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Game Theoretical-Based Logistics Costs Analysis: A Review

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ABSTRACT

As the range and complexity of outsourced services for logistics increase, Logistics has evolved into a distinct commercial service. The question of how to fairly charge logistics services has grown urgent. In this study, we conduct a comprehensive evaluation of the academic research on the cost of logistics services employing bibliometric and analyzing the content methodologies, with a focus on the application of game theory. Using three criteria logistics situations, game models, and influencing factors, we contrast and evaluate the research. This research examines the important stakeholders and research situations in logistics pricing examine the most suitable and often utilized game models, as well as highlights the primary elements determining logistics pricing. To close the gaps in our current understanding, we offer potential study directions. The present level of evidence-based study in the area of price for logistics is thoroughly reviewed in this work, this contributes to the creation of new models. From a pricing perspective, the results of this investigation are helpful in the advancement of logistics services, as a result, logistical activities will be more economical as well as environmentally sustainable.

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1. INTRODUCTION

To reduce costs, companies outsource their logistics functions to suppliers of logistical services and as a result of continued economic globalization promotion, efficiency will increase [1]. Third-party logistics and fourth-party logistics are ideas that developed in 1989 and they have received a great deal of attention as well as research from academics in the field [2]. To offer its customers customized handling, shipping, as well as additional services, a great number of logistics businesses have also appeared on the market [3]. In 2019's third-

party logistics report, outsourcing accounted for 34% of warehouse operations costs and 53% of shippers' transportation expenses [4]. Logistics activities have become a separate market service due to the expansion of logistics outsourcing, and how setting acceptable prices has become a major problem [5]. Pricing is the essential competitive component in the market [6]. Pricing for logistics services can be thought of as the exchange of prices between upstream and downstream suppliers [7]. Logistics pricing is distinct from product pricing in a supply chain because it is associated with the service business [3]. These two types have distinct origins and methods for producing and distributing system advantages [8]. Logistics operations' financial and environmental sustainability can be increased with a balanced as well as appropriate estimate of the cost of logistical services [9].

Because of the complexities of logistical operations, In recent years, scholars have honed in on ever more specific issues for their research [10]. Numerous review studies have been conducted that concentrate on individual logistical links or specific types of logistics activities, such as urban logistics, cold chain logistics, logistics location, reverse logistics, and others [11]. There are extensive literature evaluations on each of these topics that can be utilized as references [12]. Our study of review articles on logistics reveals that the systematic research that is currently being done on the price of logistics services still has certain shortcomings [3]. In addition to reviewing the pertinent literature, Jorge broadened their study of industrial service pricing to include third-party logistics service pricing [13]. Their research, on the other hand, emphasizes the parallels, contrasts including logistical and industrial cost of services [14]. According to the research findings, the majority of TPL pricing studies are descriptive and lack empirical data [15].

Recently, there has been an increase in interest in the cost of logistics services [9]. Several empirical research on logistics pricing has developed [16]. Despite the growing number of papers in this field, systematic and up-to-date research is still lacking [17]. There is a dearth of an overview of the present research status and research techniques, particularly in the topic of price for logistical evidence-based study [14]. The concept of game theory is one of the key study methodologies after examining the latest research on pricing for logistics services. Theorizing games, a traditional technique in economics, is commonly applied in coordination and price problems [6]. Several parties are engaged, particularly in supply chain and logistical settings, as well as its pricing procedure, which is the product of a profit-seeking game between the parties. The participants, influencing circumstances, and model development hold the key to pricing challenges [18]. This research examines logistics price using game theory using bibliometric and content analysis approaches. Three criteria are used to analyze the literature influencing factors, game models, and logistical scenarios [19]. We aspire to contribute both scientifically and practically, through an examination of the literature that identifies how to price decisions are made and how they are built for logistics pricing [20]. The goal of this work is to give logistic pricing researchers scientifically and practically confirmed strategies for creating new game models [21]. Furthermore, by evaluating recent literature on logistics pricing, this works a thorough as well as critical analysis assessment to make the existing situation clear about the status of empirical studies in the area, forecast tendencies in future research, as well as close inconsistencies in systematic study in this field.

