Retail Shelf Space Allocation in Supply Chain Contracts: A Literature Review

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Abstract

Due to the competitive nature of the retail industry, retailers should consider customer purchasing behavior when making critical decisions such as product pricing and the allocation of limited shelf space. Instead of the decentralized optimization, in a wider perspective, the retailers could improve their performance by managing the relationship with the upstream members in the supply chain. Coordination among members allows the supply chain to control costs and create shared value to compete in the market. Numerous studies related to the contractual agreement in the supply chain have focused on coordination mechanisms to get their insights. The objective of the contracts is to achieve coordination, as indicated by a win-win situation for all members and an increasing total channel profit. There are various factors taken into account when the demand function is defined in retail supply chain contracting. Particularly in brick-and-mortar businesses, many researchers are interested in the impact of product shelf space allocation, in addition to general price elasticity, on the company's performance. This paper presents a review and bibliometric analysis that evaluates insights on retail shelf space allocation in supply chain contracts for further investigation in the related research area. We find that the citation clusters represent different methodological aspects of supply chain contracts, consists of the vendor-buyer coordination by integrated inventory and the coordination through revenue sharing and bargaining contracts.

Keywords
Contract; Inventory-level-dependent Demand; Shelf-space-dependent Demand; Review; Supply Chain.

1. Introduction
The competitive retail business requires the design of retail capabilities that consider customer behavior when making decisions such as determining product pricing and allocating limited shelf space. When customers are constrained by limited time due to its immense shopping activities, shelf space becomes critical in retail merchandising (Chen et al., 2011). When shopping for groceries at a retail grocery store, it is observed that customers' attention in retail is easily influenced by the arrangement of shelf space, which is a significant factor in the customer purchasing decision. Drèze et al. (1994) found that considering customer behavior in the decision-making process to increase company profits requires a trade-off between determining the selling price and allocation of products in a limited shelf space capacity. The limitation of shelf space, on the other hand, tends to increase rivalry among suppliers. A typical example of this is the introduction of new contractual arrangements in the retail industry, where retailers can obtain a competitive advantage by adopting new mechanisms such as slotting allowances, category management strategies, and vertical integration.

Currently, competition has shifted away from businesses and toward supply chains. Previously focused on competition between businesses, the competition has been expanded to include the network of businesses (Sahin and Topal, 2018). As a result of this phenomenon, supply chain management is viewed as a critical component of a business's performance improvement. The strategy is consistent with the supply chain management concept, which is a customer-centric vision that motivates changes in the internal operations of the company and its external relationships with other supply chain partners, which are achieved through integration and coordination with the entire chain as supply chain members (Min and Zhou, 2002).

Urban (2005) conducted a comprehensive review of inventory-dependent demand models and concluded that increasing the available space for an item can increase demand. Huang et al. (2013) reviewed the literature on the space-dependent demand model that was used to examine space allocation for several products. When a retailer sells a variety of products, it is necessary to consider how available shelf space should be efficiently allocated between products to maximize profits. The decisions made by a retailer regarding space allocation may affect both supply and demand.

The purpose of this literature review is to show how shelf space allocation in supply chain contracts has evolved over the last two decades. We identify areas of research that have been extensively explored and areas that remain underexplored. This article presents critical reviews that examine insights on retail shelf space allocation in supply chain contracts to investigate potential research in the related field.

2. Methodology

We analyze the shelf space allocation model in supply chain contracts literature using a combination of bibliometric citation analysis and content analysis techniques. We conducted a bibliometric analysis using the VOS Viewer software, which has been widely used in other studies. It visualizes citations over time, displays the most-cited articles, and indicates the subsequent impact of those citations.

The data are derived from the Scopus database, which is extensively used in numerous other published bibliometric studies. We gathered the data sample in two stages. In the first stage, we conducted a search for articles in the Scopus database on the related topic using the following keywords: (a) shelf space = (shelf space OR "shelf-space" OR displayed inventory OR "displayed-inventory" OR stock dependent OR "stock-dependent" OR inventory level dependent OR "inventory-level-dependent") AND (b) contract = (contract OR coordination OR competition OR collaboration OR competing). We limited the search by these topics either mentioned in the title of articles, abstracts, and/or keywords. After filtering the results by language (English), document type (articles), and source type (journal), we initially identified 94 selected papers. The second step is author review. We reviewed their titles, abstracts, and keywords and only included articles published in Scopus-indexed journals in Q1 and Q2. We found 50 of these articles related to the research areas.

