Understanding Product Returns: A Systematic Literature Review using Machine Learning and Bibliometric Analysis

Quang Huy Duong[1], Li Zhou[1*], Meng Meng[2], Truong Van Nguyen[3], Petros Ieromonachou[1], Duy Tiep Nguyen[1]

[1]Faculty of Business, University of Greenwich, London SE10 9LS, UK

[2] School of Management, University of Bath, Bath, BA2 7AY, UK

[3] Brunel Business School, Brunel University London, Uxbridge, UB8 3PH, UK

[*]Corresponding author: Li.Zhou@gre.ac.uk

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Abstract

Product Returns (PR) are an inevitable yet costly process in business, especially in the online marketplace. How to deal with the conundrums has attracted a great deal of attention from both practitioners and researchers. This paper aims to synthesise research developments in the PR domain in order to provide an insightful picture of current research and explore future directions for the research community. To ensure research rigour, we adapt a six-step framework - defining the topic, searching databases, cleaning and clustering data, paper selection, content analysis, and discussion. A hybrid approach is adopted for clustering and identifying the distribution and themes in a large number of publications collected from academic databases. The hybrid approach combines machine learning topic modelling and bibliometric analysis. The machine learning results indicate that the overall research can be clustered into three groups: (1) operations management of PR, covering (re)manufacturing network design, product recovery, reverse distribution, and quality of cores; (2) retailer and (re)manufacturer issues including return policy, channel, inventory, pricing, and information strategies; and (3) customer's psychology, experience, and perception on marketing-operation interface. Furthermore, from the content analysis, five potential future directions are discussed, namely digitalisation in the context of PR; globalisation versus localisation in the context of PR; multi-layer (i.e., retailer, manufacturer, logistics provider, online platform) and multi-channel (i.e., online, offline, dual and omni channel) oriented bespoke return policy; understanding and predicting customer return behaviour via online footprints; and customer return perception across the marketing–operations interface.

Keywords

Product returns; literature review; machine learning; topic modelling; bibliometric analysis; framework

1. Introduction

The history of product returns (PR) can be traced back to the 60s-70s, when PR was implicitly embedded in business tactics and strategies. For example, one of the first types of PR was refund policy (i.e., warranty claim) introduced by Menke (1969). Years later, other types of return policies were developed to mitigate customer purchasing risks and promote sales, such as money-back guarantee (Davis et al., 1995; Patankar & Mitra, 1995). It is undeniable that PR is difficult to control and manage. According to the customer transaction analysis, Barclaycard (2018) reveals that their users returned nearly a quarter of their purchased values (approximately £7 billions) in both brick-and-mortar and online stores from 2016 to 2018. In addition, according to GlobalData (2018), in the clothing and footwear industry, it is predicted that monetary values of online returns will continue increasing to £5.6 billions by 2023, raising a huge concern to the retailers' and OEMs' capability for tackling returns. The situation became worse during the pandemic when retailers had to extend their return window to allow customers more time taking product back to stores or post offices. This return policy leniency encouraged customers to return even more than usual.

Besides, PR is driven by not only customers, but also environmental impacts, regulations, and profitability. Many firms have been implementing a take-back program for over last two decades such as Kodak, Xerox and HP to collect end-of-life products for remanufacturing or recycling (Pishvaee et al., 2010). This leads to a necessity of integrating "Green" factors into remanufacturing tasks, for instance, production and inventory model (Teunter, 2004; Teunter, 2001; Teunter, Van der Laan, & Inderfurth, 2000; Van Der Laan, Dekker, & Salomon, 1996a; Van Der Laan, Dekker, Salomon, & Ridder, 1996b). These incorporations with PR are the premise for an appearance of two well-known concepts: Reverse logistics (RL) and closed-loop supply chain (CLSC). It is argued that PR can be used as a profit source. One of the typical benefits of returned products is that they could be disassembled into components or recycled to raw materials. It would save resources for buying new materials from their suppliers while reducing the amount of unwanted waste.

However, how to manage PR has proven to be challenging. It has attracted enormous attention both academically and practically over the last couple of decades. Early studies include, for example, setting up repair facility or return plant location (Daryanani & Miller, 1992; Marín & Pelegrín, 1998), finding optimal RL/CLSC solutions to manage used product's flow and maximise firm's benefits (Fleischmann et al., 2001; Jayaraman et al., 2003; Krikke et al., 1999). Recently, due to the return policy leniency to boost sales, the development of e-commerce and the complication of customer's psychology in nature, abusive returners have been detected and started becoming a considerable concern in business (Ketzenberg et al., 2020). Even worse, fraudulent PR started exceeding the organisation's manageability. As the PR management is a complex multifaceted process and a subject of high uncertainty in terms of quality, quantity, and timing, it is critical to properly address PR issues to ensure the success of the whole RL and CLSC system. This motivates us to conduct a literature review that systematically synthesises existing findings of PR literature to accelerate progression of the research area.

There were some attempts to review some aspects of PR. While some existing literature reviews focus on RL/CLSC/Green supply chain management in which PR was mentioned as one of the elements (Govindan et al., 2015; Kazemi et al., 2019; Srivastava, 2007), other reviews focus more on specific angles of PR management. For example, Janakiraman et al. (2016) reviewed return policy using a meta-analysis to find the effects of different dimensions of return policy to purchase and return proclivity. Abdulla et al. (2019) conducted a review of consumer return policy/management and its effect on consumer return behaviours based on their proposed conceptual framework. Robertson et al. (2020) focussed on the provision of a commentary in retail PR to find how PRs are transforming from the customer's journey to retailer's perspective. To the best of our knowledge, the comprehensive review that provides a holistic view of PR management is still largely understudied. So far, we only find one recent literature review of this topic by Ambilkar et al. (2021) but we believe that by using a different approach, our systematic review enriches their findings for new explorations of the subject area.

Our main contribution is to map out an overall picture of PR which includes the synergy of current research and future directions. The key questions to be answered in this review are:

- RQ1: What are the key research problems that have been addressed in the literature of PR management?
- RQ2: What are the research methodologies used to address these key problems?
- RQ3: What are the emerging future research directions in the PR?

The paper is organised as follows. In section 2, we propose a methodology framework for the literature review, describing data collection, cleaning, and clustering protocol. Section 3, we implement the process of bibliometric analysis on defined clusters from section 2. In section 4, we conduct a co-occurrence keyword analysis on the selected papers. Section 5 is for reviewing the contents and answer RQ1 and RQ2. Next, discussion and future directions RQ3 are laid out in Section 6, where related parties can retrieve or seek theoretical, practical, and methodological implications for PR. Finally, section 7 is the conclusion and limitations.

2. Methodological Framework and Publication Clustering

2.1. Methodology Framework

In this section, we propose a methodology framework to conduct the systematic literature review. It is a synergy and advancement of Cooper (2010) and Mayring (2010), consisting of six fundamental steps as shown in **Figure 1**: (1) Research background, (2) Defining search terms and collecting data using advanced search function in Scopus, EBSCOhost and Web of Science (WoS) databases, (3) Data cleaning and clustering using several cleaning and transformation techniques as well as an unsupervised ML model, (4) Paper selection for

content analysis using Bibliometric Analysis, (5) Content analysis, and (6) Discussion and future directions.

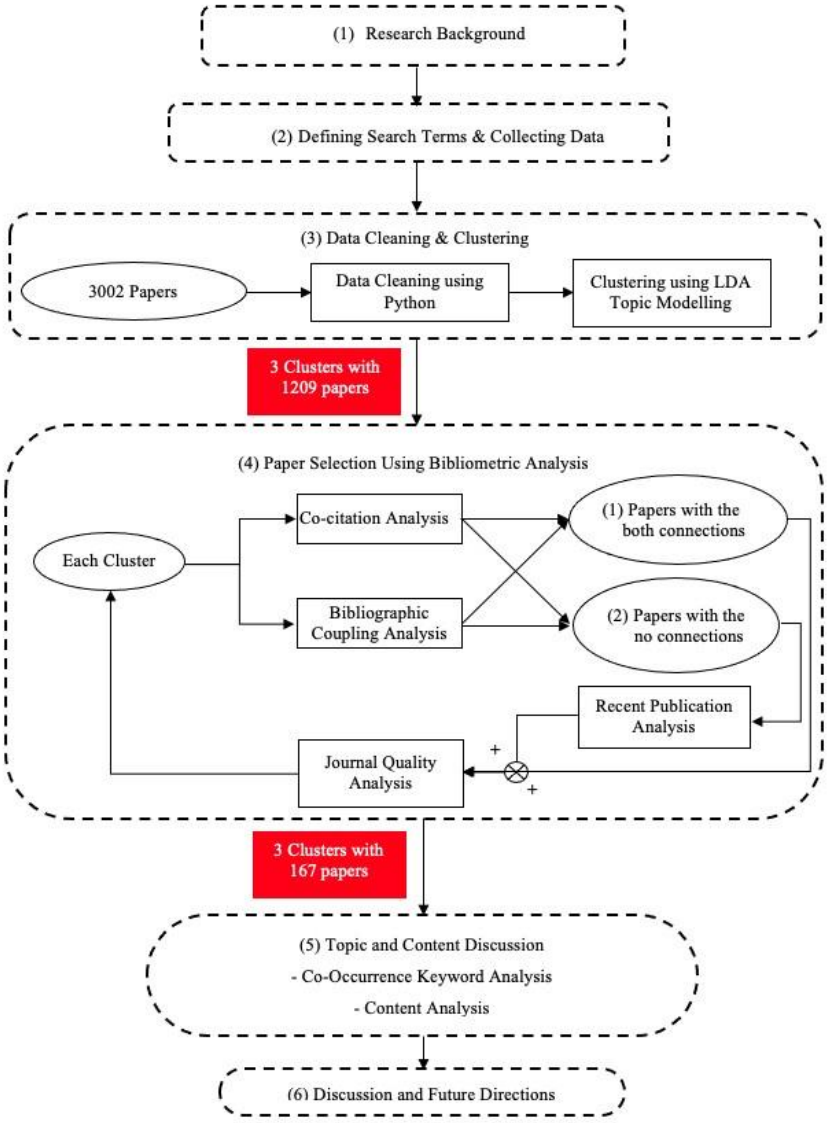


Figure 1. Methodology framework

2.2. Materials Collection

Papers were collected across three large databases - Scopus, WoS and EBSCOhost via a two-step process.

Firstly, the keywords were chosen based on the same approach from Abdulla et al. (2019), Janakiraman et al.

(2016) and Kazemi et al. (2019), in which the main topic became the keywords with different combinations. The chosen keywords were “core acquisition”, “buyback core”, “product return”, “return behaviour”, “return policy”, “consumer return”, “customer return” in different forms, for example, “return policy” versus “return policies” in the papers. We also set the focus on Business, Management, Operations, Logistics, Supply Chain, and Finance with English being the focused language. Publications were collected until Q2/2021. On that account, we collected 973 papers from Scopus, 823 papers from WoS, 1206 papers from EBSCOhost, equating to 3002 papers in total. Secondly, as the data could be duplicated, invalid or omitted to some extent, we crosschecked different datasets and removed duplications as well as invalid data by utilising Python to check their titles, authors, years, sources. In the end, 1209 papers were selected for further analysis.