The remaining portions of the document are organized as seen below. Chapter 2 presents a quick overview of game theory. The study technique is defined in Section 3, which includes the study's inquiries, and keywords, as well as book selection standards. The writing is categorized in Section 4 along with a thorough discussion of the study. Chapter 5 describes the study status as well as highlights the study's findings. Section 6 describes the findings and recommendations for future research.

LITERATURE REVIEW

Research into mathematical simulations of rational beings' tactical encounters is known as game theory. It has uses in computer science, logic, systems science, and all branches of social science [22]. It first focused on two-player zero-sum games, wherein each player's gains or losses are precisely contrasted with those of the competing players [23]. Game theory is a broad word that refers to the study of rational judgment in people, animals, as well as computers in the twenty-first century [24]. It is applicable to several different behavioral relationships [25].

John von Neumann's proof of the concept of mixed-strategy equilibria in a two-player zero-sum game marked the beginning of contemporary game theory [26]. Continual mappings into compact convex sets: The Brouwer fixed-point theorem, that evolved into a fundamental approach to mathematical economics and game theory, was utilized in Von Neumann's original demonstration [22]. Following his study, Oskar Morgenstern and him co-authored the 1944 book Theory of Games and Economic Behavior, which examined cooperative games involving multiple players [27]. This book's second edition offered a presuppositional theory of predicted utility that enabled economists and statisticians to study decision-making in the face of uncertainty [28].

Many scholars worked intensively on game theory in the 1950s. It was formally 1970s application to evolution, however analogous processes may be traced back to at least the 1930s [29]. Game theory has long been acknowledged as a valuable tool in a variety of fields. Paul Milgrom and Robert B. Wilson, two game theorists, will receive the 2020 Nobel Memorial Prize in Economic Sciences, making a total of fifteen game theorists to have received this honor. The Crafoord Prize was granted to John Maynard Smith for his use of theoretical Game Theory of Evolution [30].

2. THE COMPREHENSIVE THEORETICAL BASIS

2.1. Game Theory

In 1944, John Von Neumann and Oskar Morgenstern Game Theory and Economic Behavior was released, which served as the foundation for the growth based on a structured game theory. A series of cooperative or combative antagonistic behaviors whenever two or more logical people or groups engage. The players in a game have various objectives or interests while also being constrained by a set of rules and environmental restrictions. The best course of action for each player must be chosen by taking into account all of their opponent's potential moves. Based on how participants operate in succession and how much knowledge they have, there are various types of game theory. Additionally, it is now frequently employed in many different disciplines, such as economics, sociology, computer science, and international relations, among others.

1. Player: The subject in a game known as the "player" is one who has the ability to make the best option in order to maximize their own utility. This subject may be an individual or a group, such as a nation, business, organization, etc. participant will be used from now on.
2. Strategy: The tactic is the participant's guideline while deciding what action to take in what circumstance.
3. Utility function: The practical purpose, which reflects the players' expectations about the outcome, measures the utility that the game's participants can derive from it. Economics mandates the necessity of utility functions quantified and can either be constant functions or subtle functions. Utilities can have a positive or negative value. The utility functions of each player in the game are unique, but they are not always known to one another.

3. METHOD

3.1. Research Method

The systematic literature review method was used to assure the study's objectivity outcomes as well as regarding the study's ability to be replicated. This study presents a thorough assessment of recent game theory-based research on logistics pricing. This study's research technique is divided into three parts: the selection as well as evaluation of relevant papers, and research assessment as well as synthesis. When it first started, the objectives of the literature review and the research questions were determined, after which a software for searching the literature was created to establish Including as well as excluding standards for the written word. The following phase involved quantitative and descriptive analysis of the screened material before the literature was rated and categorized in accordance with the research questions. A complete review of the literature was carried out in the third step. To find future research trends, the two bibliometric techniques and methodologies will employ review as well as analysis of the literature as well as the shortcomings of previous study.