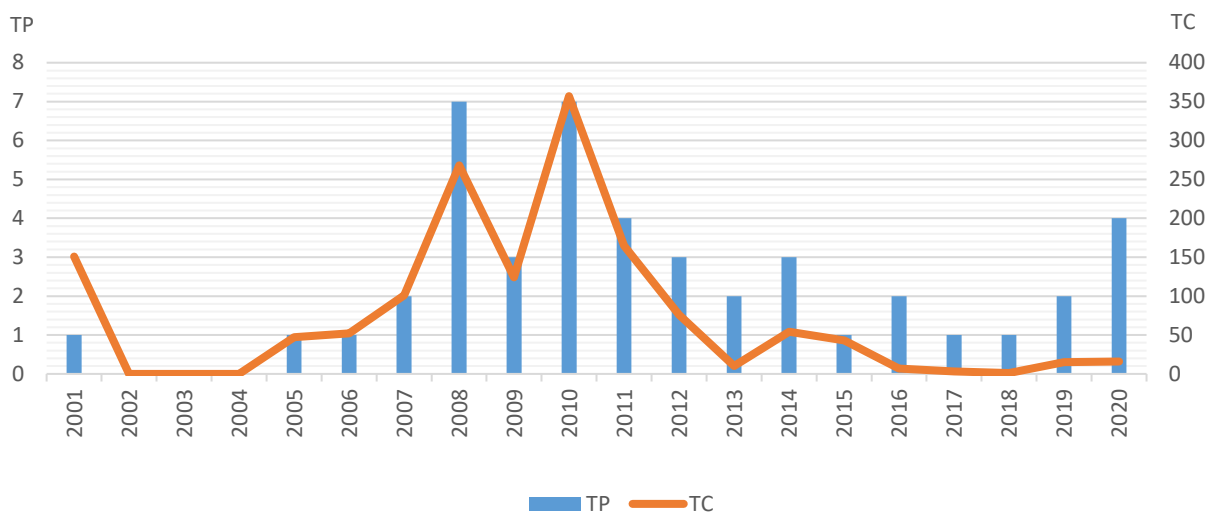

Figure 1. Total Papers (TP) and Total Citations (TC) during the last two decades

Figure 1 shows the total citations and the total citation of the selected articles since the publication. The number of publications and citations is relatively high for the articles published in 2008-2011, while apparently, there is an increasing number of papers published in 2020. In addition, we also listed the 15 most frequently cited papers in Table 1. It is found that the article by Min et al. (2010) is the most cited paper as of 2020 and currently has reached 142 citations, with the total citations per year (TC/Y) = 12.9. It is followed by the article from Zhao et al. (2020), with TC/Y = 12. Figure 2 presents the total citations in each journal in the database, which indicates that the most

cited articles are published in notable and reputable journals in the industrial systems, engineering, marketing, and operation management field.

Table 1. The top 15 cited papers ranked by total citations per year.

R	Journals	Tittle of Paper	Authors	Year	TC	TC/Y
1	Applied Mathematical Modelling	An inventory model for deteriorating items under stock-dependent demand and two-level trade credit	Min J., Zhou Y.-W., Zhao J.	2010	142	12.9
2	European Journal of Operational Research	The shelf space and pricing strategies for a retailer-dominated supply chain with consignment based revenue sharing contracts	Zhao J., Zhou Y.-W., Cao Z.-H., Min J.	2020	12	12
3	Journal of the Academy of Marketing Science	Creating commitment and loyalty behavior among retailers: What are the roles of service quality and satisfaction?	Davis-Sramek B., Droge C., Mentzer J.T., Myers M.B.	2009	104	8.7
4	Manufacturing and Service Operations Management	Supply Chain Coordination when Demand Is Shelf-Space Dependent	Wang Y., Gerchak Y.	2001	151	7.6
5	Applied Mathematical Modelling	Optimal ordering quantities for substitutable products with stock-dependent demand	Krommyda I.P., Skouri K., Konstantaras I.	2015	43	7.2
6	Transportation Research Part E: Logistics and Transportation Review	An integrated vendor-buyer model with stock-dependent demand	Sajadieh M.S., Thorstenson A., Jokar M.R.A.	2010	68	6.2
7	Transportation Research Part E: Logistics and Transportation Review	Channel coordination under consignment and vendor-managed inventory in a distribution system	Chen J.M., Lin I.C., Cheng H.L.	2010	67	6.1
8	International Journal of Production Economics	Coordination and adoption of item-level RFID with vendor managed inventory	Szmerekovsky J.G., Zhang J.	2008	74	5.7
9	Production and Operations Management	Competing for shelf space	Martínez-De-Albéniz V., Roels G.	2011	55	5.5
10	International Transactions in Operational Research	Supply chain coordination for a deteriorating item with stock and price-dependent demand under revenue sharing contract	Giri B.C., Bardhan S.	2012	49	5.4
11	International Journal of Production Economics	Supply-chain coordination under an inventory-level-dependent demand rate	Zhou Y.-W., Min J., Goyal S.K.	2008	70	5.4
12	Applied Mathematical Modelling	An integrated revenue sharing and quantity discounts contract for coordinating a supply chain dealing with short life-cycle products	Partha Sarathi G., Sarmah S.P., Jenamani M.	2014	36	5.1
13	Production and Operations Management	Category captainship vs. retailer category management under limited retail shelf space	Kurtuluş M., Toktay L.B.	2011	48	4.8
14	International Journal of Production Research	Integrated product design, shelf-space allocation and transportation decisions in green supply chains	Kuiti M.R., Ghosh D., Gouda S., Swami S., Shankar R.	2019	9	4.5
15	Journal of Law and Economics	The economics of slotting contracts	Klein B., Wright J.D.	2007	62	4.4

R = Rank; TC = Total citations; TC/Y = Total citations per year.

