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A Review of Profit Allocation Models for the Participants in a Supply Chain

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ABSTRACT

The stability and sustainability of a supply chain system can be affected by the allocation or distribution of profits to its members. Several studies have investigated this issue and proposed various quantitative models. However, no study has summarized the progress and findings of these studies. This study presents a review of the profit allocation models in supply chains. Specifically, this study aimed to identify the factors considered, the most widely used approaches or methods in model development, and research gaps for future research directions. This study applied a literature review of 53 articles were collected and reviewed. The study found that the three factors most widely considered in the studies were the level of risk faced, the resources or investments owned, and the bargaining power of supply chain participants. Cooperative games, together with the Shapley value, are the most widely used approaches or methods for model development. Several research gaps were identified, namely model development based on case studies in real supply chains involving more actors, the use of simulation approaches, and supply chain systems that consider sustainability.

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INTRODUCTION

A supply chain consists of a collection of various participants or members, including suppliers, manufacturers, operators, and retailers, who work directly or indirectly to fulfil customer demand for products (Omri, 2009). Those participants are independent economic entities and act rationally to optimize their profits (J. Gao & Shi, 2010). In an effort to achieve profit, it is possible for there to be a conflict of interest between participants. Therefore, supply chain management (SCM) has one of main tasks to align participants' independent objectives and coordinate their activities toward the optimized supply chain system (Li & Wang, 2007). Moreover, SCM is seen as a concept that can create business strategies and value for its customers (Fiala, 2016).

In SCM perspective, long-term coordination and cooperation among participants can significantly enhance the efficiency and competitive advantage of a supply chain (Fiala, 2016). This is an important strategic decision for supply chain managers (Alahmari et al., 2017). The positive impact of these coordination efforts is to increase total supply chain profit and member welfare (Guardiola et al., 2007). The key to supply chain coordination is a logical and fair profit-distribution scheme (Guangxia et al., 2013). Profit allocation is the accumulated result of all transactions in a supply chain (Zúñiga-Arias et al., 2007). A fair profit allocation is essential for maintaining stability and improving supply chains (Gao and Shi, 2010). It is a significant research topic in SCM because of its impact on the stability and efficiency of the supply chain system (L. Chen et al., 2010; Guangxia et al., 2013; Ren et al., 2015).

Due to the importance of profit allocation in the supply chain from both SCM science and practical perspectives, it is necessary to further understand the progress of research themes in this field. Three research questions were raised to answer this study. First, What factors are considered when determining the profit allocation in the supply chain? Second, What approaches or methods do researchers use to determine profit allocation for supply chain members? Third, What are the directions for future research on this topic of supply chain member profit?

Therefore, this study reviews models of profit allocation in the supply chain. Related to the research question, this study has three objectives: (1) to identify the factors considered by scholars in developing models; (2) to identify the approaches or methods used by scholars in building models; and (3) to identify research gaps as a basis for future studies that will develop the profit allocation models in the supply chain. Although Deng & Li (2017) briefly reviewed the research problem of supply chain profit allocation, their research presentation was limited to a review of the application of the game theory approach. In addition, their presentation is limited to being explained narratively and has not answered the questions raised in this study. This study applies a literature review to answer these research questions. The benefits obtained from the output of this study are that it provides future directions for studies that will develop

supply chain profit allocation models. In addition, there will be practical benefits for business actors to understand the principles of determining fair profit allocation for participants in the supply chain.

METHODOLOGY

This study applies a literature review to answer the research questions raised. The research stages are illustrated in Figure 1.