As previously said, logistics service price is a significant factor that impacts the long-term viability of logistics outsourcing. We established three primary research questions after identifying the necessity for such a study and the research gaps (QE1, QE2, and RE3):

QE1: Which of the primary participants in logistics service pricing, as well as the essential research scenarios?
QE2: What gaming platforms as well as strategies are the best suitable for pricing logistical services?
QE3: Which of the primary as well as most essential aspects influencing logistics service pricing?

We did a thorough analysis of academic articles on the subject of logistics pricing to address the research issues. The inclusion and exclusion bias of researchers is reduced by clear article selection criteria, which also increases the data's variability. As a result, we devised a strategy for conducting a review of the literature as well as established criteria for acceptance as well as exclusion. The majority of the written word sourced SCOPUS and Web of Science databases, which are at the forefront as well as comprehensive reference lists covering the majority about the logistics price writing. 397 documents were found when we conducted a subject search in the database using those keyphrases "logistics," "game theory," as well as "price." In a two-step screening procedure, the papers were assessed and chosen. Following a thorough analysis of the articles' titles, abstracts, and keywords by the inclusion and exclusion criteria, 121 publications were deemed pertinent to the topic. Second, we read their full text before conducting an exhaustive reference search using identical standards for inclusion and exclusion. In the end, The 57 documents were chosen for this study's analysis. Figure 1 depicts the literature selection procedure, including every writer participating throughout the joint evaluation. Table 1 shows the literature's criterion for inclusion as well as exclusion. We specifically stated that the logistics price should be the game model's decision variable and be endogenous by the goal of the literature review. Following a thorough review, much of the literature was removed because it did not meet this requirement.

47 journals published a total of 57 publications from various sources in total. Nine journals contain beyond two documents in the sample, utilizing Switzerland Sustainability placing the initial round with three articles. Regarding the date of publishing, the initial work found was released in 2006 in Operational Research Society Journal. Then there were intermittent peaks. 2008 saw the publication of four publications, subsequent years saw fewer studies published, and 2013 saw another high. Overall, the number of publications

published grew dramatically after 2016, with 38 papers released. 10 publications will be published in 2021, including seven this year (as of July). This demonstrates how logistics pricing is becoming more and more popular in literature. Figures 2 and 3 show the article's origin publishing as well as quantity of papers.

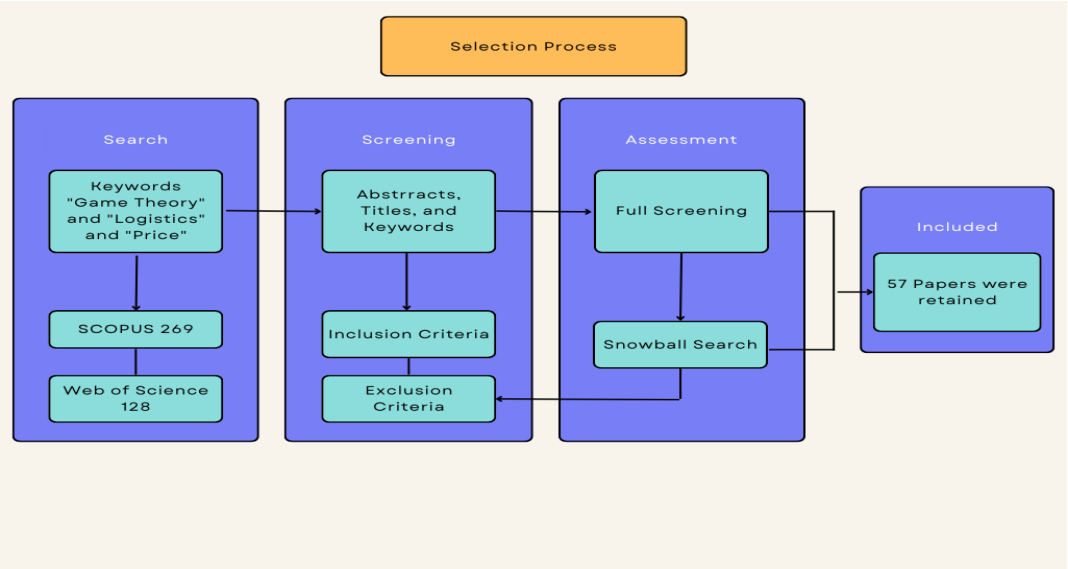

Figure 1. The procedure for selecting literature.