2.3. Descriptive Analysis

The descriptive analysis is shown in **Figure 2** indicating the distribution of the papers relating to PR. As can be seen, researchers have been paying substantial attention to PR problem since the last decade, which has gained further momentum in recent years. **Table 1** provides a list of the top 20 journals contributing to PR research in the dataset, totalling 603 papers (49.87% of the total publications). International Journal of Production Economics, International Journal of Production Research, and European Journal of Operations Research are the most contributed journals, with 260 papers being contributed (21.5% of the overall). Lastly, the diversity of journal domains (e.g., Marketing Science, International Journal of Physical Distribution and Logistics Management, Computers and Industrial Engineering, Production and Operations Management, etc) shows the breadth of influence that PR has in the field of business and management.

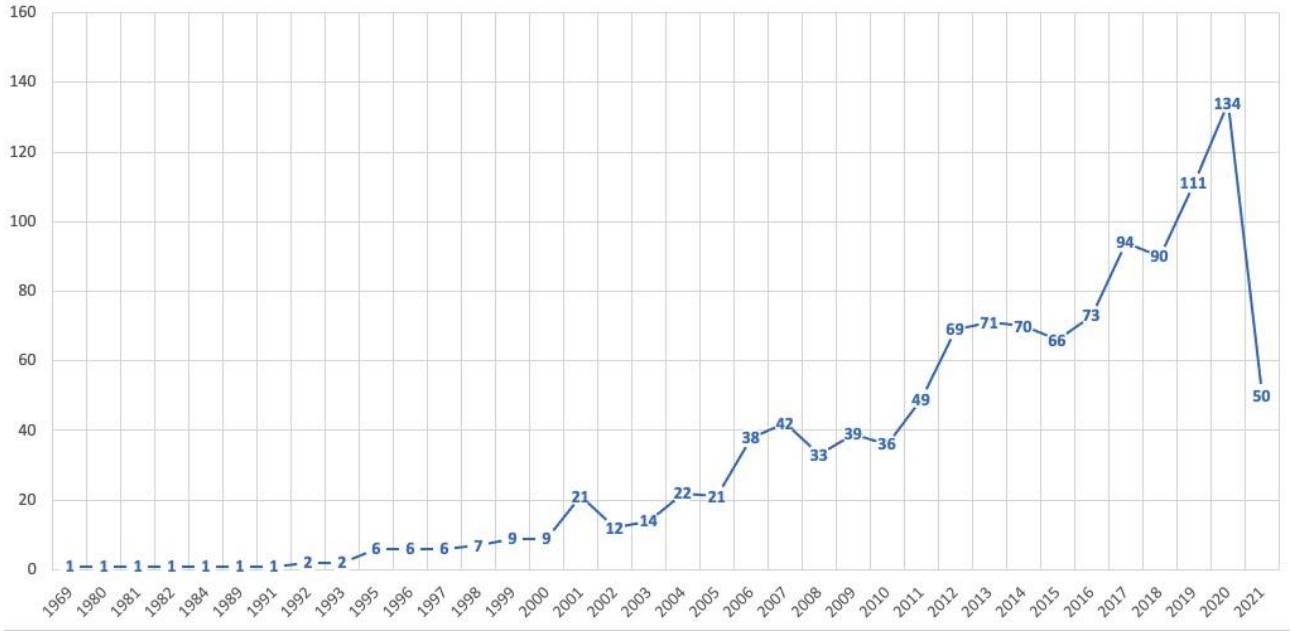


Figure 2. The distribution of publications across our study period (1969 – Q2/2021)

Table 1. Top 20 contributed journals across the period of dataset (1969-Q2/2021)

Journals	Number Of Publications
International Journal of Production Economics	106
International Journal of Production Research	78
European Journal of Operational Research	76
Journal of Cleaner Production	62
Production and Operations Management	34
International Journal of Physical Distribution and Logistics Management	26
Marketing Science	21
Omega	20

Annals of Operations Research	20
Computers and Industrial Engineering	20
Management Science	19
Journal of Retailing and Consumer Services	19
Journal of Retailing	15
Manufacturing and Service Operations Management	14
Journal of Operations Management	14
International Journal of Retail and Distribution Management	13
Transportation Research Part E: Logistics and Transportation Review	13
Psychology and Marketing	12
Journal of Manufacturing Systems	11
Decision Sciences	10

2.4. Latent Dirichlet Allocation Clustering and Results

- Latent Dirichlet Allocation (LDA) Clustering and Visualisation

LDA-based topic modelling is a typical clustering technique for grouping documents (i.e., papers) in a collection of documents (i.e., dataset) into topics (i.e., clusters) based on their semantic similarities (Blei et al., 2003). Traditionally, to determine which cluster a paper belongs to, we create a matrix to check the occurrence of a word appears in every individual document such as latent semantic indexing (Deerwester et al., 1990; Dumais et al., 1988) and probabilistic latent semantic indexing (Hofmann, 1999). However, these approaches

would result in an exponentially large combination and expensive computation. One of the initiatives of LDA is that it reduces the number of dimensions between words and their documents by adding a latent layer, so-called latent clusters. These latent clusters will also be the clusters to which papers are classified. LDA also provides the top frequent and representative words per cluster. The mathematical aspect of LDA can be seen in **Appendix A1**.

LDA requires user to pre-define the number of clusters (K) before clustering. To find the optimal number of K, Blei et al. (2003) originally proposed a perplexity score which was used to judge how good a LDA model to derive meaningful cluster given a textual dataset. This metric has been widely used by many authors to find the optimal number of topics from textual data such as online employee reviews (Jung and Suh, 2019), discussion forum postings (Narang et al., 2021), loan requests (Netzer et al., 2019) and automobile insurance claims (Wang and Xu, 2018). We use Python Gensim package which applies a log of the perplexity score for evaluating the model. The higher the log of a perplexity score is, the better performance of the LDA model. The LDA model with the K having the highest perplexity score will be selected as the optimal number of clusters for the dataset. How the log of a perplexity score is calculated can be found in **Appendix A2**.

The procedure for clustering and labelling our dataset has the following steps:

1) Abstracts cleaning and preparation.
2) Identifying the optimal value of K using log perplexity score.
3) Clustering 1209 abstracts using LDA model and the optimal K.
4) Visualising top keywords in each cluster using LDAvis technique (Sievert & Shirley, 2015) (see **Appendix A3** for mathematical expressions).
5) Cluster labelling.

 LDA Results

Before clustering the data, a protocol of cleaning noises such as punctuations, stop words (e.g., and, or, they, could, etc) and lemmatising each abstract is necessary to reduce noises and increase the accuracy. Furthermore, bigram and trigram (e.g., two, three words are likely together) models are applied to improve the meaningfulness. The choice of cleaning process is synthesised from Chae and Olson, (2021), Netzer et al., (2019) and Wang and Xu (2018).

To determine the optimal K value, different K values are trained in the range from 2 to 71 clusters, equating to 70 runs in total. From **Figure 3**, we can see that three clusters are the highest value of log perplexity.

Hence, in the next analysis, we select three clusters.

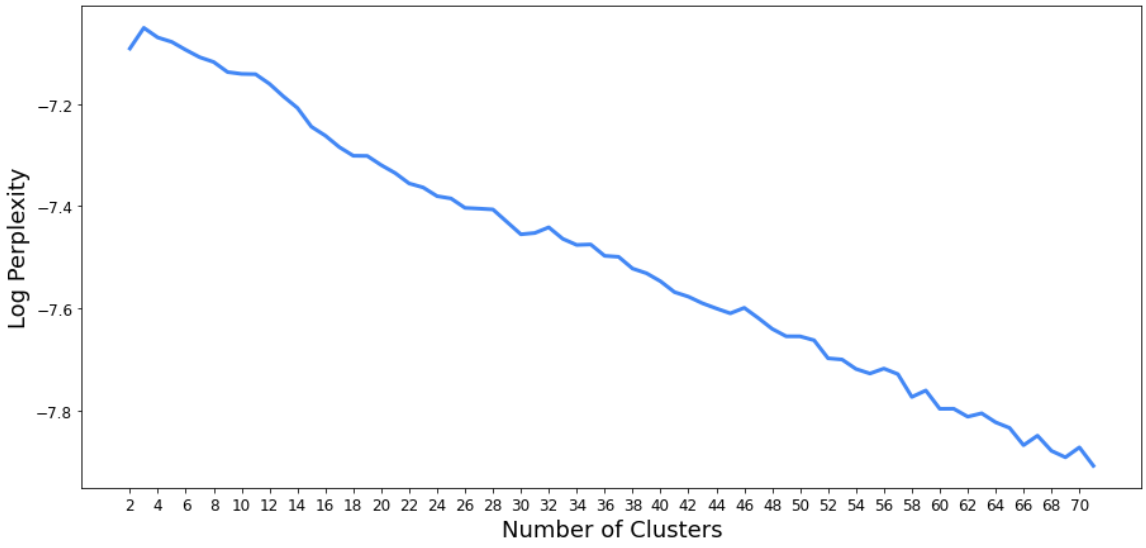
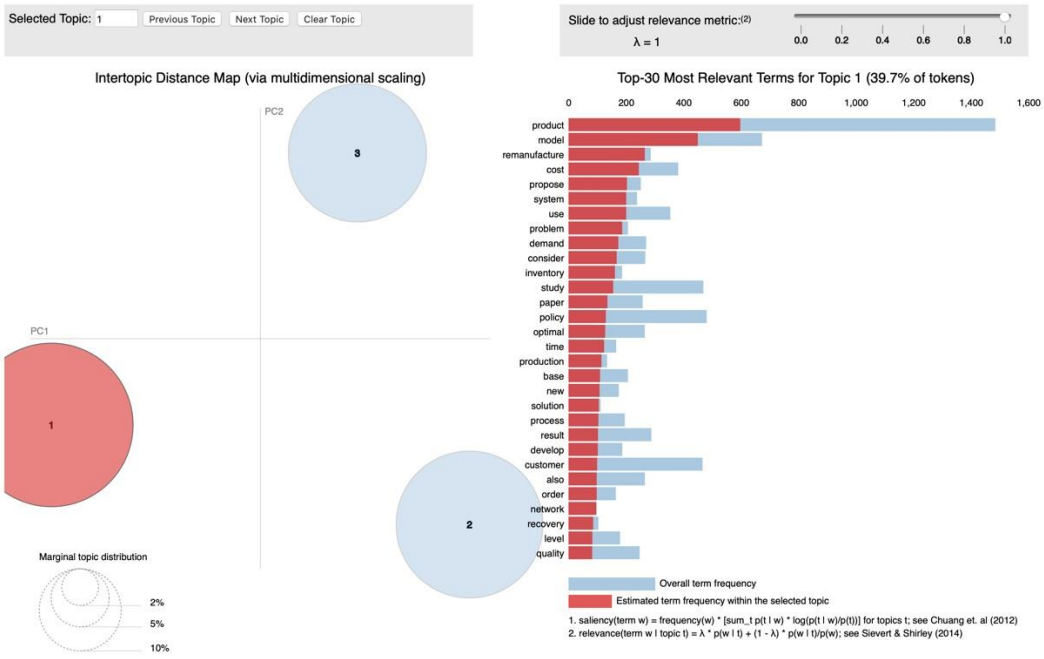


