Supply Chain Coordination: A Review

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***Abstract*— Supply chain is complex, it is characterized by many activities scattered across multiple functions and organizations, and this poses many different challenges for effective supply chain coordination. In order to meet these challenges, one can establish a unified system to facilitate the coordination. In addition, a variety of coordination mechanisms have been proposed for supply chain coordination to address a range of issues that arise during the supply process. This paper analyses the articles published in international journals from 1994 to 2018 and presents a systematic literature review to clarify problems and challenges in supply chain coordination and various supply chain coordination mechanisms used in supply chains. These study not only demonstrate the importance of supply chain coordination but also help researchers and policymakers use these methods effectively to solve problems in their supply chain activities.**

***Index Terms*— supply chain management, coordination mechanisms, challenges, optimize performance of supply chain.**

I. Introduction

A supply chain can be defined as system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. According to [1] the supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer.

Since the 1990s, the development of the supply chain has been very rapid. Academics and practitioners have exponentially published papers in different journals ([2]). According to [3], the development of numerous supply chain essays and diverse case studies have stimulated further research on issues related to the supply chain. Supply chains are often complex and valuable, often distributed across multiple functions or organizations, sometimes over a long period of time (logistics, inventory, purchasing and purchasing, production planning, intra-organizational and inter-organizational relationships, and performance measures). The global economy is ushering in a fierce competition and living environment in the process of information technology development. The market becomes unpredictable, consumer diversification of products and services, personalized demand is also getting higher and higher. The cost and the quality are no longer seen as the competitive advantage of the business, but the necessary conditions for the survival of the business in the market. In supply chain, time and reaction speed become the first element of competition. Supply chains tend to be more complex, with many suppliers, service providers and end consumers participating in the network of relationships, resulting in risks and vulnerabilities at every stage ([4]).

This article mainly takes the coordination mechanism and models in supply chain management as the research object. The paper is organized as follows: section two describes the literature classification and observations in supply chain coordination. Section three and section four analyses the various mechanisms and the challenges in coordinating the supply chain. Section five suggests for future research and some addition observations. Finally, section six provides a summary.

II. Observations

During this paper, we try to analyze and classify the supply chain coordination literature based on four main axes, as follows: the perspective and conceptual model of supply chain coordination, various supply chain coordination mechanisms adopted in the supply chain, supply chain coordination to manage uncertainty in the supply chain and future research direction of supply chain coordination.

A. Various Perspectives

Burgess et al. (2006) ([2]) shows the importance of the different theories in supply chain management. By studying the relationship management between supply chain members, the coordination theories should be applied to solve the problem ([5]). In fact, coordination is considered to be a prerequisite for integrating supply chain entity operations to achieve common goals. The literature on supply chain coordination (SCC) reports different views. The researchers describe SCC as an application of coordination in different activities in the supply chain.

Manuscript received July 6, 2018; revised November 2, 2018.

doi: 10.18178/joams.6.4.213-217

A number of coordination strategies have been developed to coordinate supply chain processes and activities to ensure better supply chain performance. Through coordinated procurement - inventory - production allocation process ([6]; [7]; [8]; [9]).

Hoyt and hooker (2000) ([10]) studied the relationship between buyer and supplier from the perspective of transaction cost theory, strategic structure theory and enterprise resource theory. The concept of supply chain partnership is rich in literature.

Power (2005) ([11]) reviewed three key elements of supply chain integration: information systems, inventory management and supply chain relationships, aimed at reducing costs and improving customer service levels. In the case of insufficient supplier capacity, the emerging field of supply chain coordination is outsourcing practice ([12]).

Other pragmatic measures, such as synergistic planning, forecasting and supplementation (CPFR) ([13]) and supply chain operation reference (SCOR) ([14]) may be related to the views of practitioners.