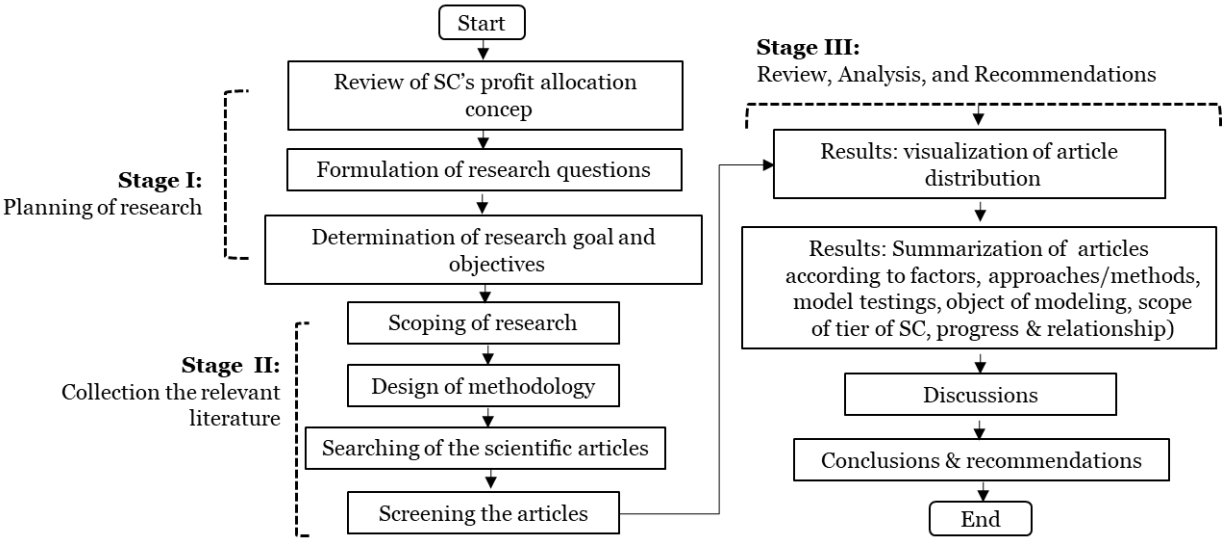

Figure 1. Stages of research

This study is limited to a review of profit allocation or distribution in the supply chain. Other topics that are somewhat similar, such as revenue sharing, are not discussed in this study because they are conceptually different. This study collected and reviewed articles published between 2007 (when the topic of profit allocation in supply chains began to be found on Google Scholar) and 2022 (the year this study was conducted). In addition, articles were searched using ScienceDirect, IEEE Xplore, Emerald Insight, Proquest, and Google Scholar. Articles were carefully selected based on content relevance and quality (peer-reviewed articles in both journals and proceedings). For the identification and collection of articles, several keywords are used including “profit allocation,” "revenue allocation,” "profit distribution,” and "revenue distribution" by adding the "supply chain”. Only articles written in English were included. To ensure that the article fulfilled the quality and relevancy requirements, we selected peer- reviewed articles and screened their content.

RESULTS AND DISCUSSION

Identification and collection of relevant articles.

From the results of the article search process, this study collected 52 relevant articles, both in the form of journal and proceedings articles, as shown in Table 1.

Table 1. List of reviewed articles

Journal articles	Proceedings articles
(Guardiola et al., 2007), (Zúñiga-Arias et al., 2007), (H. Z. Chen et al., 2013), (Q. N. Song, 2013), (Kumoi & Matsubayashi, 2014), (X. Wang et al., 2014), (Wei-qiong, 2014), (X. Wang et al., 2014), (Fiala, 2016), (Ren et al., 2015), (Lv & Qi, 2016), (Ponte et al., 2016), (Hu et al., 2017), (Alahmari et al., 2017), (Anna, 2018), (S. Gu et al., 2018), (Xu et al., 2018), (Prasad et al., 2019), (E. Gao et al., 2019), (F. Wang & Dong, 2019), (X.-X. Zheng et al., 2019), (Asrol et al., 2020), (Sha & Zheng, 2021), (Fei & Li, 2021), (Lyu et al., 2021), (Wei, 2021), (L. Zhang & Guo, 2021), (Maflahah et al., 2021), (J. Song et al., 2021), (F. Gu & Yu, 2022), (Zeng & Yang, 2022), (Dai et al., 2022)	(L. Wang & Zhou, 2008), (Hong & Yanhong, 2008), (Shi & Wu, 2009), (Huo & Liu, 2009), (Yi, 2009), (Wenwei & Jianguo, 2009), (J. Gao & Shi, 2010), (L. Chen et al., 2010), (J. Zheng & Wang, 2011), (Karmperis et al., 2011), (Jiang, 2011), (Yu et al., 2012), (Y. Zhang & Geng, 2012), (Guangxia et al., 2013), (Du, 2015), (Sun et al., 2019), (Sun et al., 2019), (Zhou & Zhu, 2021)