Figure 3. Log perplexity values by number of clusters

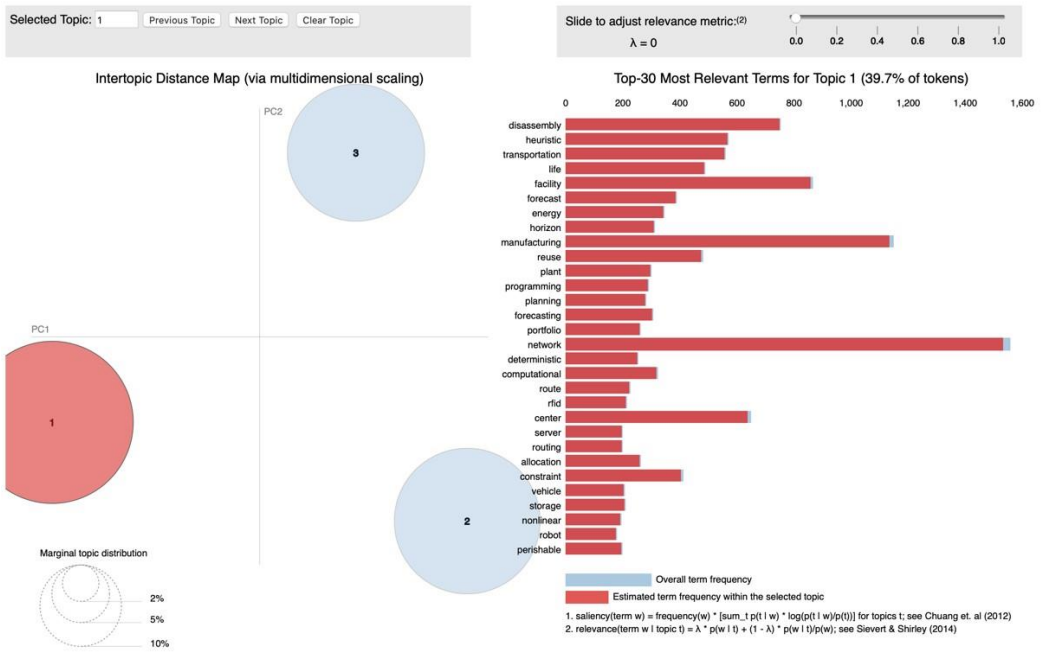
Our dataset is clustered with K = 3 clusters using LDA topic model. The outcomes include two main figures: (1) top keywords of each cluster (**Table 2**) and (2) papers in each cluster (**Table 3**).

In order to visualise the top keywords of each cluster, we adopt LDAvis (Sievert & Shirley, 2015) to depict the semantic distance map among three clusters and their keywords. The trained LDA model is input to LDAvis for keywords' visualisation. **Figure 4** shows the results from LDAvis. There are two main parts from LDAvis results: (1) The left side shows the semantic map over the clusters. Overall, three clusters are highly distinctive in terms of semantic words. (2) The right side shows top keywords in each cluster adjusted by the value λ. The value of λ is between 0 and 1. When λ is closer to 1, the model returns common keywords that may appear in other clusters. In contrast, when λ is closer to 0, the unique keywords are returned only in their clusters. **Table 2** depicts the top 20 keywords in three clusters with $\lambda = 1$ and 0

In order to label each cluster, we based on a basis of top frequent keywords per cluster in **Table 2** and the expertise of our research group. Each researcher in the group independently labels the clusters, then all researchers collectively discuss and cross-check to determine the final labels for the three clusters. As a result, labels of the three clusters are displayed on **Table 3**.



(a)



(b)

Figure 4. Semantic keyword visualisation with $\lambda = 0$ (a) and $\lambda = 1$ (b)

Table 2. Top 20 keywords with $\lambda = 0$ and $\lambda = 1$ for each cluster

Cluster 1	**Cluster 2**	**Cluster 3**

$\lambda = 1$	$\lambda = 0$	$\lambda = 1$	$\lambda = 0$	$\lambda = 1$	$\lambda = 0$
Product	Network	Product	Contract	Product	Author
Model	Manufacturing	Retailer	Pricing	Customer	Survey
Remanufacture	Facility	Price	Decentralize	Consumer	Intention
Cost	Disassembly	Manufacturer	Valuation	Study	Trust
Propose	Center	Consumer	Equilibrium	Retailer	Perception
System	Heuristic	Policy	Game	Policy	Recall
Use	Transportation	Model	Dealer	Service	Empirically
Problem	Life	Strategy	Utility	Research	Regret
Demand	Reuse	Online	Centralize	Management	Understanding
Consider	Constraint	Channel	Tax	Purchase	Abuse
Inventory	Forecast	Optimal	Centralize	Online	Feedback
Study	Energy	Profit	Showroom	Result	Cue
Paper	Computational	High	Centralized	Use	Mediate
Policy	Horizon	Decision	Sensitive	Increase	Device
Optimal	Forecasting	Increase	Wholesale price	Effect	Leniency
Time	Plant	Quality	Freight	Also	App
Production	Programming	Market	Buyback	Process	Questionnaire
Base	Planning	Customer	Decentralized	Identify	Returner
New	Allocation	Contract	Revenue share	High	Rating
Solution	Portfolio	Sell	Greenness	Firm	Employee

Table 3. Cluster labels and number of publications from results of LDA

Cluster	Label	Number of Publications
Cluster 1	Operations Management of PR	478
Cluster 2	Retailer and (Re)Manufacturer	418
Cluster 3	Customer's Psychology and Experience	313

3. Bibliometric Analysis for Paper Selection of Content Analysis

After three clusters are identified from LDA cluster modelling, the next stage is to select the most representative papers for each of the clusters for further analysis. Here, bibliometric analysis is adopted for three reasons. Firstly, bibliometric analysis enables users to demonstrate the dynamic knowledge domain based on scientific connection and development. Secondly, it is a quantitative method that map out the relationship between publications mathematically and statistically (Si et al., 2019). Lastly, there has been a widespread use

of bibliometric analysis in several aspects of operations, logistics and supply chain management to select appropriate papers for the content analysis (Ciano, Pozzi, Rossi, & Strozzi, 2019; Kazemi et al., 2019; Laengle et al., 2017; Li, Huang, & Yang, 2020; Merigó & Yang, 2017; Si et al., 2019; Wang, Chen, Rogers, Ellram, & Grawe, 2017; Xu, Zhang, Feng, & Yang, 2020; Xu et al., 2018). In this paper, we use VOSviewer software (van Eck & Waltman, 2010) among various available bibliometric software such as Pajek (Dohleman, 2006), Gephi (Bastian et al., 2009), Sci2 (Börner et al., 2003) to conduct the analysis. VOSviewer is compatible with a range of handy and flexible publication formats such as RIS, Scopus, WoS, etc. Also, advanced bibliometric tools such as co-author, co-occurrence, co-citation, and bibliographic coupling are integrated into VOSviewer.

3.1. Co-citation and Bibliographic Coupling Analysis

From a scientific perspective, co-citation (Marshakova, 1973; Small, 1973) and bibliographic coupling (Kessler, 1963) analysis are two tools utilised to map the citation relationships among publications in a systematic manner. Papers are more likely to represent the same clusters and methodologies if they cite or are cited by each other more frequently (Hjørland, 2013). The reason why we do not use the direct citation analysis to find representative papers is because direct citation is argued to require a lengthy yet less accurate time connection to fully depict the whole citation picture (Boyack & Klavans, 2010). Instead, co-citation and bibliographic coupling connect two papers using a third paper, hence the connection is not influenced by the timeline, but it is complemented by a third paper. Therefore, it is easier to accurately capture a full picture of the topic in a limited time period. We simplify the definition of both analyses as illustrated in **Figure 5**: (a) Paper B and C are considered to have a co-citation relationship when there is paper A cites both B and C, and (b) in contrast, paper B bibliographically coupled with paper C when they both cite paper A (van Eck & Waltman, 2014). Both techniques have been widely used in different domains to find the well-discussed papers within a cluster (Modak et al., 2020; Pilkington & Meredith, 2009; Wang et al., 2016; Xu et al., 2018).

In this paper, we apply a hybrid approach, running co-citation and bibliographic coupling analysis at the same time for each cluster. We input three clusters respectively to VOSviewer and set up a threshold of 3 connections to be included in the network. The chosen papers will be the ones which satisfy 2 criteria: (1) got at least 3 co-citation connections (2) got at least 3 bibliographic coupling connection. As a result, Cluster 1 (29 papers), Cluster 2 (59 papers) and Cluster 3 (23 papers) are selected for further analysis.

(a) (b)

Figure 5. Example of a co-citation relationship (a) and a bibliographic coupling relationship (b)

3.2. Recent Publication Analysis

For the papers which are left outside bibliographic coupling and co-citation networks, there is a concern about overlooking the emergence of new trends in scientific research. Specifically, it is unlikely that many recent papers are cited by peers, yet they are very valuable as these papers have contributed to the most up-to-date findings. Within each cluster, there are a number of papers without any connection (Cluster 1: 147 papers, Cluster 2: 153 papers, Cluster 3: 178 papers). As such, we scrutinise papers published between 2019 to Q2/2021 in order to capture the current trends, with 62, 61, and 76 papers the being selected corresponding to Cluster 1, Cluster 2, and Cluster 3 respectively.

3.3. Journal Quality Analysis

We conduct content analysis on the papers published in Grade 3, 4, 4* journals based on the Academic Journal Guide (AJG) 2018. AJG (2018) is a well-known guide which ranks the quality of journals in Business and Management domains. In summary, Cluster 1 (91 papers), Cluster 2 (120 papers) and Cluster 3 (99 papers) equating to 310 papers after co-citation, bibliographic coupling and recent publication analysis are checked via the journal quality analysis. The results show 167 out of 310 papers (53.87%) were published in Grade 3, 4, 4* journals, with the details for each cluster are shown in **Table 4**.