B. Gaps on Different Views

1) There seems to be no standard definition on SCC. The literature on SCC proves this point. The authors have different views on these issues because of different stakeholders and expectations in their respective areas of problem. Some of these views demonstrate the inherent ability or intangible assets needed to coordinate responsibilities, relationships, cooperation and trust. Another view can be visualized, based on the coordinated effort required to achieve common goals in different supply chain activities. Due to different activities, coordination requirements vary with the complexity of the activity. The most challenging coordination idea is to extend the concept of coordination from within the organization to the coordination of the organization.
2) By observing these different points of view, SCC can be regarded as a set of steps:

- Determine why the members of the supply chain should coordinate, and why they depend on each other's activities/processes.
  The interdependencies among different supply chain members can be: order, procurement, inventory management, production, design and development, supply, prediction and distribution.
- Determine which activities or groups of activities require coordination, activity complexity (activities) and the level of coordination required.
- Identify the reasons for coordination. Can the demand uncertainty and/or supply uncertainty, double marginalization or other external risks in the supply chain be resolved through coordination?

1) To determine whether one or more of the coordination mechanism to solve complex management issues, such as knowledge sharing, information sharing, resource sharing, joint work, joint decision-making, joint design and development products, joint promotion, implementation of information system, design of risk sharing contract.
3) While there is an attempt to focus on coordinating different supply chain processes, most of the papers discuss the work done in the analysis model of joint decisions in different processes. In the empirical relationship between coordination means and mechanism (information sharing, trust and information sharing) and SCC, the literature seems to lack experience.
4) Various views on supply chain coordination, various coordination issues and the means and mechanisms to achieve harmonization in a comprehensive manner are needed.
5) The various coordination mechanisms recommended in these models help improve the performance indicators of the supply chain. These mechanisms include: joint decision-making, information sharing, resource sharing, implementation of information technology, joint promotional activities, etc. Other motives seem to be the ability of supply chain members to share risks and then share benefits.
6) Coordination in the supply chain needs to be monitored because of the lack of coordination on the adverse effects of supply chain performance. There seems to be no measure of coordination. Some models can be proposed.
7) Quantization and evaluation of coordination capacity on the basis of coordination mechanisms.
8) Appropriate implementation of the coordination mechanism requires more empirical research so that the combination of different feasible coordination mechanisms can reflect the impact of coordination on the performance measures of various supply chains.

The conceptual model of the above supply-chain coordination has been presented in a fragmented manner. It is important to understand different supply chain management functions. The complexity of coordinating the various SC members may also depend on the interfaces of the two supply chain members.

III. Coordination Mechanisms

A. Model Classification

According to [15], in coordination mechanisms, contracts are valuable tools that are used in practice to coordinate the SC, many forms of SC contracts have been adopted in the industry and are analyzed or researched by researchers. However, they are not complete, and the considered classes are not disjoint. Most models are based on single-period (newsvendor model) issues and are coordinated by setting the optimal order quantity to

maximize the overall profitability of the SC. According to [16], we can summarize following different viewpoints:

1) Decision-Making Process:

- Decision-making distribution among supply chain participants: centralized and decentralized.
- Compliance system: This system will constrain members of the supply chain to comply partially or completely with the terms of the contract ([17]).

2) Supply Chain structure:

Most contract models consist of a single monopoly and a single retailer that have a bilateral monopoly in SC, a chain of services from supplier to customer, serving the ultimate customer needs. At present, many studies have solved the coordination problem of the three-level SC ([18]) or two-level SC ([19]) with single actors at each stage in SC. At present, many studies have solved the coordination problem of each level of the three-level supply chain or two-level supply chain and the supply chain.

3) Certainty/ Uncertainty of demand:

Uncertainty in the supply chain environment generally refers to market demand. The demand can be random (uncertain) or deterministic, but of course he can be static (constant) or dynamic (with seasonal changes or market preferences) ([15]).