The articles according to publication year are shown in Figure 2. It can be seen that the number fluctuates, but the trend is increasing. The highest frequency is from 2019 to 2022. Thus, it can be concluded that research on the allocation or distribution of profit in supply chains is an active research theme in the field of supply chain management.

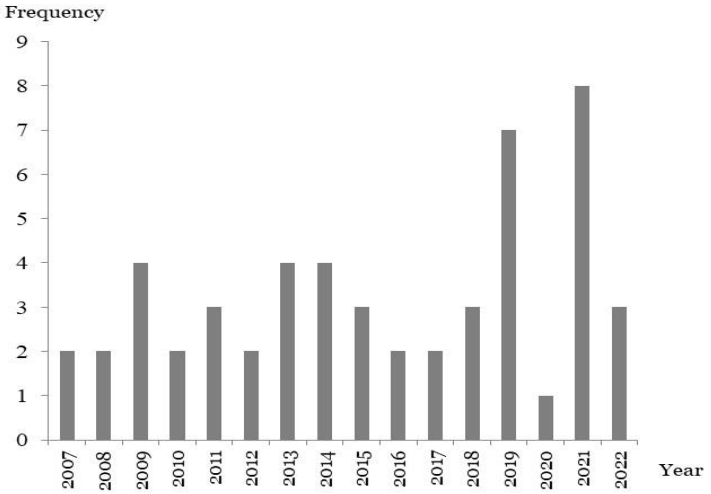

Figure 2. Number of articles by year

The factors considered in the models of profit allocation in supply chain

To answer the first research question regarding what factors scholars consider in developing profit allocation models in the supply chain, see Figure 3.

Figure 3. Considered factors in modeling

Figure 3 shows that the top three factors that are often considered in profit allocation models in the supply chain are: (1) the level of risk faced by participants or members; (2) the amount of investment, resources, or capital input issued by participants; and (3) the bargaining power of participants relative to other participants.

The approaches or methods used in the models of profit allocation in supply chain

To answer the second research question regarding the approach or method used by studies in developing profit allocation models in the supply chain, see Figure 4. It can be seen that the cooperative game approach together with the Shapley value method gained popularity in the development of profit allocation models in the supply chain. Subsequently, in a very wide frequency range, several scholars have used an analytical approach using mathematical models. Other approaches or methods vary widely, including non-cooperative game theory approaches, optimization methods, grey methods, entropy methods, Monte Carlo simulations, and multi-criteria decision- making (MCDM) techniques.