Table 4. Number of selected papers for content analysis after the journal quality analysis

	Cluster 1	Cluster 2	Cluster 3
Selected papers with all connections	21	55	10
Recent published papers without connections	25	42	14

4. Cluster Analysis using Co-occurrence Keyword Heatmap

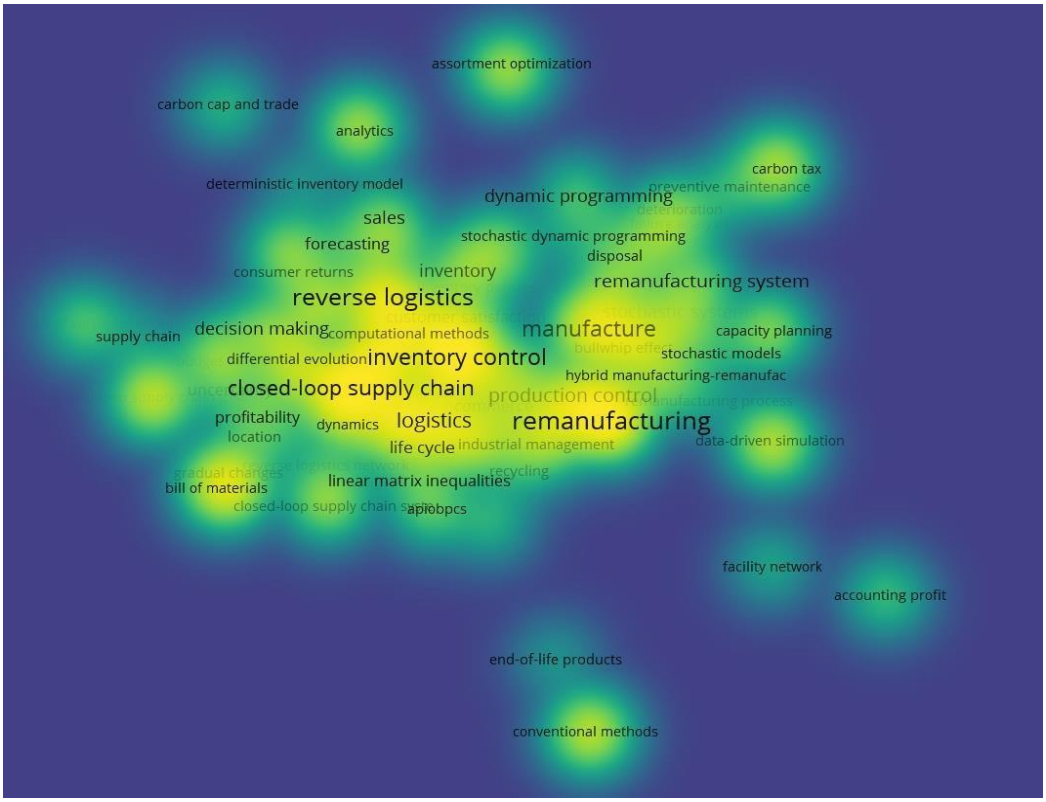
In this section, we deploy a co-occurrence keyword analysis on selected papers. This analysis provides a comprehensive overview of what has been addressed among the publications as well as initialises potential sub-clusters in each cluster. We implement the analysis by using VOSviewer software. Having the function of density visualisation, under heatmap format, the software provides glances of papers' content on each cluster.

Figure 6 illustrates the distributions of the keywords in Cluster 1 (373 keywords), Cluster 2 (554 keywords) and Cluster 3 (167 keywords). With regards to Cluster 1, a first glance gives an initial sense of how operations management have appeared in PR research (**Figure 6a)**. More specifically, considering keywords' magnitude, the most prevalent keywords are "remanufacturing", "reverse logistics", "remanufacturing system", "logistics", "supply chain", "location" and "inventory". Furthermore, the density of these keywords locating in the middle relatively shows the connection between papers within the cluster. This indicates that the papers in Cluster 1 specialise in manufacturing and structuring of a supply chain as well as dealing with problems at the upstream and (re)manufacturing stage. These stages integrate a reverse flow while implicitly embed a PR flow into a supply chain. In terms of methodology, despite sharing the same clusters, their solutions, which can be seen at the edges of **Figure 6a**, vary from "assortment optimisation", "stochastic

model", "data-driven simulation", etc, illustrative of the diversification in techniques for solving operational problems in RL and CLSCs.

With respect to Cluster 2, what stands out in **Figure 6b** is that "product returns" is explicitly discussed. "return policy", "electronic commerce", "supply chains", "costs", "sales", "money-back guarantee", "online retailing", "optimal pricing", etc. also stand out among the common keywords. This indicates that authors mainly focus on solving PR problems at the single/dual echelon level with the participation of manufacturers and retailers. Regarding methodology, there are few methodology keywords such as "artificial intelligence", "field experiment", "average treatment effect". It suggests that solutions are more case-oriented than using generic solutions/optimisations.

The final cluster addresses customers' different perceptions of PR. It is apparent from **Figure 6c** that the distribution is scattered, hence, it could be explained as customer's elements are heterogeneous in nature. Interestingly, while "product return" is the most common cluster, it has been approached using different themes such as "consumer behaviour", "attractiveness of alternatives", "return abuse", "brand equity", "customer satisfaction", "brand familiarity", etc. These keywords provide an initial overview of what has been done by previous authors from the customer perspective. Methodologies are also affected by the variety of perceptions. In this regard, authors adopted some techniques and data such as "econometric model", "formalization", "behavioral studies", "archival data".


assortment optimization
carbon cap and trade
analytics
carbon tax
deterministic inventory model
preventive maintenance
dynamic programming
sales
forecasting
stochastic dynamic programming
disposal
consumer returns
inventory
remanufacturing system
reverse logistics
supply chain
decision making
computational methods
manufacture
capacity planning
differential evolution
inventory control
stochastic models
hybrid manufacturing-remanufac
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remanufacturing
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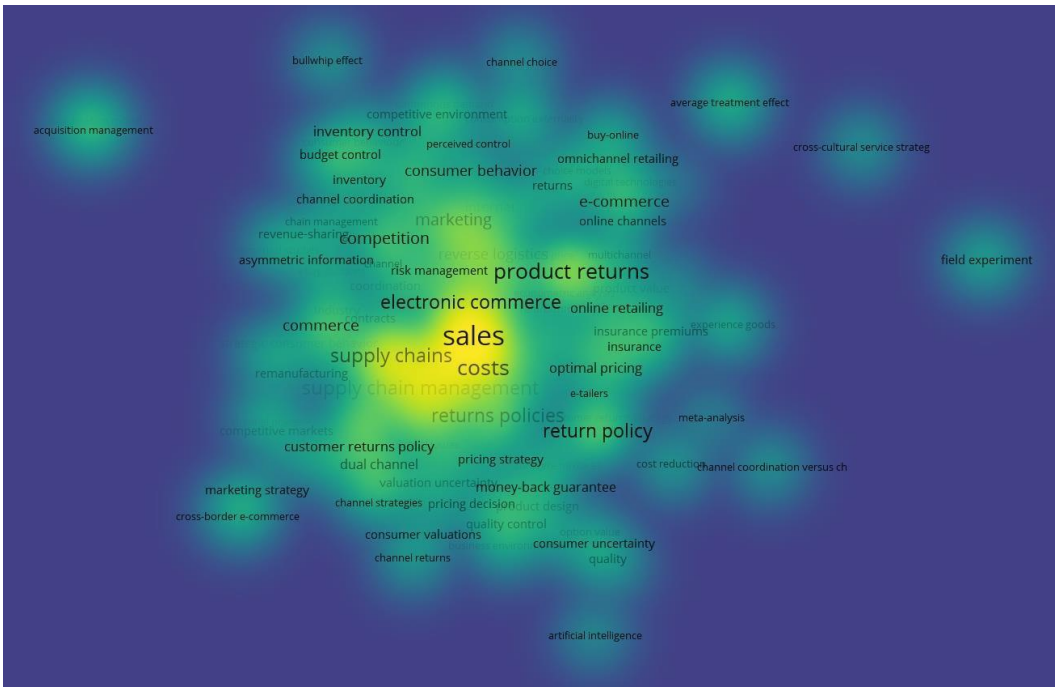
end-of-life products
conventional methods

(a)



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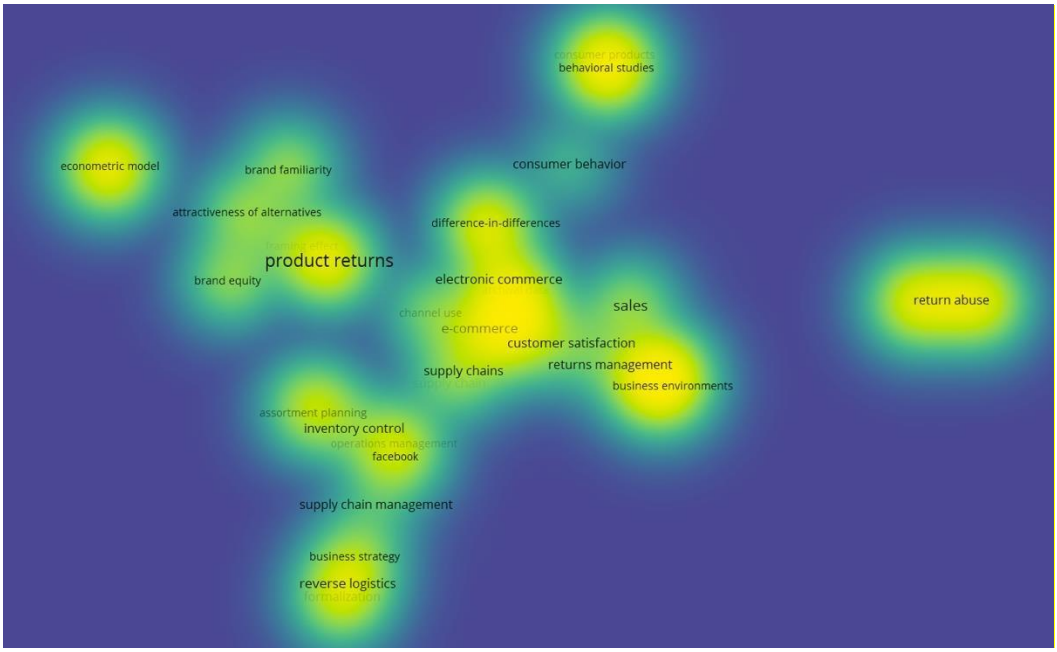

(c)

Figure 6. Density graphs with co-occurrence author and indexed keywords analysis for Cluster 1 (a), Cluster 2 (b) and Cluster 3 (c)

Overall, Cluster 1 covers the whole structure of a closed-loop supply chain, integrating main (re)manufacturing activities and supporting activities such as collecting, acquisition, etc. Cluster 2 targets the way how firms handle and respond to the returns flow focusing on (re)manufacturer and retailer domain. Cluster 3 studies the way customers perceive returns function/process/policy by themselves or under retailers'

impacts. Therefore, based on the heatmap from **Figure 6** and the labels from **Table 3**, we can draw a map to integrate the three clusters into a typical CLSC model (**Figure 7**).