4) Environment dependence of supply chain decision:

Market demand usually depends on the sales price and marketing tools. [20] and [21]studied the problems in the context of price dependent needs and studied the two aspects of quantity in stock and sales prices. For the research dimension of inventories, in the case of stock outs, many authors think it would make merchants offer lower prices or lose sales. Of course, some models also have service level limitations, resulting in a failure to predict the number of out-of-stock items.

5) Risk treatment:

In most models, supply chain agents can be risk-neutral. Means that agents want to maximize their expected profit. However, the other studies ([22]) suggest that supply chain agents can also show aversion to risk by looking at the expected value and variance of profits and looking for an acceptable balance.

6) Information structure:

We understand the two aspects of information structure. On the one hand, when all the information in the supply chain is exactly the same and receive the information at the same time, we think the information structure is complete or symmetrical, at this time, more profit will be gained and the cost will be reduced. On the other hand, the structure of information is incomplete or asymmetric when there is a gap between the information in the supply chain or the information is delayed.

7) Game theoretic model:

Game theory will analyze the key role that participants play in cooperation. According to [23], in cooperative game theory, it is most reasonable for the participants to decide which contract to implement and to make a win-win contract. If both parties are inconsistent in terms of the contract, then there is no cooperation in the cooperative game and the supply chain members will become competitors.

B. Model Classification

Supply chain contracts act as a coordination tool and are mainly used for the business relationship between two or more independent participants and the supply chain. ([24]) provide two broad categories of coordinated contracts: quantity dependent contracts (quantity discounts, quantity flexibility) and price dependent contracts (buyback/ return policy, revenue sharing, sales rebate, quantity discounts). As described in [25], the goals of each business can be aligned with those of the supply chain with the following contract types to achieve the best results.

1) Quantity discounts contract:

Under a quantity discount contract, we can differentiate between increments and all unit discounts, and the customer pays the wholesale price based on the order quantity in order to order the world's best quantity to increase the profitability of the supplier and the buyer ([26])

Cachon (2003) ([25]) based on the assumption of a single issue of newsboy, clarified the coordination of the number of discount contracts. This is similar to a sales rebate contract, but without a defined threshold. According to [27] contracts are applicable in many situations, such as international supply chains with fluctuating exchange rates ([28]).

2) Quantity flexibility contract:

This coordination mechanism allows downstream actors to change their order quantities within a predetermined range as they gain more market insight. That means the customer gives a preliminary forecast, and then it can give a fixed order within the forecast time interval ([17]).

T.say (1999) ([15]) shows that under certain conditions, under this contract, the uncertainty risk of participants in the market can be discussed and the optimal result can be obtained based on the forecast. Such contracts are common in several markets. [15], [29], [30] and [31] have been done valuable work in approaches of quantity flexibility.

3) Buy back contract:

This type of contract supports shared inventory risk among partners, which means that suppliers or upstream distributors set discounted prices and promised to repurchase excess inventory at discounted prices. Another policy is to agree to return the full wholesale price of all returned products. [25] and [26] show partial rewards and partial rewards can be coordinated. [32] studied the coordination of repo contracts and optimized the industry's forecast of information. [33] studied supply interruption and decision-making under the risk of repurchase contracts.

4) Revenue sharing contract:

Under this agreement to share revenue, downstream agents (distributors or retailers) not only pay for purchased goods, but also share a given percentage of revenue with upstream agents (suppliers or manufacturers) in exchange for lower wholesale prices ([26]).

The contract has been successfully used in video rental and movie exhibitions. [25] turns out that the optimal revenue sharing and revenue sharing contracts are equivalent, which can create the same profits for partners.

They also show that in the case of a single distributor and a single retailer, a revenue-sharing contract coordinates the supply chain and can arbitrarily distribute profits among the participants. [34] made a research has come to a revenue sharing mechanism to coordinate the three-tier supply chain and improve the profits of participants.