In bibliometric analysis, the article is used as the unit of analysis. To demonstrate the interconnections between papers and research topics, we examine the number of times an article is cited and co-cited by other articles. Bibliometric co-citation analysis assumes that published articles in journals are developed based on the previously published papers (van Raan, 2012). The bibliometric study is conducted to obtain a comprehensive picture of the related research area's current condition. Then, we analyzed the contents of the papers and classified them according to a specific category of methodological aspects.

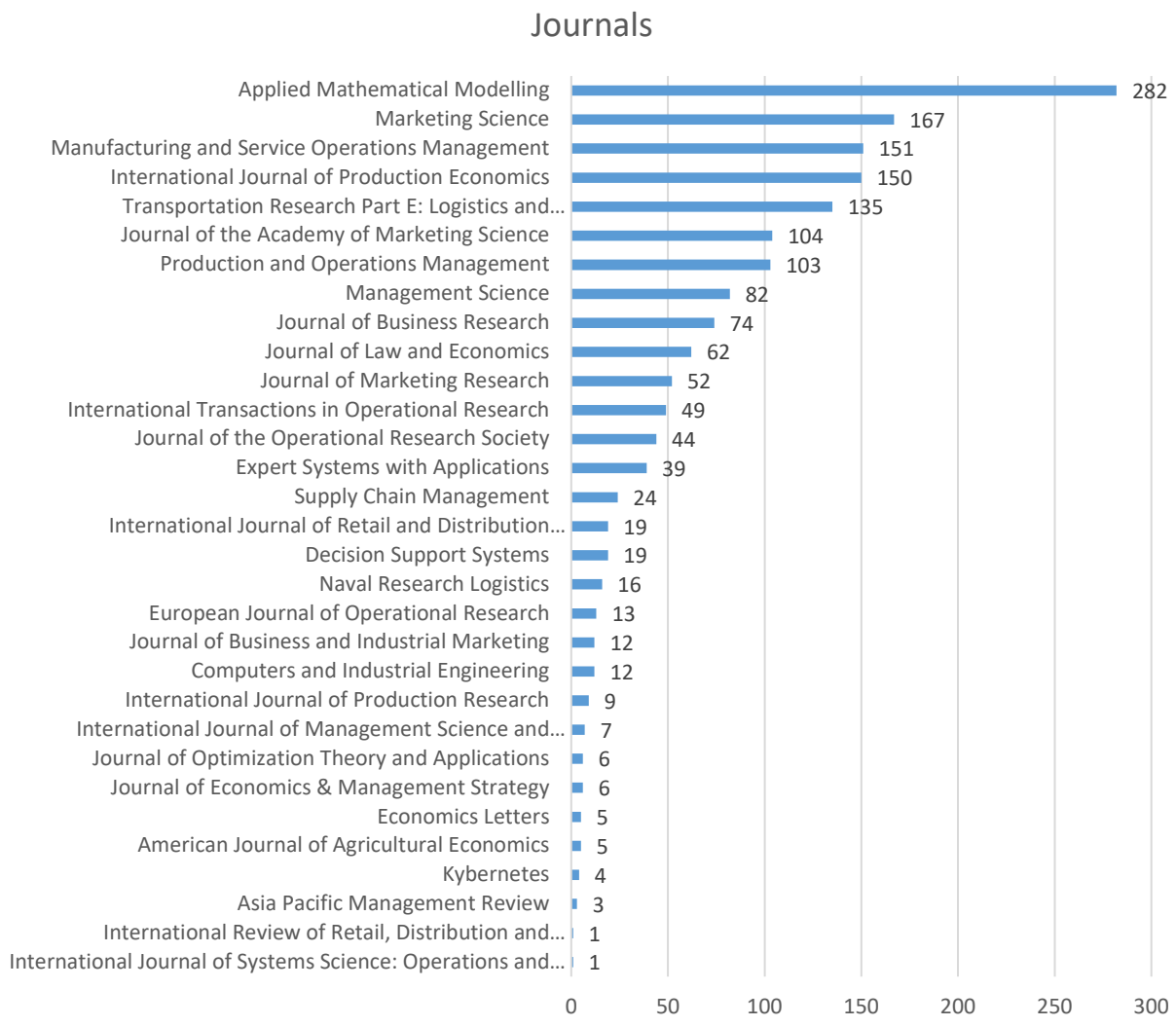

Figure 2. Total citations of the papers in each journal

3. Retail Shelf Space Allocation in Supply Chain Contracts Models

Multiple parties are involved in the supply chain. In practice, there is rarely a centralized authority to make decisions that affect an entire supply chain. Instead, each member makes decisions in order to maximize his or her profit. However, the outcomes of one party's decisions have an influence on the performance of the other supply chain partners. Thus, the local conduct of optimization in a firm may become inefficient for the supply chain, which the phenomenon is referred to as double marginalization (Cachon and Kök, 2010). One strategic approach for resolving the issue of double marginalization is to align each member's goals with those of the supply chain). To act in cooperative manner, supply chain members may offer additional incentives or tariff payments to their partners. These incentives include, but are not limited to, revenue sharing, rebates, time incentives, quantity incentives, capacity-based incentives, or related to the requirement for information sharing between channel members.

Along with selecting a suitable supply contract model, the consumer demand function also should be adapted to the product's business characteristics and supply chain. The demand function should take into account all possible factors affecting consumer demand. Contract models typically take into account the price elasticity of demand or the product's sensitivity to the retail price of the product. However, customer demand is not solely dependent on the product's selling price; it is also necessary to consider the level of product availability or shelf inventory, especially for demand with a high degree of product substitutability. Furthermore, since retail has a limited amount of shelf