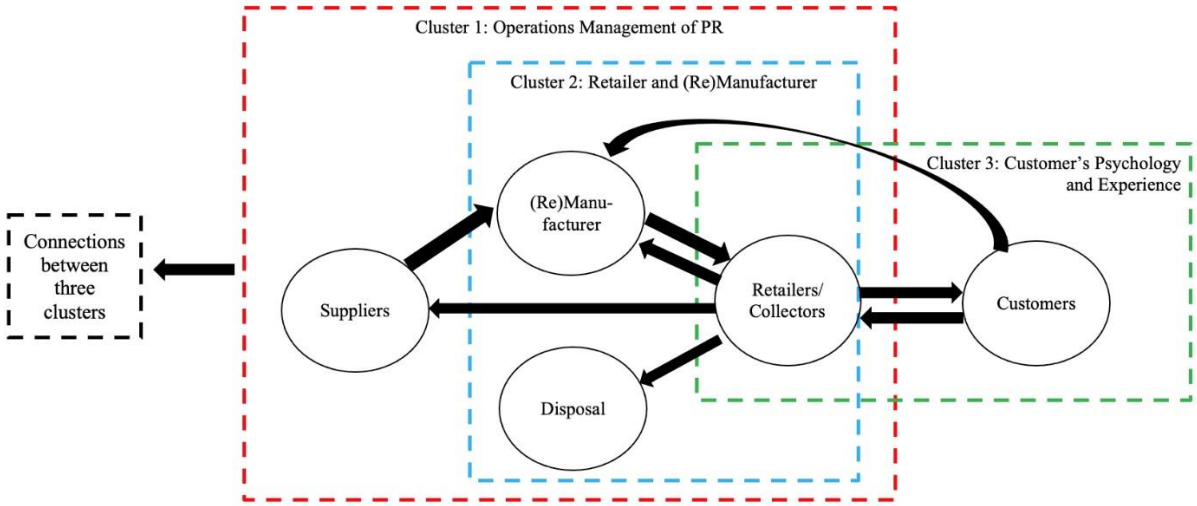

Figure 7. Clusters' focus to forward and reverse flows in a closed loop supply chain

5. Content Analysis

This section closely explores the insights of sub-themes in each of the three clusters by examining their research issues and methodologies. Compared with previous literature reviews in topics such as Ambilkar et al. (2021), which identified six research themes of PR management (i.e., return policy, product recovery, consumer behaviour, forecasting PR, product uncertainty, and technology), our findings unveil some of the other key research issues that are worthwhile of investigation. The details of our research themes can be seen as below.

5.1. Cluster 1 – Operations Management of Product Returns

With 46 papers, Cluster 1 is the second largest cluster. According to LDA results and co-occurrence keyword analysis, papers in this cluster prominently discuss about operational aspect of PR such as

remanufacturing, disassembly and distribution. In fact, these concepts were initially established to deal with various reasons for PR from environmental factors (e.g., end-of-life products (core), waste disposal) to mismatch with customer preferences (e.g., defective returns, unused returns). This cluster has gained more attention in recent years (2019-2021) due to the uncertainties of the dynamic world (e.g., disasters, digitalisation).

Because of the homogeneous connections of the papers in this cluster and the hierarchical order via a preliminary analysis, the content analysis will be conducted by dividing and reviewing papers according to three subsections: (1) Operations issues in (re)manufacturing, (2) Network design and product recovery management, and (3) Reverse distribution and quality of returned product for reprocessing.

- Operations Issues in (Re)Manufacturing

Overall, there are 27 papers (58.69%) in this subtheme. It is clear that the papers in the earlier years focussed on various aspects of operations for production and inventory problems in both planning and control in manufacturing/remanufacturing operations (de Brito & van der Laan, 2009; DeCroix & Zipkin, 2005; Guide Jr, 2000; Mahadevan, Pyke, & Fleischmann, 2003; Minner & Kleber, 2001; Niknejad & Petrovic, 2014; Van Der Laan, Salomon, Dekker, & Van Wassenhove, 1999; Zhou, Tao, & Chao, 2011). Until recently, while the stream of inventory and production are still trending, the research focus has evolved to some contemporary combinations such as trade-in and refurbished service level (Jiang et al., 2019; Shin et al., 2020), inventory policy via PR forecasting (Chou et al., 2020), location-inventory problems (Guo et al., 2020a, 2020b), repairable inventory system (Lin, Leung, Zhang, & Gu, 2020), quality-grading scheme (Ponte et al., 2021), and capital investment (Reddy and Kumar, 2021). In terms of production, researchers have prominently addressed production issues along with machinery problems, failures and maintenance (Assid et al., 2020; Ndhaief et al., 2020; V. Polotski et al., 2019; Vladmir Polotski et al., 2019) and global production and distribution (Mishra & Singh, 2020a, 2020b).

Beyond what has been discussed, researchers also study some other aspects of operations such as disassembly planning (Kumar & Putnam, 2008; Wang et al., 2020), dynamics in the hybrid system (Aras, Boyaci, & Verter, 2004; Zhou, Naim, & Disney, 2017) and accounting-financial tension (Mutha et al., 2021). In addition, climate change and environmental issues prompt organisations to extend their single financial objective into multi-objective comprising “Green Performance” e.g. minimising negative environmental impacts (Mishra and Singh, 2020b, 2020a). Another common stream in remanufacturing returned products is extracting salvageable value of returned products for further inspection, disassembly, cleaning or refurbishment (Chou et al., 2020; Minner & Kleber, 2001; Zhou, Tao & Chao, 2011).

The comprehensive summary of the papers in this sub-theme is shown in **Appendix B**.

 Network Design and Product Recovery Management

There are 13 papers (28.26%) in this subtheme. According to **Appendix C**, the addressed clusters and methodologies are as premises for remanufacturing cores. There are two main streams discussed: network design and product recovery management.

Remanufacturing cannot be operated without various prerequisites. One of these significant elements is reverse logistics/closed-loop supply chain network design for PR flows (Alumur, Nickel, Saldanha-Da-Gama, & Verter, 2012; Fleischmann et al., 2001; Tosarkani & Amin, 2018; Yıldız & Soylu, 2019; Zarbakhshnia, Kannan, Kiani Mavi, & Soleimani, 2020). Despite the intention towards corporate objectives, the practical implications of network design research are prominently to address some daily issues in remanufacturing operations such as facilities, collection centres, repair services and cost of CO2 emission management.

Product recovery management is another considerable stream in this sub-theme. In fact, handling returned products from the downstream back to manufacturers is initially challenging and cost inefficiency. This is the reason for researchers to study comprehensively pre-activities of remanufacturing such as cores acquisition management (Guide & Jayaraman, 2000), product recovery management (e.g., procurement, disposal) (Inderfurth, 1997), data-driven simulation for smart remanufacturing system (Goodall et al., 2019), facilities (e.g., location, repair facilities) (Krug et al., 2021; Min and Ko, 2008a).

Forecasting PR is a crucial aspect of product recovery management and plays an important role in ensuring remanufacturing stability, inventory control and reducing uncertainty. Accurate predictability can be enhanced by various attributes (e.g., sales, transactions) (Clottey et al., 2012; Shang et al., 2020) and data mining techniques (Cui et al., 2020).

The comprehensive summary of papers in this subtheme is in **Appendix C**.

 Reverse Distribution and Quality of Returned Product for Reprocessing

Also in this cluster, we review 6 papers (13.05%) addressing reusable products from PR. Varying the quality of returned products prompt researchers to find the optimal profitability of reuse activities (Zikopoulos & Tagaras, 2007), dynamic assortment (Rusmevichientong et al., 2020), product lifecycle (Muyldermans et al., 2019) and reverse distribution (Jayaraman et al., 2003). Their methodologies are quantitative models such as finite lifecycle model, choice model. In this cluster, there are two literature reviews of closed-loop supply chain and potential uncertainties on the remanufacturing (Goltsos et al., 2019; Souza, 2013).

Overall, the papers in this cluster are strongly connected with each other. From a methodological perspective, most of the papers adopt quantitative research (i.e., mathematical modelling or simulation), starting from identifying problems, mathematical model development, model solution, numerical experiments, and practical and managerial implications. There are some common quantitative models such as mixed-integer linear programming (MILP) (Alumur et al., 2012; Fleischmann et al., 2001; Krug et al., 2021; Min and Ko, 2008b; Yıldız and Soylu, 2019) or mixed-integer non-linear programming (MINLP) (Guo et al., 2020a, 2020b; Mishra and Singh, 2020b, 2020a) or fuzzy mixed-integer programming (FMIP) (Niknejad & Petrovic, 2014), full fuzzy programming (FFP) (Tosarkani & Amin, 2018), continuous-time Markov chain model (Aras, Boyaci, & Verter, 2004), finite horizon periodic review backlog models (Chou et al., 2020; Zhou et al., 2011) and data-driven simulation (Goodall, Sharpe, & West, 2019).

5.2. Cluster 2 – Retailer and (Re)Manufacturer

97 papers make Cluster 2 the largest cluster. At the first glance, researchers mainly seek to solve marketing related problems at manufacturer/retailer level because most papers (69.07%) addresses return policy issues. We structure this cluster as return policy issues and miscellaneous issues.

 Return Policy (RP)

There are 67 papers (69.07%) reviewed, starting from 1985 to 2020. Even though RP has been presenting since 1985, the recent figure shows the highest number of papers in 2020 (13 papers) in comparison with previous years. It suggests that RP is still a state-of-the-art cluster and retailers still need to enhance their RP to cope with new dynamic concepts (e.g., e-commerce, AI). Some interesting patterns are recognised. Firstly, because of the longitudinal existence, RP has been evolving from monetary perspectives to more supply chain related operations such as inventory, information strategies, ordering quantity, brand competition, return freight insurance, pricing, etc. Secondly, RP is usually deployed at retailer level where PR occurs from customers (Akçay, Boyacbox, & Zhang, 2013; Anderson, Hansen, & Simester, 2009; Bonifield, Cole, & Schultz, 2010; Bower & Maxham, 2012; Che, 1996; Chen & Chen, 2017; Chen & Bell, 2012; Heiman, McWilliams, Zhao, & Zilberman, 2002; Hess, Chu, & Gerstner, 1996; Hsiao & Chen, 2012, 2014, 2015; Huang & Zhang, 2020; Janakiraman et al., 2016; Jin, Caliskan-Demirag, Chen, & Huang, 2020; Khouja, Ajjan, & Liu, 2019; Lal & Sarvary, 1999; Lee, Choi, & Edwin Cheng, 2021; Lepthien & Clement, 2019; Wei Li, Chen, & Chen, 2018; Li, Xu, & Li, 2013; Lin, Zhang, & Cheng, 2020; McWilliams, 2012; Mukhopadhyay & Setaputra, 2007; Mukhopadhyay & Setoputro, 2005; Nageswaran, Cho, & Scheller-Wolf, 2017; Shang, Ferguson, & Galbreth, 2019; Shehu, Papies, & Neslin, 2020; Shulman, Coughlan, & Savaskan, 2009, 2011; Su, 2009; Sun, Chen, Tian, & Yan, 2021; Wagner & Martínez-De-Albéniz, 2020; Xing Wan, Li, Chen, & Lei,

2020; Wood, 2001; Xu & Duan, 2020; Yalabik, Petruzzi, & Chhajed, 2005; Yang, Ji, & Tan, 2020).