IV. Challenges

In any system, the smooth operation of the entity is the result of a well-coordinated entity. Defining "coordination" accurately can be difficult, but lack of coordination can be easily expressed through a variety of alternatives. Supply chain members have conflicting goals and differences in the field of supply chain decision-making and behavior. It must be pointed out that a typical supply chain also involves the human system, so it is possible to have such problems in coordinating the challenges and difficulties of supply chain members.

- The individual interests of supply chain members, local views and opportunistic behaviors lead to mismatch between supply and demand ([35]).
- The traditional performance measurement based on individual performance may be consistent with the maximization of supply chain profit. Similarly, traditional policies, particularly rules and procedures, may have nothing to do with the new circumstances of inter-organizational relations. In the process of trying to implement technology, there has been a problem of excessive dependence on technology ([36]; [37]).
- According to [38], the dislocation of the "plug and play" supply chain is related to the difficulty of dynamic exchange of products (short life cycles) in rapidly changing business environments and the difficulties of partners.
- Organizations want to reach out to the best suppliers, regardless of their global location, which brings many risks and uncertainties to cross-border supply chain management.
- Supply chain members jointly identify supply chain performance indicators and supply chain members without a fair sharing mechanism. The benefits generated are of no value.

Effective SCC has many benefits. Including: remove excess inventory, shorten delivery time, increase sales, improve customer service and efficient product development efforts, low manufacturing cost, improve the flexibility of dealing with high demand uncertainty, increase customer retention and increase their income ([35]; [36]; [39]).

V. Future Research

Coordinating the supply chain may be the most difficult aspect of supply chain management. Because many companies do not understand the supply chain coordination mechanism, although some companies understand these coordination mechanisms, there is no way to completely adjust the gap between various departments. In this case, the business must recognize the importance of coordination, also need to do a detailed study. Coordination mechanisms can also be different subtypes. To coordinate the entire supply chain, all coordination mechanisms need to capture the impact of supply chain performance ([40], [41]). In this study, we considered the situation of a single retail store and a single manufacturer's facility.

However, in real life, the supply chain is often complex and varied. So we need to study the feasibility of this model for a more complex reserve supply chain. For further research, we can also consider how market segmentation affects reverse supply chain performance because we cannot predict consumer behavior.

It is observed that with the support of a large number of documents, scholars have done a great deal of work on the applicability of the contract. The details from very simple models to very complex models are different, and coordination among multiple actors at different levels of the supply chain can be achieved through contract execution ([42], [43]). The analysis of the contract implementation between supply chain members should pay more and more attention in theory and practice.

Acknowledgment

This project (PERFAD) is funded by the European Union. Europe is committed in Normandy with the European Regional Development Fund. This document commits only the University of Le Havre, the managing authority is not liable for any use that may be made of the information in this publication.

References

[1] I. Kozlenkova, "The role of marketing channels in supply chain management," *Journal of Retailing*, vol. 91, pp. 586–609, 2015.

[2] K. Burgess, P. J. Singh, and R. Koroglu, "Supply chain management: a structured review and implications for future research," *Int J Oper Prod Manage*, vol. 26, no. 7, pp. 703–729, 2006.

[3] K. Arshinder, A, Kanda, and S. G. Deshmukh, "Supply chain coordination: Perspectives, empirical studies and research directions," *Int J Prod Econ*, vol. 115, no. 2, pp. 316–335, 2008.

[4] H. Pfohl, H. Kohler, and D. Thomas, "State of the art in supply chain risk management research: Empirical and conceptual findings and a roadmap for the implementation in practice," *Logistics Res*, vol. 2, no. 1, pp. 33–44, 2010.

[5] T. Malone and K. Crowston, "The interdisciplinary study of coordination," *ACM Comput Surv*, vol. 26, no. 1, pp. 87–119, 1994.

[6] S. K. Goyal and S. G. Deshmukh, "Integrated procurement-production systems: a review," *Eur J Oper Res*, vol. 62, no. 1, pp. 1–10, 1992.