space, shelf space allocation becomes critical. It depends on how elastic customer demand is in relation to shelf space allocation (Urban, 1992). Therefore, the retailer is motivated to keep a high level of inventory, knowing that the item is profitable and demand is influenced by the inventory level, which will improve their sales, service level, and profit. Many other authors have acknowledged the stimulating effect that inventory levels have on demand for a wide variety of retail items. Wolfe (1968) conducted an empirical study of this relationship and discovered that the displayed inventory influences fashion items sales, while Urban (1969) then introduced the shelf space allocation model, assuming that demand is a function of the shelf space allocated for an item.

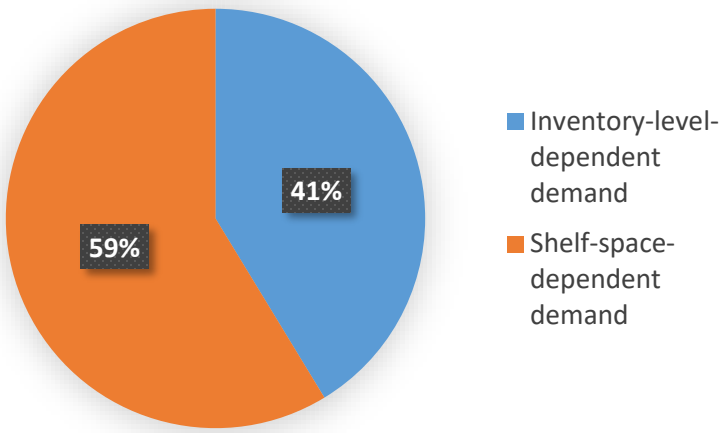

Figure 3. Classification of papers according to the type of demand function

According to the 50 papers examined in this research, the contractual model that takes shelf-space dependent demand into account is more often employed in the model, as shown in Figure 3. The model assumes that the displayed inventory in the shelf is constant and that replenishment from (backroom) storage occurs instantaneously. The space allocation problem has numerous types of demand functions. Chen et al. (2011) and Kuiti et al. (2019) examined the individual space elasticities. The effect of complementary or substitutive relationships between several items may be evaluated through the demand function's cross elasticity parameter. Urban (1969) initiated a discussion of cross-elasticity, followed by numerous authors' development of the model. The Cobb–Douglas model is the most often used in quantitative research. It is expressed in log-linear function form and was modified by Corstjens and Doyle (1981) to include individual space elasticity. In specific investigations of supply chain coordination mechanisms, the cross elasticities parameter is used to simulate channel member competitiveness. For example, Martnez-de-Albéniz and Roels (2011), Reisi et al. (2019), and Zhao et al. (2020) investigated the competition for retail shelf space among suppliers. Wang and Gerchack (2001) addressed supply chain coordination in the presence of a demand function for aggregate inventory between two competing retailers.