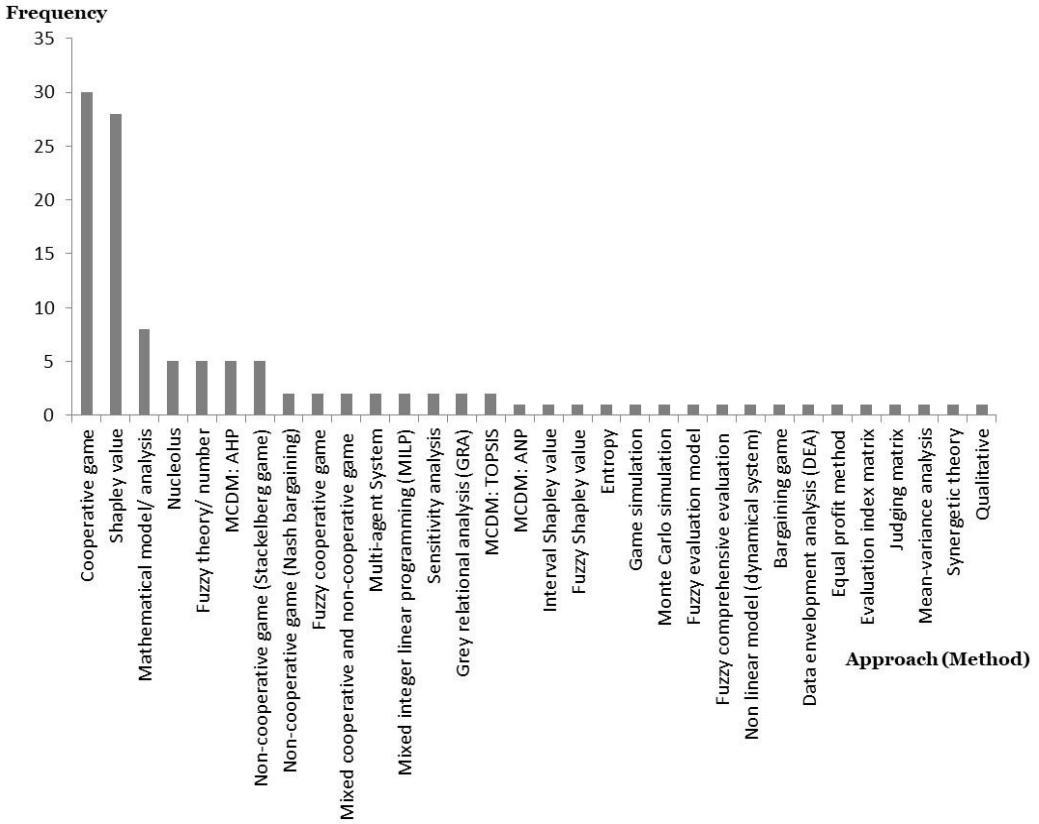

Figure 4. The used approaches in the studies

Identification of research gaps

To identify research gaps from previous studies, we first examine how the models developed using the above approaches or methods are tested. In this case, we can observe in Figure 5.

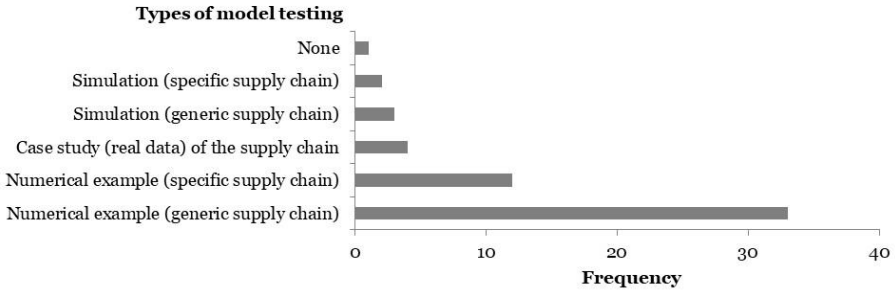

Figure 5. Types of model testing

As can be seen in Figure 5, most scholars conduct numerical model testing through hypothetical data, with most being in the form of a generic supply chain system and some with specific supply chains such as the agricultural or food sector. For details regarding the selected study objects, one can see the graph in Figure 6 .