[7] D. J. Thomas and P. M. Griffin, "Coordinated supply chain management," *Eur J Oper Res*, vol. 94, no. 1, pp. 1–15, 1996.

[8] A. M. Sarmiento and R. Nagi, "A review of integrated analysis of production– distribution systems," *IIE Trans*, vol. 31, no. 11, pp. 1061–1074, 1999.

[9] S. P. Sarmah, D. Acharya, S. K. Goyal, "Buyer–vendor coordination models in supply chain management," *Eur J Oper Res*, vol. 175, no. 1, pp. 1–15, 2006.

[10] J. Hoyt and F. Huq, "From arms-length to collaborative relationships in the supply chain: an evolutionary process," *Int J Phys Distrib Logistics Manage*, vol. 30, no. 9, pp. 750–764, 2000.

[11] D. Power, "Supply chain management integration and implementation: a literature review," *Supply Chain Manage Int J* vol. 10, no. 4, pp. 252–263, 2005.

[12] S. Sinha and S. P. Sarmah, "Supply chain coordination model with insufficient production capacity and option for outsourcing," *Math Comput Modell*, vol. 46, pp. 1442–1452, 2007.

[13] T. S. Larsen, C. Thernoe, and C. Anderson, "Supply chain collaboration theoretical perspective and empirical evidence," *Int J Phys Distrib Logistics Manage*, vol. 33, no. 6, pp. 531–549, 2003.

[14] S. H. Huan, S. K. Sheoran, and G. Wang, "A review and analysis of supply chain operations reference (SCOR) model," *Supply Chain Manage Int J*, vol. 9, no. 1, pp. 23–29, 2004.

[15] A. A. Tsay, S. Nahmias, and N. Agrawal, "Modeling supply chain contracts: A review," In: Tayur,S, Ganeshan, R., Magazine, M. (eds.): Quantitative Models for Supply Chain Management. International Series in Operations Research and Management Science, 17, Kluwer Academic Publishers, pp. 299-336, 1999. (ISBN O-792-38344-3)

[16] N. Labiad, Z. Beidouri, and O Bouksour, Laboratoire de Mécanique Productique & Génie Industriel (LMPGI) ; Université Hassan II Ain Chock, Ecole Supérieure de Technologie, Km 7 Route El Jadida, Casablanca, Maroc. IJCSI (international journal of computer science issues). vol. 9. no. 1. January 2012.

[17] G. P. Cachon and M. A. Lariviere, "Contracting to assure supply: How to share demand forecasts in a supply chain," *Management Science*, vol. 47, no. 5, pp. 629–646, 2001.

[18] D. Ding and J. Chen, "Coordinating a three level Supply Chain with flexible return policies," *Omega*, vol. 36, pp. 865 – 876, 2008.

[19] M. A. Darwish and O. M. Odah, "Vendor managed inventory model for single-vendor multi-retailer supply chains," *European Journal of Operational Research*, vol. 204, no. 3, pp. 473-484, 2010.

[20] Y. He, X. Zhao, L. Zhao, and J. He, "Coordinating a supply chain with effort and price dependent stochastic demand," *Applied Mathematical Modeling*, vol. 33, no. 6, pp. 2777–2790, 2009.

[21] N. C. Petruzzi and M. Dada, "Pricing and the newsvendor problem: A review with extensions," *Operations Research*, vol. 47, no. 2, March–April 1999.

[22] X. Gan, S. P. Sethi, and H. Yan, "Coordination of supply chains with risk-averse agents," in Supply Chain Coordination under Uncertainty (pp. 3-31). *Springer, Berlin*, Heidelberg, 2011.

[23] M. Albrecht, "Supply chain coordination mechanisms: New approaches for collaborative planning," *Lecture Notes in Economics and Mathematical Systems* 628, Springer -Verlag Berlin Heidelberg, 2010.