Furthermore, RP in the coordination channels between single/dual manufacturer – single/dual retailer in which PR is induced by unsold stocks or consumer PR is also considered (Ai, Chen, Zhao, & Tang, 2012; Bandyopadhyay & Paul, 2010; Chen & Grewal, 2013; Chen, 2011; Choi, Li, & Yan, 2004; Crocker & Letizia, 2014; Emmons & Gilbert, 1998; Fan & Chen, 2020; Lee, 2001; Li, Li, Sethi, & Guan, 2019; Li, Chen, Liang, & Chen, 2018; Liu, Mantin, & Wang, 2014; Ma, Di, & Hsiao, 2020; Matsui, 2010; Padmanabhan & Png, 1997; Pasternack, 1985; Ruiz-Benitez & Muriel, 2014; Shulman, Coughlan, & Savaskan, 2010; Tsay, 2001; Wang, 2004; Xiao, Shi, & Yang, 2010; Xu, Li, Govindan, & Xu, 2015; Yang, Chen, Chen, & Chen, 2017; Yoo, 2014; Yue & Raghunathan, 2007). In terms of RP elements, five factors are commonly discussed namely monetary (e.g., refund policy, money-back guarantee (MBG), restocking and handling fees, shipping fees), time (e.g., return window), effort (e.g., the extent of hassle in return procedures), exchange (e.g., refund in cash or discount, vouchers) and scope (e.g., different policies within the same retailer) (Janakiraman et al., 2016). The existence of five factors is fully observed in aforementioned papers, yet it is worthy to point out that a single-factor research tendency in the past is being replaced by a joint effect of a dual-factor in recent years, for example, time and scope (Ma et al., 2020; Shang et al., 2019). More recently, there is a tendency to focus on RP in the context of e-commerce due to the acceleration of online commerce platforms such as post-purchase warranty and return insurance for platform providers (Chen et al., 2021; Fang et al., 2021; Li et al., 2021) and service strategy (Gäthke et al., 2021).

From a methodological perspective, most papers are conducted with similar procedures of problem

identification, mathematical modelling, scenario comparison, and testing/experiments with a diversity of product types (e.g., consumables, durable, build-to-order, etc.). Some common models can be listed such as newsvendor models, field experiment, meta-analysis, and stylised model. There are a few papers addressing problems by using conceptual frameworks with customer engagement (Bonifield et al., 2010; Bower & Maxham, 2012; Wood, 2001) and only one paper reviewing the literature (Janakiraman et al., 2016).

Appendix D summaries current focusses in PR.

 Channel, Inventory, Pricing, and Information Strategies in the Context of Retailers

30 papers (30.93%) concern the other dilemmas of managing and handling PR in the context of retailers. Such supply chain coordination and reverse channel are focusses which are used to decide whether a manufacturer collected consumer returned products directly from customers or via a retailer/collector with the risk of fusing unsold products and used products together (Ferguson et al., 2006; Hosseini-Motlagh et al., 2020; Kumar et al., 2019; Lee and Rhee, 2021; Liu et al., 2020; Mandal et al., 2021; Ofek et al., 2011; Pun et al., 2020; Savaskan and Van Wassenhove, 2006; Tang et al., 2020; C. Wang et al., 2020; X. Wang et al., 2021; Zhang and Choi, 2020). Inventory management and the Bullwhip Effect are also issues because unsold products are returned to manufacturers, which may induce overstocking or understocking (Dimitrov and Ceryan, 2019; Papanagnou, 2021; D. Wang et al., 2020; Zhang et al., 2020). While some retailers may anticipate and take into account RP for pricing strategy (Chen & Bell, 2009; Mahmoudzadeh, 2020; Vorasayan & Ryan, 2006; Wang, Wang, & Chen, 2021; Zou, Zhou, & Jiang, 2020), some authors argue that information sharing/ asymmetric information between parties in the CLSC or between customers and retailers are also important in mitigating the uncertainties (Casalin & Dia, 2019; Rao et al., 2014; Seeger et al., 2019; Yan & Cao, 2017). Finally, solutions for some special problems of PR in retailers such as optimal resources allocation and trade-in value effects are derived (Borenich et al., 2020; Ke & Yan, 2020; Petersen & Kumar, 2015) or the

interpretation and calculation of return rates (El Kihal et al., 2021).

Regarding the methodological aspect, along similar lines with other papers in this cluster, the majority of papers are conducted by quantitative research. A minor number of papers adopt a conceptual framework and hypothesis testing to find the customer insights (Mahmoudzadeh, 2020; Rao et al., 2014; Seeger et al., 2019; Yan & Cao, 2017). A more detailed summary can be found in **Appendix E.**

5.3. Cluster 3 – Customer's Psychology and Experience

In this cluster, our review captures and expresses the content of 24 selected papers. The prominent concentration is in ways that customers perceive various types of returns management strategy/activity from sellers. Hence, the majority of papers are conducted in conceptualisation with customer's participations as a distinct feature. Furthermore, it is undeniable that customer perception is a multi-faceted concept (e.g., consumer behaviour, cognitive dissonance, satisfaction, risk, etc) under many business problems (e.g., sales, environment, etc), that is also not exceptional for PR. Hence, in customer perspectives prevails, various aspects of what have been addressed in the literature, comprising of (i) customer's psychology, (ii) marketing and operation interface, (iii) customer perception on information and technologies, and (iv) customer perception on RL and CLSC Management will be navigated from the selected papers.

- Customer's Psychology

There are 5 papers (20.83%) which solely studied the dynamic perceptions of customers, but their focuses varied in diverse circumstances of PR. To be more specific, Powers & Jack (2013) and Ketzenberg et al. (2020) addressed the motivations to return a product, including cognitive dissonance and return abuse when a customer is uncertain about their decisions or just taking it for granted under the presence of liberal

return policies. From another aspect, in 2005, a study's focus was on the perception of consumers in the pre-choice process (i.e., between choice and consumption) which may be reversible because of disconfirming information at the post-purchase stage (i.e., a customer recognises an inappropriateness in their purchase) (Bechwati & Siegal, 2005). In contrast, Griffis et al. (2012) examined customer returns experience towards repurchase behaviours. The final paper concentrated on customer viewpoints under two key psychological rewards (e.g., financial and emotional) toward product retention and disposal decision when a product still possesses reusable value (Simpson et al., 2019).

Regarding to research methods, most papers use conceptual modelling (4 papers), except one paper (Ketzenberg et al., 2020) conducts a large data-driven approach in finding customer return behavioural patterns.

 Marketing and Operations Interface

In this subset, a total of 6 papers (25%) are explored. In terms of marketing aspect, customer loyalty towards firms with or without the existence of returns management system is studied via different determinants such as customer satisfaction, perceived value offerings and previous service experience in internet retailing (Mollenkopf et al., 2007). An interesting trend that is being developed recently is brand awareness in PR. Ertekin et al. (2019) and Lee & Yi (2019) prominently focused on promotion/stacked discount framing on PR, they stated that the effects may differentiate by different levels of brand recognition. Recently, Moreau (2020) raised an issue of first brand impression through improving their package for delivery, called "doorstep branding" strategy that sharpens their brand equity and decreases return probabilities. Yet, the elements of branding and promotion in e-commerce have not been discussed thoroughly and reveals some potentials for

future contribution.

However, due to the explosion of e-commerce, the line between operations and marketing is gradually blurred, which prompts a well-discussed concept called marketing-operations interface (M-OI). Bijmolt et al. (2021) and Mollenkopf et al. (2011) examined the role of M-OI in driving the way customers perceive returns management process and how PR engages into a M-OI process in the omni-channel.

In addition, there is a wide range of methodologies that have been adopted ranging from conceptual modelling (5 papers) and literature review (1 paper).

 Customer Perception on Information and Technologies

There are 8 papers (33.34%) in this subset. With the shift from brick-and-mortar retailer to online retailer, the role of information and technology in terms of sufficiency and accuracy to supplement the lack of physical inspection is deemed to receive much attention. Because customers cannot directly experience in-store products to mitigate their uncertainties and perceived risk about the new products, they are inclined to rely on the only information available –website information (WI). On one hand, some articles address aspects of WI generating by novel technologies (e.g., information search in mobile, zoom, alternative photos, social media, and colour swatch) on PR and customer returns perception (e.g., attractiveness of alternatives, perceived of risk) (De et al., 2013; Huang et al., 2020; Li and Choudhury, 2021; Zhang et al., 2021). These technologies are to dictate factual and impression-based information which matters at both pre-purchase and post-purchase stages to consolidate for purchasing and varying returns. On the other hand, Maaya, Meulders & Vandebroek (2020) raised quality of information of provision of WI such as the arbitrary WI of delivery time, price, discount, returns, and especially the reliability. In addition to WI, online customer ratings are considered as a valuable source for exploring customer behaviour (e.g., customer loyalty) towards some risk characteristics of products (Ramanathan, 2011). Another

noteworthy phenomenon is retail return abuse which could be due to the leniency of RP. Akturk et al. (2021) studied two technologies which are customer profiling and product tracking to potentially address this issue. Another stream of information is commonly derived from website data can be studied the short-term and long-term impact of promotion to PR after sale (Liu et al., 2021).

In summary, online information and technologies have effects on consumer returns cognition, but they are undeveloped and fragmented with rare connections to one another. The methodologies of what have been conducted to address the research problems in this subset are mathematical modelling (1 paper), conceptual modelling (6 papers) and a systematic review (1 paper).

- Customer Perception on RL and CLSC Management

There are 5 papers (20.83%) in this subset, mainly focusing on consumer perception in product returns operations. Different with what have been discussed in Cluster 1, the concepts of RL and CLSC are considered as a marketing strategy of firms which affects customer's perception when they make purchase and returns decision. In addition, there is no overlap with Cluster 1 in terms of both theories and methodologies. In fact, 3 papers discuss about the role of designing RL program and process such as return policy, capabilities, innovation onto the business performance (Autry, 2005; Richey et al., 2005; Stock et al., 2006). Yet, their studies consider a business-to-business (B2B) model under the perspective of buyers as customers. Another aspect of RL and CLSC is raised recently by Stauffer & Kumar (2021) based on the emergence of disasters (e.g., hurricane, flood, pandemic, etc.) in the context of donation that could be managed by incorporating humanitarian PR and disposal in a preparation stage. Frei et al. (2020) conducted a general view of the scale and significance of returns systems towards achieving simultaneously economic and ecological sustainability.