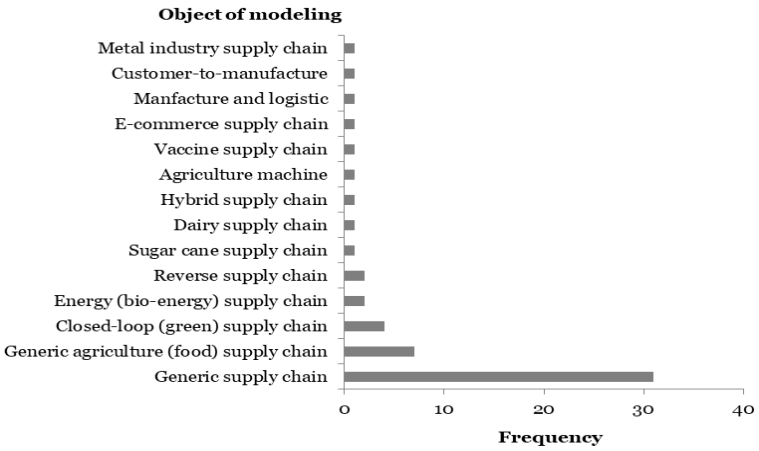

Figure 6. Objects of system modelling

Studies that develop models for certain sectors using both hypothetical and real data are limited. Furthermore, it is necessary to examine the number of actors or supply chain echelons accommodated in the studies, as shown in Figure 7. Most studies have developed models involving two to three supply chain echelons. Those that are more than cover only four echelons.

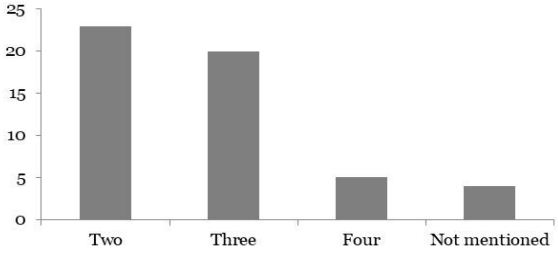

Figure 7. Number or supply chain echelons

Furthermore, by applying text mining to the words in the title and abstract of an article in the VOSviewer application, we can draw a network of developments in studies on this topic over time, as shown in Figure 8.

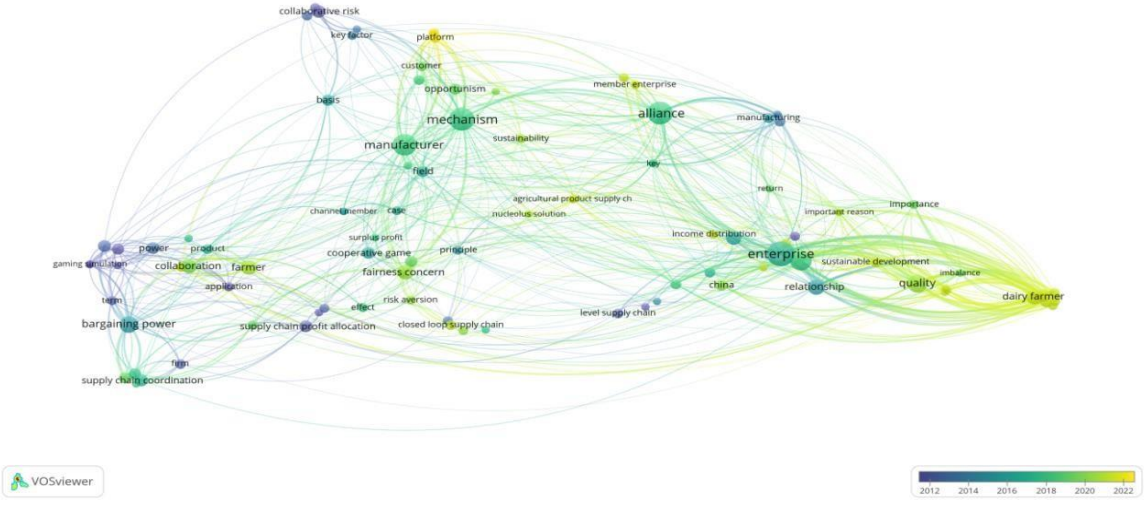

Figure 8. Study network based on the occurrence of words in titles and abstracts

Based on the results of the analysis, through the visualization of several aspects of previous research, several research gaps can be identified as the basis for further research on profit allocation in the supply chain, as follows:

Discussion

Regarding the factors that are taken into consideration in developing a model for determining profit allocation in the supply chain, it was found that the risk level factors faced by participants, the investment level or input factor, and the participant's bargaining power position factor were the most considered in existing studies.