[24] B. Hezarkhani and W. Kubiak, "A coordinating contract for transshipment in a two-company supply chain," *European Journal of Operational Research*, vol. 207, no. 1, pp. 232-237, 2010.

[25] G. P. Cachon, "Supply chain coordination with contracts," In: Graves, S.C., de Kok, A.G. (Eds.), *Handbooks in Operations Research and Management Science: Supply Chain Management: Design, Coordination and Operation*, vol. 11. North-Holland, Amsterdam, pp. 227–339, 2003.

[26] K. Govindan, M. N. Popiuc, "Overview and classification of coordination contracts within forward and reverse supply chains," *Discussion Papers on Business and Economics*, No. 7/2011.

[27] N. Altintas, F. Erhun, and S. Tayur, "Quantity discounts under demand uncertainty," *Management Science*, vol. 54, no. 4, pp. 777–792, 2008.

[28] A. Scheller-Wolf, S. Tayur, "Reducing international risk through quantity contracts," *Carnegie Mellon University Graduate School of Industrial Administration Working Paper*, 1997.

[29] Y. Bassok and R. Anupindi, "Analysis of supply contracts with commitments and flexibility," *Wiley Periodicals*, 2008.

[30] Z. Lian and A. Deshmukh, "Analysis of supply chain contracts with quantity flexibility," *European Journal of operational Research*, 196, 526-533, 2009.

[31] Z. Li, Z. Lian, and W. Zhou, "Analysis of a quantity flexibility supply contract with postponement strategy," *IEEE International Conference on Grey Systems and Intelligent Services*, Nanjing, China, 2010.

[32] K. L. Donohue, "Efficient supply contracts for fashion goods with forecast updating and two production models," *Management Science*, vol. 46, no. 11, pp. 1397-1411, 2000.

[33] J. Hou, A. Z. Zeng, and L. Zhao, "Coordination with a backup supplier through buy-back contract under supply disruption," *Transportation Research*, vol. 46, pp. 881-895, 2010.

[34] I. Giannoccaro and P. Pontrandolfo, "Supply Chain coordination by Revenue Sharing contracts," *Int. J. Production Economics*, vol. 89, pp. 131–139, 2004.

[35] M. L. Fisher, A. Raman A. S. McClelland, "Rocket science retailing is almost here: are you ready?" *Harv Bus Rev*, vol. 72, no. 3, pp. 83–93, 1994.

[36] H. L. Lee V. Padmanabhan, and S. Whang, "Information distortion in supply chain: the bullwhip effect," *Manage Sci* vol. 43, no. 4, pp. 546–558, 1997.

[37] S. McCarthy and S. Golocic, "Implementing collaborative planning to improve supply chain performance," *Int J Phys Distrib Logistics Manage*, vol. 32, no. 6, pp. 431–454, 2002.

[38] R. Piplani and Y. Fu, "A coordination framework for supply chain inventory alignment," *J Manuf Technol Manage*, vol. 16, no. 6, pp. 598–614, 2008.

[39] A. Taghipour and J. M. Frayret, "A new heuristic search with local optimization to manage a supply chain," *Meta*, 15, 2011.

[40] A. Taghipour and J.M. Frayret, "Mutual adjustment search with incentive for supply chain planning coordination," *International Journal of Computer Integrated Manufacturing*, vol. 25, no. 10, pp. 946-962, 2012.

[41] A. Taghipour and J. M. Frayret, "Coordination of operations planning in supply chains: a review. *International Journal of Business Performance and Supply Chain Modelling*, vol. 5, no. 3, 272-307, 2013.

[42] A. Taghipour and J. M. Frayret, "Dynamic mutual adjustment search for supply chain operations planning co-ordination," *International Journal of Production Research*, vol. 51, no. 9, pp. 2715-2739, 2013.

[43] A. Taghipour, "A contemporary approach to plan independent logistics actors, in *Proc. Contemporary Approaches and Strategies for Applied Logistics*, pp. 337-364. IGI Global, 2018.

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