Table 1. Criteria for inclusion and removal.

Criteria for Inclusion	Exclusion for Criteria
English language.	Non-English language.
Complete journal articles and conference proceedings.	Lectures, policy documents, presentations, and gray literature.
The logistics price is an endogenous decision variable in the system.	Logistics cost is an external variable.
The game theory method utilized to research logistics price.	The study just cites Game theory, pricing, or logistics as among the crucial components, no detailed analysis or research is conducted.
Peer-reviewed.	Not peer-reviewed.

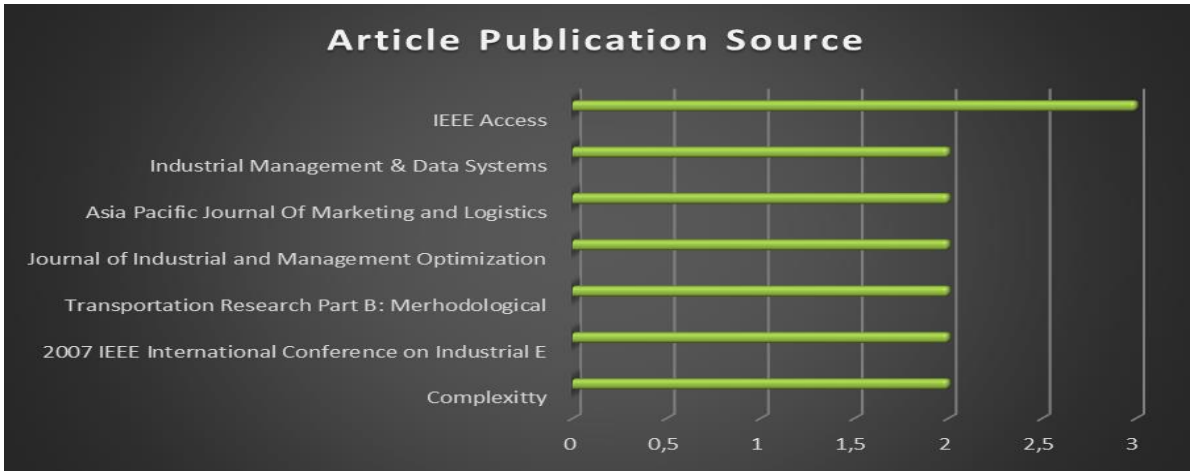

Figure 2. Article publication source.