The dominated methodologies in this subset are conceptual modelling (3 papers), interdisciplinary

research (1 paper) and stochastic optimisation modelling (1 paper). Overall, clusters in this cluster stretch in a wide range and contribute significantly to PR literature, yet each focus potentially proposes some prospective directions for researchers that will be discussed in section 6.

5.4. Summary of Theoretical, Managerial/Practical and Methodological Contributions

To summarise, the identified theoretical, practical, and methodological contributions provide a rationale behind the future directions for researchers.

To answer RQ1, a summary is derived based on a subject-wise approach for three clusters. Generally, Cluster 1 covers operations management of PR, considering the manufacturing/remanufacturing from product recovery and resale management when finding solutions for improvements. This cluster can be best treated under three level headings in business management: (1) operations issues in (re)manufacturing, (2) network design and product recovery management, and (3) reverse distribution and quality of returned products for reprocessing. The quantitative models cover network design, product recovery and disposal management (e.g., production and inventory in both planning and control), facility location, remanufacturing, recycling, financial and quality aspects in the context of PR. These models enable managers/practitioners to design their business remanufacturing structure and address their specific dilemma. Furthermore, these initiatives are credible as a guide to potentially map out the procedures and outcomes for practitioners to follow. It helps them save resources and reduce the probability of failure in deploying remanufacturing.

Turning now to the discussed evidence in Cluster 2, at the retailer and (re)manufacturer level, there is a shift in PR from manufacturing/remanufacturing operations to marketing aspects, especially manufacturer-retailer-customer relationships. These relationships can vary depending on the degree of coordination or competition and the number of players in a CLSC. In terms of theoretical aspects, papers have been broadened to mainly addressing RP issues (both for manufacturer and retailer) in many dimensions such as monetary,

time and process of RP. These RP issues usually incorporate with channelling, pricing, information, and inventory strategies. Regarding managerial/practical aspects, with the wide range of RP issues, practitioners decide what is the optimal RP in terms of terms, conditions, and implementation in their customised context.

Cluster 3 considers customer perspective. In terms of theoretical aspect, this cluster prominently concentrates on how customers perceive PR as well as returns management system from retailer. These psychological aspects can be listed as customer loyalty, behaviour, purchase and returns intention in the context of PR. By understanding customer's psychology, practitioners can adjust their operational and marketing strategies to mitigate the effect of PR and enhance business performance.

To answer RQ2, a summary is drawn from the methodological aspect. A wide range of methodologies has been used to deal with PR issues. Cluster 1 prominently applies quantitative models (e.g., mixed-integer programming models) and procedures (i.e., mathematical modelling, formulating/optimising, testing, and inference). In Cluster 2, the methodologies are more diversified, listing newsvendor models, field experiment, meta-analysis, stylized model, and conceptual model. In Cluster 3, the main methodology is theoretical/conceptual framework development using both quantitative and qualitative for finding the implications.

A full detailed summary is in **Appendix F**.

6. Discussion and Future Directions

In order to answer RQ3, the suggestions for future directions are structured based on three discussed clusters with a total of **five** future streams as follow:

(1) Digitialisation in the Context of Product Returns

There are potential research areas in the context of digitalisation such as digital twin (DT); physical internet (PI); artificial intelligence; big-data driven simulation and optimisation; Internet of Things (IoT), Blockchain, Industry 4.0 for strategically implementing and manging a (re)manufacturing system in a RL/CLSC. So far, most of the research have been on logistics/supply chains but none of them specifically focuses on RL, not to mention PR. For example, among the aforementioned technologies, a digital twin is the one that integrates most of the technologies into its operations. It constitutes a digital model for a real-world object by using sensors and network technologies. Some studies found the extended application to digitalise a logistics/supply chain network, called the digital logistics/supply chain twin (Ivanov et al., 2019; Ivanov & Dolgui, 2020) but no one has studied a digital twin on remanufacturing system. In fact, the integration of technologies in a digital twin would possibly visualise, simulate, and diagnose the status of real-time PR, remanufacturing and RL/CLSC systems.

The application of digitalisation on remanufacturing returned products can be divided into two potential parts:

Firstly, digitalisation would be applicable for RL/CLSC network design and monitor. A RL/CLSC is increasingly complicated to manage because firms cannot control completely the whole operations of their CLSC if they are outsourcing or running multiple suppliers/retailers. Successfully implementing a RL/CLSC digitalisation for the whole network would help firms keep up to date with the status of their reverse flow of PR (e.g., Blockchain, IoT). Moreover, it helps obtain a diagnostic and predictable system to detect probable root causes in the RL/CLSC. However, the way and areas to which a digital RL/CLSC can be applied are still big dilemmas. In the future, researchers could develop a digital system for RL/CLSC in reverse shipment, collection centres, RL/CLSC infrastructure and global RL/CLSC networks.

Secondly, digitalisation would be applicable for managing product lifecycle. Conventionally, sellers usually lose track of their products after sales, which induces the uncertainties in returns management such as quality, quantity and time of PR. Digitalisation turns out to be a potential solution to access the product footprints that used to be impossible to measure at post-purchase stage. Digitalisation would enable real-time product's footprints after sales to be visual and measurable for forecasting returns likelihood. By doing this, remanufacturing could effectively and efficiently prepare their resources and capabilities as well as reduce variations. Nevertheless, the traceability after sales could controversially cause a negative implication for customer's privacy and transparency. In the future, how to apply digitalisation to obtain product and customer's information after sales need to be considered carefully.

(2) Globalisation versus Localisation in the Context of Product Returns

Making the decision between globalisation and localisation modes for a logistics and supply chain system is always challenging, especially in the context of PR. Wang et al. (2021) initialised three cross-borders e-commerce modes, namely overseas-to-overseas (O2O), overseas-to-domestic (O2D) and domestic-to-domestic (D2D) to reflect the trade-off between globalisation and localisation. Although this paper discussed the impact of three cross-borders e-commerce modes in delivery time at pre-purchase stage to returns likelihood of customers, there is no attempt to develop a cross-borders e-commerce in handling the reverse flow of PR. It raises an issue of how an international corporate resolves a dilemma of reverse flows, for example, choosing the optimal mode between O2O, O2D and D2D. Furthermore, research on identifying and tackling the extra challenges related to the events such as pandemic and Brexit in the context of remanufacturing is noteworthy to dig into. Hence, handling product returns in cross-boarder business would be a considerable challenge in the future.

Some PRs with low salvageable value would be disposed and ended up at landfill as wastes. Global waste importation is increasingly urgent and controversial in many countries. Large multinational companies abuse the lenient policies to export their wastes (e.g., plastic recyclables, electronic and paper products) into some countries (e.g., China, Malaysia, Thailand and African countries). For example, China was the largest landfill of the world, importing nearly 50% of the plastic of the world for three decades (McNaughton and Nowakowski, 2019). The low-cost labours and domestic landfill reduction attracted companies to turn these countries into waste hubs in which they are beneficial to set up remanufacturing/recycle facilities nearby. However, a growing number of countries are fighting against environmental risks and public health, prompting these countries to ban waste importers (BBC News, 2019). This would reshape and challenge the whole global remanufacturing systems and facilities, strictly transforming from globalisation to localisation in dealing with end-of-life PRs. In the future, researchers/practitioners need to address the challenges of managing waste resources for recycling and remanufacturing returned products domestically.

(3) 'Multi-X' Oriented Bespoke Return Policy (RP)

Research in RP has been evolving in decades. There exists various forms of RP among manufacturers and retailers. However, these proposed RP models are generic which possibly misalign to individual customers. With the development of ML/Deep Learning, manufacturers/retailers could develop big data-driven bespoke RPs for individual customers. This type of adaptive RP system can automatically adjust return terms and conditions based on the likelihood of each customer return prediction. In addition, the presences of digitalisation and globalisation also leads to the complex structure of RL/CLSC which prompts research to extend their focus into a multiple structure. We call this a *'multi-X'* structure for RP where X is a variable refers to:

The *multi-layer* structure where multi-manufacturer, multi-retailer, and multi-third-party logistics (3PL)

service providers are attached to RPs. As observed from **Appendix D**, literatures prominently address RP as a single manufacturer – a single retailer; or a single manufacturer – multiple retailers; or multiple manufacturers – a single retailer with both supply chain coordination and competition. Nevertheless, in reality, this type of single *x* vs. multiple *y* relationship rarely exists. Furthermore, it is not uncommon that many manufacturers/retailers are partnering with multi-3PL service providers at the same time due to geographical advantages, packaging, and handling specialties. Taken together, it leads us to propose a potential future direction for developing optimal RPs dealing with multi-players in the manner of either coordination or/and competition.

The above *multi-layer* for RPs can extend to online platform provider. According to the results from **Appendix D**, researchers focus mainly on manufacturers and retailers. Yet, the presence of platform providers is increasing in quantity (e.g., Amazon, Alibaba, eBay, etc). They supply an infrastructure to display and sell products directly to consumers, which is especially beneficial for small and medium enterprises who want to spread their brand awareness globally. However, this business model raises questions about who is responsible for return policy and handling returns as well as how customers perceive the new RP model. In the future, it is worth to explore further the effect of the multi-layer RPs in various dimensions towards PR in the context of sellers and platform providers.

Multi-channel is also an interesting aspect in designing RP. Conventionally, RP research in different channelling strategies is not a new cluster. In fact, some channelling strategies have been well-discussed such as a single online/offline channel, dual channel and omni channel. While these brick-and-mortar and click-and-mortar are still the main channels for trading, the evolution of Industry 4.0 and advanced technologies have reshaped the way retailers operate these channels in many aspects. For example, the diversity of payment methods such as pay later, instalments, and mobile/watch payment may dictate differently the monetary aspect

of RP in different channels. Furthermore, operating a multi-channel system including mobile channel is increasingly popular due to its portability and convenience. It raises a question of how to redesign the PR process and the level of incurred hassle accordingly in their RP. To summarise, exploring a multi-channel with advanced technology in the context of RPs is proposed as a potential approach in the future.

(4) Understanding and Predicting Customer Returns Behaviour via Online Product Reviews (OPRs) and Customer's Footprint

Customers are one of the significant roots causing returned products. It is undeniable that customer product reviews are valuable sources to expose customer experience and behaviour, especially in the context of PR. However, in researching OPR effects on PR, many papers extracted the sentiment of reviews by using customer ratings (Minnema et al., 2016; Sahoo et al., 2018) which is subjective and insufficient to explain customer return behaviours. Natural language processing (NLP) techniques (e.g., text mining) which is developing significantly would potentially help researchers embed customer reviews quantitatively to explain their behaviour toward returns decision in the future.

