et al. (2019)	Lack of expertise, Lack of awareness, Resistance to change, Cost and financial constraint, Lack of technical and technological capacity, Learning process and associated risk, Lack of resource, Profit and market demand level, Feasibility of CE implementation, Quality of finished product, Unused material, Lack of government policies, Lack of industrial support, Lack of supply chain integration, Lack of effects of supply chain complexity	CSCM; Automobile; China
Levering and Vos, (2019)	Economies of scale, High costs of remanufacture products, Lack of Stakeholders interests, Organizational needs.	CSCM; Manufacturing; Netherlands
Tura et al.(2019)	Lack of top management support, High cost of remanufacture products, Lack of performance measurement system, Lack of social awareness, consumer behavior towards remanufacture products, Lack of market for remanufacture products, Lack of clear incentives, Lack of regulatory acts, Lack of governmental support, Lack of information and knowledge, Lack of technologies and technical skills, Lack of network support and partners. Strong industrial focus on linear models, Lack of collaboration and resources, Incompatibility with existing (linear) operations and development targets, Lack of risk management, Conflicts with existing business culture, Lack of internal cooperation among employees, Heavy organizational hierarchy.	CSCM; Manufacturing; Finland
Vermunt et al. (2019)	Lack of financial resources, High up-front investment costs, Higher costs related to the new circular business model, Administrative burden, Lack of proper organizational structure for CE implementation, Complex management and planning processes, Lack of technical expertise, Lack of information, Lack of quality products, Design challenge, Lack of resources, Higher dependence on external parties, Lack of information exchange between supply chain actors, Lack of circular design aspects, Reluctance of third parties, Lack of consumer interest, Resistance from stakeholders, Ineffective recycling policies, Lack of management system for CE implementation, Lack of standards and guidelines for refurbishment products, Lack of awareness and sense of urgency.	CSCM; Manufacturing; Netherlands
Govindan and Hasanagic (2018)	Lack of standard system for performance indicator measurement, Unclear vision, Lack of laws and policies, insufficient fund, High upfront investment cost, High production cost, design challenges, Lack of information, Lack of awareness, Lack of knowledge, Poor leadership, Lack of business models, Lack of framework, Consumers behavior towards remanufacture products, Take-back issues, Lack of standards on refurbished products, Limited availability of reuse products,	CSCM; Manufacturing; Denmark
Mangla et al. (2018)	Lack of industrial incentives for greener activities, Lack of environmental laws and regulations, Lack of preferential tax policies, Lack of employee involvement in promoting greener products, Lack of customer awareness, Poor acceptance for environmentally superior technologies, Lack of technology transfers, Lack of knowledge, Lack of training and education, Lack of effective planning and management, Lack of systematic	CSCM; Manufacturing; India

	information systems, Lack of coordination and collaboration among SC members, Lack of support and participation of stakeholders, Lack of economic benefits.	
Masi et al. (2018)	Lack of awareness and sense of urgency, High up-front investment cost, High cost of remanufacture products, Higher costs for management and planning, Lack of government support, Competition legislation inhibits, Collaboration between companies, Lack of recycling policies, Lack of issues such as responsibilities, Liabilities and ownership, Lack of sustainable business models, Lack of an information exchange system between different stakeholders, Lack of performance measurement system, Lack of products design attention to CE perspectives, Lack of recycling material availability.	CSCM; Manufacturing; England