First, in terms of supply chain risk factors, Hu et al., (2015) and Xu et al., (2018) highlighted previous studies that used the Shapley value method in determining profit allocation in the supply chain that did not consider risk factors. This means that each participant is assumed to face the same level of risk, whereas in a real supply chain system, participants are likely to face different levels of risk. When an enterprise (participant) finds a greater risk than the average of other participants, it should obtain a greater profit distribution than the other participants (Wei-qiong, 2014). In their empirical study, Asrol et al., (2020) found that actors in the sugarcane agro-industry supply chain have different risk shares and this is the basis for determining a fair profit allocation.

Second, in terms of investment or input factors, Lyu et al., (2021) defined investment as the basis for a company to carry out economic activities and is an important source of income. Thus, with increasing investment from a supply chain participant, the profit location ratio should also increase. In line with this, ei-qiong, (2014) also stated that if an enterprise invests more capital than others, it should obtain a larger profit distribution. In their study, the input factors included the fixed investment and operating costs. Additionally, it includes start-up capital, human capital, and intangible assets.

Third, in terms of bargaining power factors, Zúñiga-Arias et al., (2007) stated that an agent who can increase his bargaining power will be able to reduce his dependence on other agents. In the context of supplier - customer, Prasad et al., (2019) shown that factors that influence suppliers' bargaining power include the level of importance of raw materials, availability of substitute raw materials, and alternative suppliers. While, the factors that influence customers' bargaining power include the number of buyers, customer-base integration, purchasing power, and availability of substitute raw materials/products. Anwar (2023) and (Anwar et al., (2024) provided an example of an indication of this imbalance in bargaining power in the agro-industry chain sector where downstream actors (i.e. middlemen or buyers) enjoy a higher level of income than upstream actors (i.e. smallholders).

Regarding the approaches or methods for model development, it was found that the cooperative game together with the Shapley value were the most used by the existing studies. Cooperative games (CG) are part of the game theory model of Operations

Research as an approach for analyzing a problem (Guardiola et al., 2007). In contrast to the non-cooperative game (ICG) type, which is based on independent and rational decision making by players, the CG concerns how players form optimal and stable coalitions, including the distribution of profits for coalition members (Fiala, 2016). The Shapley value in this context is a solution method in CG to distribute or allocate profits among participants in the supply chain (Guangxia et al., 2013). For details on the formulation of the CG model and Shapley values, readers can refer to the articles reviewed in this study, including Wei-qiong, (2014), Ren et al., (2015), Alahmari et al., (2017), Xu et al., (2018), Zheng & Wang, (2011), and Maflahah et al., (2021). Other approaches or methods that are limited in number are not discussed in this paper, and readers can refer directly to the articles listed in the References section.

Finally, future research directions regarding the development of profit allocation models in supply chains can be provided by filling in the research gaps identified from the visual displays in the previous subsection. First, most studies test their models in general supply chain systems and are limited to supply chains with two or three participants from different supply chain tiers. Studies that consider case studies (real supply chains) in certain sectors, such as agriculture and food, for model testing are still very limited. Second, most studies use a numerical approach (dominantly using the CG approach and the Shapley value method] for model development, and there are still few studies that use a simulation approach. Third, profit allocation models that take into account sustainable supply chain systems, including green, reverse, and closed supply chains, are still limited and have only emerged in the last few years.

CONCLUSION

The allocation and distribution of profits to participants is an important aspect that determines the stability and survival of a supply chain system. This paper reviews the development of research in this field. This study considers three factors that researchers mostly consider in developing models: the level of risk exposure faced by actors, the amount of investment or resources owned by actors, and the bargaining position of actors in the supply chain. Cooperative games with Shapley values are the most widely used approach or method by researchers to develop models to determine the optimality of coalitions and profit distribution for supply chain members. The next research direction is the development of a model based on case studies in real supply chains involving more actors, the use of simulation approaches, and supply chain objects that consider sustainability. This study has several limitations in several respects, including not covering the supply chain allocation model in sectors unrelated to manufacturing. In addition, this study does not discuss the literature on the theme of revenue, because it has different definitions.

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