A retailer's space allocation decision may affect its inventory level and, consequently, on demand. We include inventory-level-dependent demand (stock-dependent demand) models in our study since Urban (2005) offered an in-depth examination of such models. The bulk of these models in deterministic function are categorized as initial inventory level (Type I) or instantaneous inventory level (Type II) models. Type I models have a constant demand rate throughout the period and a constant inventory level; however, the demand rate increases when the order-up-to level rises. On the other hand, the Type II model assumes that demand is proportional to the current inventory level. Therefore, demand drops as the inventory level lowers; consequently, as the inventory displayed to the customer depletes over time, the demand rate changes proportionately. For example, some authors use the instantaneous inventory level model for deteriorating items. For instance, Chen et al. (2018) established a method for coordinating a short life cycle supply chain with the retailer's instantaneous inventory level of deteriorating items. The retailer's inventory level declines over time as a result of demand and deterioration. Bai et al. (2008) assumed the presence of backroom storage for fresh product items, where demand is a polynomial function and time-varying. When the backroom storage is filled, the shelf is considered wholly stocked; however, when the backroom storage is emptied, the shelf is only partially stocked, and the current inventory level determines demand. Another kind of inventory-level-dependent demand function is the linear form, which Chen et al. (2010) and Giri and Bardhan (2012) utilized

to create mechanisms for deteriorating items coordination. Partha Sarathi et al. (2014) established a stochastic coordination mechanism for a short life-cycle item, with demand represented as a function of initial stock.

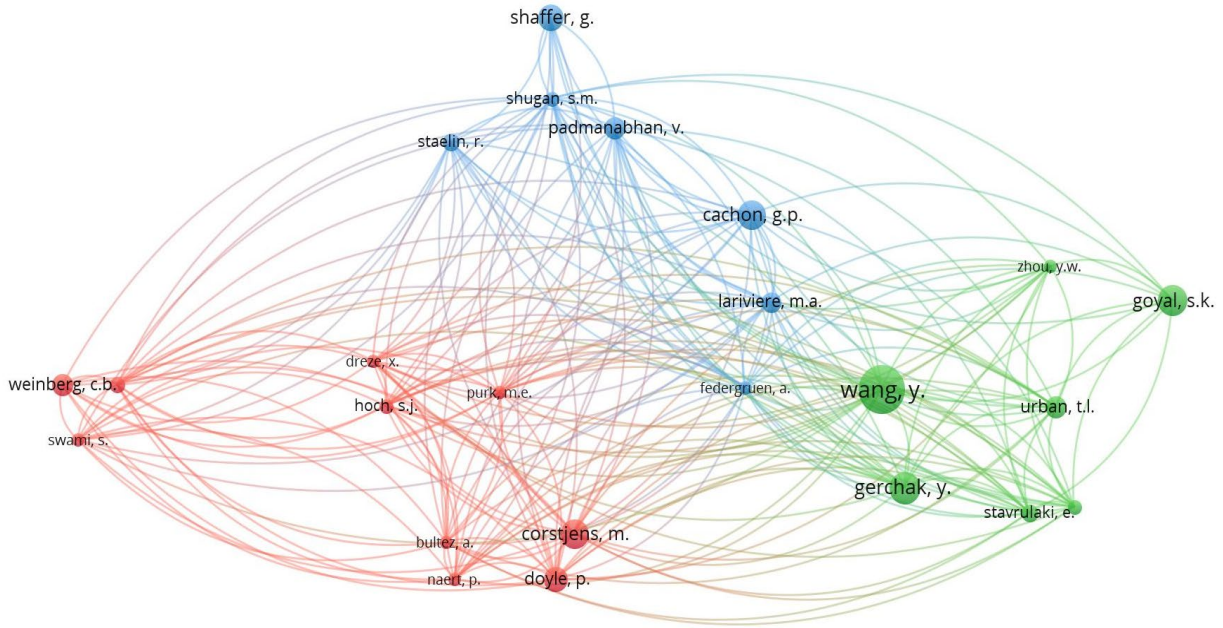

Figure 4. Co-citation of authors for publications of shelf space allocation in SC contracts