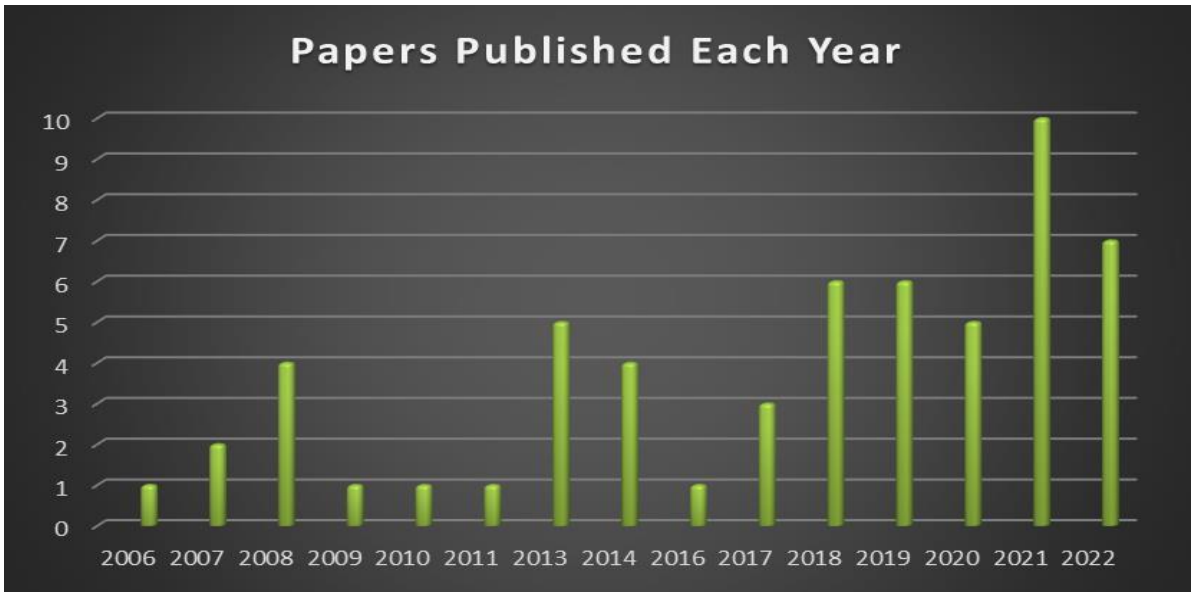

Figure 3. Papers are published each year.

3.2. Classifying and Analyzing the Literature

Content analysis was utilized as a way to conduct an observational study to examine the corpus from the literary systematically. In this section, we perform a detailed assessment of the chosen literary works using the content analysis method, explain the present research's situation, as well as analyze the impact of the literature that is already out there. We categorize and analyze the literature for the research issues in three primary dimensions: logistical scenarios, game approaches, and influencing factors.

1) Logistical Case Studies

There is current logistics across the whole manufacturing as well as the method of distribution, from company production to home consumption. In diverse circumstances, customers, participants' behavior methods, and its influence elements of logistical operations will alter, influencing the construction and study of pricing models. The literature is categorized into groups based on the research situations, including price of logistics

platforms, crowdsourcing logistics, third-party logistics, freight logistics, logistics for the cold chain and reversal logistics.

A significant portion of the literature (48%) focuses on the pricing issue facing third-party logistics providers (TPLs). The majority of scholars recognize the TPLs' price issues in the supply chain system and develop pricing models for TPLs and manufacturers or TPLs and retailers. Some publications develop a three-tier pricing structure made up of retailers, manufacturers, and TPLs based on this theory. Furthermore, as the demand for logistics has grown, the industry has gotten more competitive. Scholars have devised the competitiveness aspect to evaluate TPL price in a competitive market. Meanwhile, experts propose logistics business collaboration due to the high externalities of logistics networks. In several academic studies, the pricing tactics and service standards of two TPLs are examined in both autonomous and collaborative decision-making. The findings demonstrate that the price equilibrium under collaborative decisions boosts system profit while simultaneously enhancing service quality. A portion of the literature looks into the price challenge of an additional chain of logistics-related services made up the logistical support integrator as well as an effective provider of logistical services. LSI and FLSP cost and capacity sourcing inside the LSSC are the topic of these investigations. In contrast, Teresa Ralustic looked at the costing issue in a four-level supply chain that involved manufacturers, retailers, and a two-level LSSC. This is an intriguing concept, but there have been no analogous investigations. Furthermore, Teresa al. talked about how much logistics services cost between centralized distribution facilities run by the parent company and its subsidiaries. Fredrin colleagues investigated a three-tiered supply chain for logistics comprising a courier company, an online store, providing end-delivery services. Express firms and terminal-express service providers have gained extensive attention in last-mile delivery studies, however the price technique they use has not been thoroughly studied.

Freight logistics price is another thoroughly analyzed scenario. For statistical purposes, freight logistics include land, air, and shipping. With alternative pricing schemes depending on service quality, Darla examined the correlation of transportation service rates as well as service excellence in the road freight business. The air-cargo transport pricing problem was proposed by Antoine, and others, who incorporated risk attitudes into optimal price decisions. Cooperation among freight forwarders has grown in popularity as a result of the concept of sustainability. Several studies have been conducted to determine the best option for freight transportation under a two-level logistics paradigm. Sharon et al. investigated a supply-chain pricing model in which short-distance and long-distance logistics service providers (LSP) collaborate to deliver differentiated logistical services. As a result of its environmental friendliness, the pricing of multimodal transportation has also gained attention. In the existence of multimodal service providers as well as a single direct transportation system, Jason et al. discovered a price challenge in the competitive freight transportation sector. Furthermore, numerous academics have examined container freight price, particularly in port logistics.