Most literatures studied customer's perspective on the post-purchase stage. There are little efforts on the pre-purchase stage. A possible explanation would be the lack of customer data at this stage. However, as customers switch to the online channel, not only they would leave OPRs, but also, they unconsciously leave their footprints. These valuable data can be used to analyse pre-purchase customer behaviour. Researchers and practitioners may seek to understand customer behaviour at pre-purchase stage as a signal to predict purchase and returns behaviour, thus mitigate negative impacts of PR, especially in the context of e-commerce.

(5) Customer Returns Perception on Marketing – Operations Interface (M-OI)

M-OI has been recognised as a bridge between marketing and operations activities. The coordination between marketing and operations may resolve the mismatch between customer demand stemming from marketing strategies and supply from operations capabilities. There are some discussions of M-OI such as inventory, product lead-time information disclosure at the pre-return stage and returns management system at the post-return stage. They mainly focus on how M-OI is deployed to prevent/manage PR. There is no effort to understand customer perception on M-OI aspects. In fact, customers may selectively prioritise marketing information which is necessary for them to make decisions regardless purchasing or returning. Understanding which marketing-operations collaboration is the most contributed to perceptions of customers helps firms allocate their resources in a more strategic way. In addition, M-OI could be extended to marketing and RL/CLSC interface where customers can specify their perceptions on "Green" approaches. It enables firms to better understand the customer's attitude and behaviour toward their RL/CLSC operations when they use it as a marketing strategy. Hence, it is noteworthy to dig into customer's perceptions toward M-OI and Marketing – RL/CLSC interface.

Overall, from the results of the content analysis and five future directions, our paper proposes some potential research questions deriving from research gaps for each direction in **Table 5**. In summary, **Figure 8** advances **Figure 7**, showing the overall picture of PR future directions and their applicable areas.

Table 5. Research Gaps and Potential Research Questions

Future Direction	Potential Research Gap	Some Potential Research Questions

Digitialisation in the Context of Product Returns	Network Design and Monitoring	There might be gaps in adopting cutting-edge technologies (Industry 4.0) for digitalisation to managing PR process and product flows, especially under the uncertainties such as disruptions (e.g., pandemic)	- What are appropriate tools and technologies for detecting process and product faults in the context of smart remanufacturing? (e.g., sensors, block-chain, ML/DL) - How computer vision (i.e., virtual reality) can remotely visualise disruptions in reverse shipment and collection? - What extent robots can alternate human at collection points under cost perspectives?
		Limited papers acknowledge the role of big data and digital technologies to design a RL/CLSC network	- How can PI be integrated into a RL using big data-driven simulation? - What are architectures of DT to build a Smart Remanufacturing System using data-driven simulation?
	Managing Product Lifecycle	Most papers in this cluster did not consider customers as an important element for managing remanufacturing and operations activities, while customers induce the uncertainties of timing, quality, and quantity of PR.	- What and how DT/PI/Blockchain infrastructures track and trace the status of products without violating customer privacy? - Which customer and product information impacts PR timing, quality, and quantity as a basis for a digital remanufacturing system?

Globalisation versus Localisation in the Context of Product Returns	E-commerce for RL	Many papers addressed the impact of the international or domestic channelling choice on PR decision and intention. No one has addressed how to design an e-commerce channel for reverse flows.	- What are cost benefits of O2O, O2D and D2D? - What are architectures of O2O, O2D and D2D for RL?
	Environmental Sustainability	Some papers addressed environmental aspects of emission such as CO2 (Mishra and Singh, 2020a, 2020b). There might be a gap in considering economic, social, and geographical factors for dealing with wastes after returns.	- Where is the strategic location for setting up disposal and remanufacturing centres? - What are social and economic considerations for setting up local and global facilities?
'Multi-X' Oriented Bespoke Return Policy (RP)	Multi-layer structure	A structure of multimanufacturer-3PL-retailer RP is still understudied due to its complexity.	- What is the optimal RP for multi-layer structure that optimises restocking fees? - What is the optimal buy-back contract for multilayer structure? - What are the optimal return deadlines for each party in a multi-layer structure?
	Online platform provider	In modern world, a coordination between sellers and platform providers is increasingly common. However, a study about RP in this context is still missing.	- Should sellers adopt platform provider's RP in terms of cost perspectives? - Which factors of RP are more beneficial for sellers and platform providers?
	Multi-channel	Single, dual and omnichannel have been well discussed. However, with the development of new technologies (i.e., smart phone, tablet, smart watch), RP studies with these channels are still understudied.	- What is the optimal coordination of channels under current RP of sellers? - What extent the rigorousness and leniency of RP under multi-channel of a seller?
Understanding and Predicting Customer Returns Behaviour via Online Product Reviews (OPRs) and Customer's Footprint	OPRs and Online Footprints	Several attempts tried to understand online customer return behaviour (OCRB) using valence, volume of customer reviews (Minnema et al., 2016; Sahoo et al., 2018). There might be a gap in analysing textual information and customer footprints (e.g., website logs) using NLP.	- By using text mining and customer footprints, what drivers associate with high return intentions? - Can these drivers be sufficient to predict OCRB?

	Pre-purchase behaviour	There may be a link between pre-purchase and post-purchase behaviours (Dowling et al., 2020). OCRB is a part of postpurchase behaviour. A study for understanding prepurchase behaviours to navigate OCRB is still missing.	- Which signals from customers at the pre-purchase stage associate with OCRB at the post-purchase stage?
Customer Returns Perception on Marketing – Operations Interface (MOI)		Designing M-OI system was mainly focussed by researchers (Bijmolt et al., 2021; Mollenkopf et al. 2011). How customer return perspective is influenced by information given by a MOI (or extending to Marketing-RL/CLSC Interface) is still understudied.	- Which informational drivers of M-OI leading to the variation of returns intention?

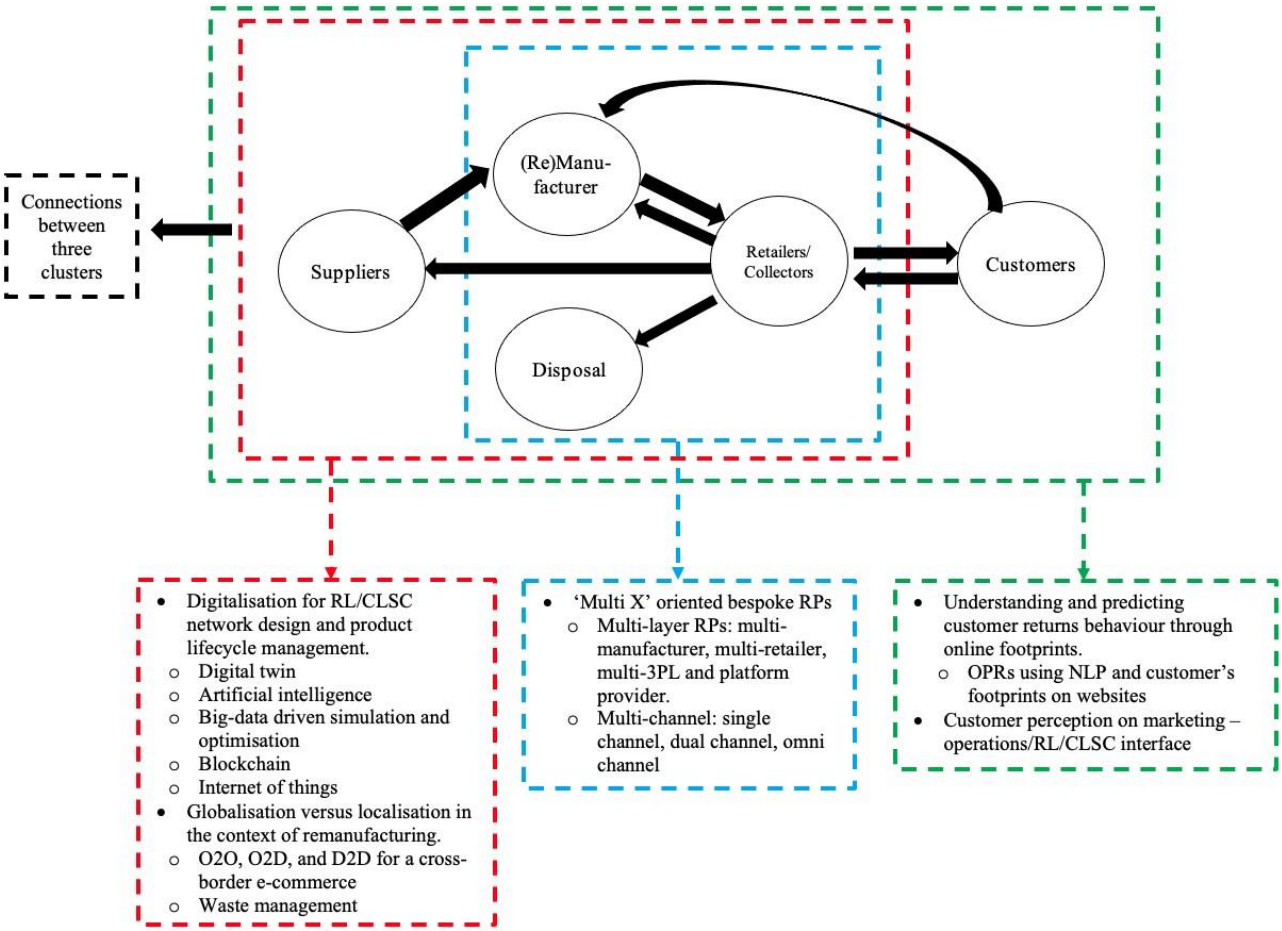

Figure 8. Applicable areas for PR future directions

7. Conclusion

The aim of this paper is to review the state-of-art research in product returns and provide future research directions. A total of 1209 publications were collected from three large scientific databases, Scopus,

EBSCOhost and WoS. Following the review framework, machine learning clustering model and bibliometric analysis are undertaken. Three broad categories are labelled as Cluster 1 – operations management of PR (39.53%), Cluster 2 – retailer and (re)manufacturer (34.57%), Cluster 3 – customer's psychology and experience (25.9%), and 167 papers are selected for content analysis. The results from these analyses are used to derive the answer to the key research question stated at the beginning.

This study has provided the overall picture of PR themes. The contributions can be summarised as following. Firstly, the investigation of current PR literatures helps researchers locate their PR research in our map of PR literatures. They will be able to access to relevant research to supplement their own research area. In terms of practical implications, practitioners could position their circumstances into the map to strategically apply these initiatives for their business problems. Secondly, a wide range of identified methodologies will serve as an advice for researchers to appropriately inherit or develop their own methodology. Finally, the carefully proposed five research directions lay the groundwork for future research on PR.

This study also presents some limitations. Firstly, choosing keywords for search terms cannot be completely exhaustive. Secondly, our chosen cluster of PR has many synonyms, for example, return behaviour or consumer return also means as return on investment in finance which is irrelevant to our study. Even though, we made significant efforts to remove them. We believe there might be still a certain number of irrelevant papers available in our dataset which is inevitable if you obtain a large dataset.

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Method Details (MethodX)