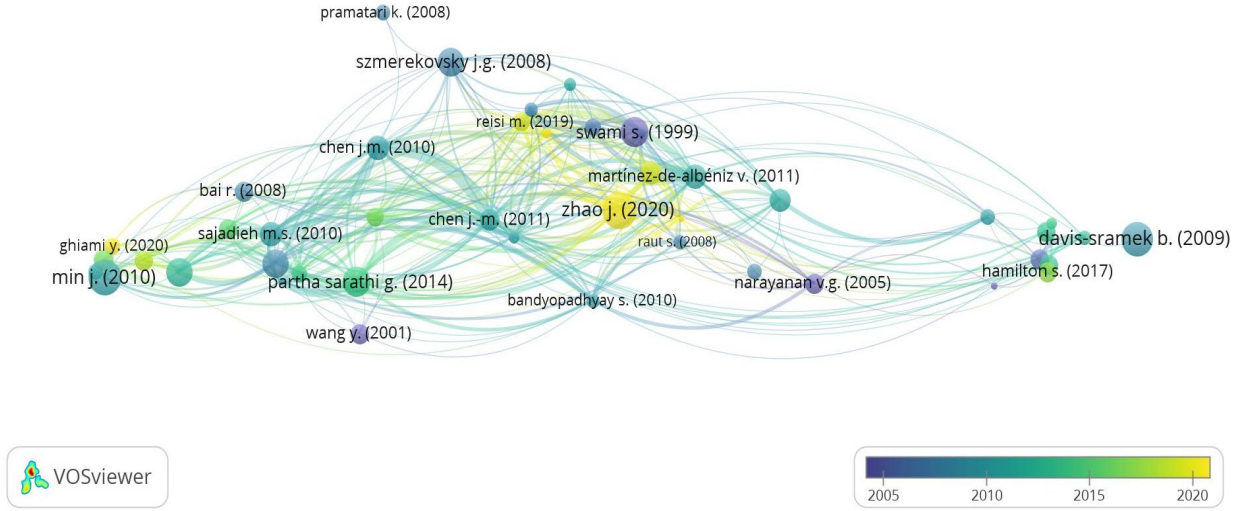

Figure 5. Bibliographic coupling of documents

As shown in Figure 4-6, the citation clusters reflect two distinct methodological aspects of supply chain contracts: (1) vendor-buyer coordination through integrated inventory; and (2) vendor-buyer coordination through revenue sharing and bargaining contracts. Numerous studies have been conducted on developing mechanisms for coordination amongst supply chain partners in order to enhance supply chain performance. It is noted that the majority of these studies focus on establishing coordination contracts between supply chain partners in order to create mutually beneficial partnerships and improve the supply chain's performance.

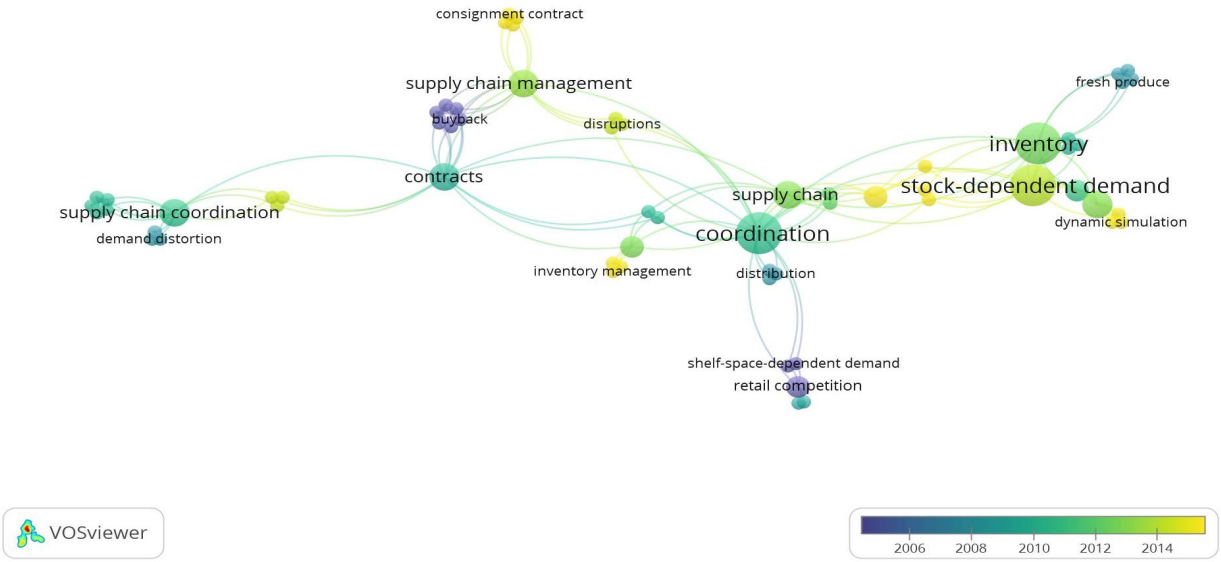

Figure 6. Co-occurrence of authors' keywords

From the 50 papers in our dataset, four articles deal with qualitative research under the related topic. The classification of quantitative researches according to methodological aspects is represented in Figure 7. These articles develop analytical models for channel members to coordinate the system considering retailer shelf space allocation. We observe that most papers (40 papers; 87%) illustrate their theoretical models using the coordination through revenue sharing and bargaining contracts model, while the remaining papers (6 papers; 13%) can be classified as the vendor-buyer coordination by integrated inventory model.