The demand for cold chain logistics has grown in tandem with the advancement of e-commerce and agricultural technology. For optimum freshness and a low loss rate, fresh agricultural products require cold chain logistics, unlike other commodities. E-commerce enterprises play a vital role in the cold chain logistics pricing landscape. Agricultural supply-chain pricing model with three stages farmers, chilly chain LSPs, as well as electronic commerce enterprises has been researched by certain researchers. In a pre-sale situation, Jade et al. studied the best the cost of logistics services for a supply chain with three stages that was predominately made up of agricultural product producers. On the other hand, other researchers have looked at a three-stage B2C pricing model that includes customers, e-commerce companies, and cold chain LSPs. Furthermore, a brand-new businesses to

businesses supply-chain pricing model comprised of manufacturers, merchants, and TPLs was researched. Furthermore, some articles have investigated a two-stage pricing approach for logistics companies and merchants.

Another situation for pricing research is reverse logistics (RL). Reverse logistics refers to the process of moving about physically from the point use of products to the point of product manufacturing between logistics members. A number of various reverse logistics business structures. The three models that the participants identified are recycling from manufacturers, retailers, and LSPs. The first and second reuse of models, logistical undertakings are performed from manufacturers also merchants, as well as solely Costs associated with logistics must be evaluated, with no regard for logistics service price. As a result, only use investigated reversal logistics partnerships to recycle LSP. Fan brought up the issue with recycling unaffiliated logistics pricing. Meave Holy investigated the costing for medicine producers as well as 3PLs in the context of a drug take-back program. Academic interest has been drawn to pricing in the supply chain using a two channels dilemma involving producers, merchants, as well as third-party logistics providers (TPLs). Camila Becker, for example, contends that the manufacturer controls this pricing structure, but Latisha et al. contend that the merchant dominates. Kieren et al., on the other hand, investigated In a dual-channel supply chain, price and return policy decisions in centralized and decentralized situations. Furthermore, several researchers established recyclers as an idea, which are in charge of obtaining second-hand goods from customers.

Furthermore, crowdsourcing logistics supplies logistics companies innovative concepts for long-term growth. Logistics crowdsourcing is a new third-party distribution approach that uses an Internet platform to outsource distribution as well as logistics tasks to mass service personnel who are socially apathetic. Prices for crowdsourcing services are essential. Several research on this subject have been undertaken by academics. Claire et al. suggested an efficient cost structure for in times of peak demand, crowdsourced logistics services are subject to price rivalry during distribution, taking into account socialization's variable distribution capacity. The best pricing method for crowdsourced logistics services was further investigated by Sullivan based on two scenarios: cumulative delivery-order minima under stochastic demand and supply-demand equilibrium.

Numerous platforms for logistical information have appeared to offer internet services and applications for logistics, and as a result of The logistical industry has developed quickly as well as the advancement of information technologies, the pricing issue for new logistics services has also grown. Based on the bargaining approach of game theory, Wesley et al. offered the best pricing decision of a logistics-software customisation service. A three-story price system for supply chain management was developed by Qin and Juan after they researched the price issue of an intelligent cloud network for logistics. Yu as well as Ji used game theory to develop an information platform for local logistics that uses a two-step pricing system. Hou et al. explored the ideal price competing platforms for logistical services by incorporating user distance preferences into the pricing decision.

2) Game Methods

The study of gaming models for price is quite mature, as well as numerous classical game approaches have emerged as a result of years of game theory research and development. The fundamental model is typically built on stringent assumptions, and the gaming method selected has a direct impact on the price results. The choice of game method is critical in the research of logistics service pricing. Some scientists have increasingly begun to modify some

hypotheses incorporated in conventional models in order to bring the research more in line with reality. As a result, this paragraph examines the literature's use of gaming mechanics.