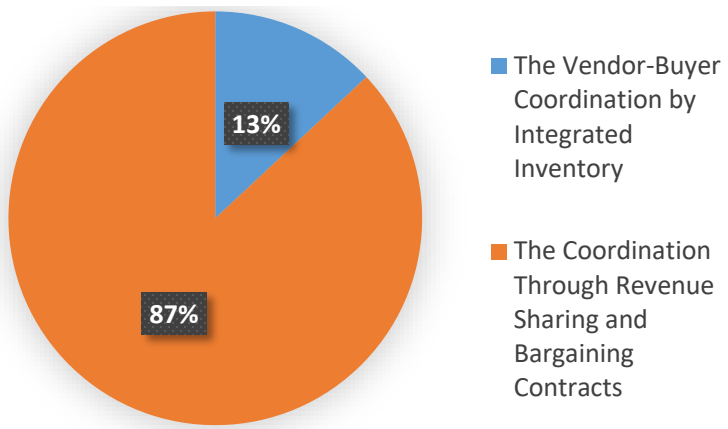

Figure 7. Classification of quantitative researches according to methodological aspects

3.1 The Vendor-Buyer Coordination by Integrated Inventory

The vendor-buyer coordination by integrated inventory models is performed by developing integrated inventory models that reflect the connection and understand the motivating influence of inventory on demand. In the inventory model, the concept of psychic stock is closely related to the term inventory-level dependent demand. Unlike in conventional inventory models, the demand for a given item is not assumed to be an external variable; instead, it is assumed that the demand rate is endogenous to the firm and is a function of the inventory level. The dependency effect implies that the retailer is motivated to maintain higher inventory levels, despite increased holding costs, as long as the item is profitable and demand is a function of the inventory level, leading to more sales, higher fill rates, and possibly better profitability. Sajadieh et al. (2010) published a notable work in which they built an integrated

vendor-buyer model for a stock-dependent demand. A supplier manufactures and distributes items to a retailer, where they are displayed. The contribution of this study to the literature on joint economic lot sizing is the inclusion of a stock-demand dependency within the existing integrated vendor-buyer model. Its purpose is to optimize the supply chain's total profit. The results indicate that buyer-vendor coordination benefits channel members more when demand is more dependent on inventory displayed on retailer shelves. The study also demonstrates that in an uncoordinated supply chain, stock dependency results in a double marginalization consequence.

3.2 The Coordination Through Revenue Sharing and Bargaining Contracts

Contracts for supply chain coordination have garnered attention among practitioners and academics. The revenue sharing contract is a model that most researchers use to solve supply chain coordination mechanism problems. When handling returns is physically impractical or not feasible, this model is considered a substitute for the buyback contract model. Cachon and Lariviere (2005) developed a revenue sharing contract model that enables retailers to obtain products at a lower wholesale price, encouraging retailers to place larger orders with the supplier. Furthermore, retail distributes a portion of its revenue to suppliers as compensation. Giri and Bardhan (2012) developed a revenue sharing contract for a single deteriorating item using an integrated single-manufacturer single-retailer supply chain model. Market demand is assumed to be dependent on both inventory levels and price. The revenue sharing contract model is suitable for supply chain coordination when profit distribution is not evenly distributed between retailers and suppliers. The revenue sharing contract model could also be integrated with other types of coordination contracts or incentive schemes. For instance, Partha Sarathi et al. (2014) developed an integrated revenue sharing and quantity discount contract model to coordinate a two-stage supply chain by taking into account the stochastic nature of price-sensitive and stock-dependent demand.

Many authors consider the consignment model in retail, in which suppliers retain inventory ownership and are compensated based on the number of products sold to consumers (Gerchak and Wang, 2004). This arrangement will affect the supply contract model's cost structure, as retail will bear only the marginal costs associated with retail operations, while the supplier bears the product's unit cost of capital, thus the risk of the unsold product being transferred to the supplier. Chen et al. (2011) and Zhao et al. (2020) focused on coordinating a channel with price and shelf-space-dependent demand through a consignment contract with revenue sharing. Chen et al. (2010) investigated the performance of a combined vendor-managed system and consignment with revenue sharing contract as a coordination mechanism for a decentralized distribution system.

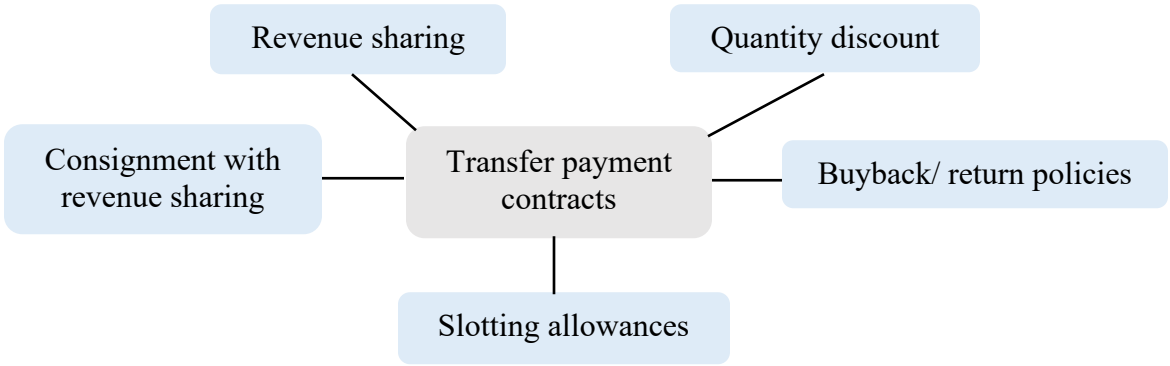

Figure 8. Types of transfer payment contracts

Besides the revenue sharing mechanisms discussed above, there are other contractual incentives for transfer payments, such as quantity discount contracts, buyback/return policies, and tariffs on slotting allowances. Zhou et al. (2008) and Chen et al. (2016) proposed a quantity discount contract mechanism between supplier and retailer in the presence of inventory-level-dependent demand. Parthasarathi et al. (2010) and Wang et al. (2016) investigated a decentralized supply chain's return policy scheme. To manage the chain as a centralized system, the manufacturer delivers items to the retailer on a stock-dependent demand basis and offers reduced wholesale pricing and buyback contracts. Wang et al. (2016) also evaluated channel performance in terms of temporary and permanent inventory losses in such settings. Chen et al. (2010) and Zhao et al. (2020) introduced slotting allowances/slotting fees in a retailer-led Stackelberg game, in which the supplier pays an up-front lump-sum side payment to the retailers in order

to coordinate channel members under a cooperative fashion. Chen et al. (2011) used two types of tariff slotting fees in their model: the slotting charge per unit shelf space and the fixed slotting fee. The typical contracts involving various transfer payments arrangement are presented in Figure 8.

4. Future Research Directions

Based on our review, various potential research directions in future research on contracts in the supply chain considering the allocation of shelf space in retail can be suggested. We present future research directions based on the status of current literature and justify the challenges and opportunities of the prospects of research extensions.

Supply chain structure and power balance. Although most studies examine two-echelon supply networks with a supplier and a retailer, many commodities products require the involvement of multiple parties in the supply chain. Furthermore, it is important to consider the balance of power among channel members for coordinating the supply chain, for instance, asymmetric (i.e., dominant suppliers/retailers) or symmetric conditions among all partners. Some papers have examined this problem; however, obtaining an analytical solution for such a model is challenging.

Considering shelf space location. According to the literature review, the coordinating contractual model considers only the volume of displayed inventory when allocating shelf space. However, altering a product's visibility through changes in location or number of facings may affect consumer attention and the possibility of consumer purchases. Considering the cross elasticities of multiple products and the shelf placement of items tends to maximize potential retail sales by diverting customer purchases to higher-margin products or increasing the number of unplanned purchases. This model is often a single-firm optimization problem in most cases. Thus, when the objective is to determine the equilibrium points between two or more firms in the supply chain, the problem requires a more complex mathematical solution approach.

Supply chain under new business models. Currently, there has been a massive leap in sales increase through the online marketplace. Various new business models are growing in line with the technological developments that are well received in the markets. Asymmetrical conditions between channel members, such as dominant platforms or manufacturers, require a mechanism for coordinating orders and pricing policies. The coordination contract model could consider the location and ownership of the inventory sold in the new hybrid business models such as omnichannel and online-to-offline (O2O) channels. The development of the O2O channel in the market has a close relationship with the growth of sharing economy companies (such as the delivery of products using this type of online transportation). In the literature review, only three studies raised the topic of online sales, including e-commerce and direct store delivery. According to these findings, research that is potentially carried out in the future is related to the supply chain coordination mechanism based on the development of this new business model.

Integrated contractual terms. Combining and comparing results under different trading terms to determine the best performance of the coordination mechanism model, revenue sharing contracts appear to be the most commonly applied contracts. Several studies have combined them with other contractual agreements. Several studies have developed revenue sharing mechanisms with the consigned inventory model to coordinate the supply chain under stock-dependent demand. The growth of various types of new business models in the market certainly brings opportunities for integrating the coordination contract model used, whether related to transfer payments, inventory ownership, and/or information sharing mechanisms (such as using vendor-managed inventory systems, RFID, blockchain).

5. Conclusions

Retailer's ability to consider customer behavior when making decisions, such as determining selling prices and allocating limited shelf space, is essential in a competitive retail environment. Coordination between players in the supply chain can provide a competitive advantage in the marketplace. A supply contract is a type of coordination mechanism frequently used in the supply chain management industry. Contract parameters are designed in such a manner that both suppliers and retailers could gain advantages. It is also possible to avoid double marginalization in the supply chain, which will help improve the overall performance of the supply chain as a whole. According to a literature review on the retail supply contract model, two types of demand functions are commonly used in research for shelf space allocation in retail by taking into account the effect of shelf space elasticity or the level of product inventory (stock) on customer demand. We discover that the citation clusters represent different methodological aspects of supply chain contracts, consists of the vendor-buyer coordination by integrated inventory and the

coordination through revenue sharing and bargaining contracts. As a method for improving supply chain performance and could benefit all participants in the supply chain, the supply contract model could contribute to the managerial role of the retail business by serving as a mechanism for establishing coordination to achieve better supply chain performance.

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