The Stackelberg leadership model has been adopted by the majority of researchers in the study of logistics pricing. Price leadership is a concept used in the Stackelberg model in which both parties compete in a market with asymmetrical information with a different order of action. It is expected in the Stackelberg game that Stackelberg's game person 1 (captain) selects his pricing policy v1 first, as well as person 2 (follower) watches v1 before determining his pricing policy v2. That is situation, person 1 (the captain) having the advantage of being the first since can calculate his work that maximizes his profits depending on player 2's response performance (follower). Person 2 looks at v1 after that decides on his pricing policy, therefore v1 determines v2 and a mapping function link exists, i.e., v1 v2. LSPs typically operate as price takers in a supply chain and do not have pricing precedence. As a result, academics employ a game of Stackelberg to investigate the issue of supply-chain pricing with LSP involvement. For example, Gillian et al. investigated the price decisions made by a closed-loop supply chain with three levels of producers, retailers dominated TPLs, followed by them. However, due to market imperfections in real-world circumstances, cold chain LSPs might increase their market share in the fresh supply chain by increasing the core of their capabilities. As a result, some researchers developed a pricing scheme for the supply chain in which chilled-chain LSPs are the leaders. Because LSIs are typically in the lead in the logistics service supply chain (LSSC), scholars frequently employ the Stackelberg game to investigate their pricing challenge. Dunkley and colleagues proposed a two-stage LSSC pricing model, with the second stage characterized by a surge in market demand. They reduced the incapacity to meet market demand caused by LSI's overconfidence by modifying the dominating mechanism of the Stackelberg game. Furthermore, they analyzed how pricing strategy and logistics loss preference are affected by each other creating four-game situations to achieve the maximum payoff price a plan for making decisions. Additionally, academics have utilized the game of Stackelberg to investigate the price under competition of LSPs situations. Kailum investigated new entrants' distribution decisions and optimal pricing as soon as there was only one market participant offering logistics services. Furthermore, based on the Steinberg game model, several researchers have proposed other prices coordination tactics, for instance, revenue-sharing plans, combination strategies, cost-sharing methods, and unit-delivery price agreements.

The Bertrand model is also extensively employed in costings for logistics services. It is a pricing competition model that takes pride in being a decision variable. Model Bertrand presumes that person offers standardized services with identical marginal expenses. The competitors compete with setting their own pricing. When there is a fluctuating need for logistical services, Shino Houka explored Bertrand pricing rivalry between two crowdsourcing logistics service companies. According to the study, the lower the finest crowdsourcing logistics service pricing, the more intense the competition. Kayden investigated two express businesses' price wars in the context of online shopping, the findings revealed that cost rivalry among uniform businesses leads to the company's non-profitability.

Furthermore, some academics have used bargaining theory to the price problem of logistical services. A bargaining game is when two or more participants negotiate a solution to the benefit distribution problem. The players agree on a minimum acceptable cost as well as a highest amount already paid, then, using a predetermined pricing policy, each side contributes up until a Nash equilibrium is reached. To examine the outsourcing pricing choice between manufacturers and TPLs, Karl built a bilateral bargaining model incorporating switching costs. Aaron et al. created a price model based on game theory bargaining. To determine the ideal pricing approach for a logistics software customisation service, a three-round negotiating backward regression computation is used. Wickens used

the Rubinstein bargaining model to investigate price in an intelligent system of a logistics cloud network. Nate et al. investigated a fresh-food supply chain's best logistics price under various replenishment techniques using the Generalized Nash Bargaining (GNB) paradigm. The bargaining game can be used in discussions with complex negotiation situations. Rubinstein's bartering model as well as the Nash bartering model for example, can be viewed as a cooperative gaming process.

We discovered during the review of the literature that some academics used bilevel programming for the price. Bilevel instruction is a two-level recursive difficulty with system optimization, its personal choice variables, restrictions, as well as primary functions. When selecting the best option to attain the target, a decision-maker in a higher position must evaluate the potential negative consequences of the lower-level decision maker's strategy. Simultaneously, the lower-level decision maker must use the upper-level choice as a parameter and select the best option within this range. As a result, dynamic game issues with limitations can be described using bilevel programming. Using this method, we classify price concerns grouped together. Michaela Frank suggested programs on two levels to describe the match connection with a logistical integrator as well as a subcontractor's vendor. Their higher-level goal decreases the LSP's entire price, while their low-level goal maximizes the subcontracting supplier's service excellence overall. Marlen et al. developed a Bilevel programming pricing model after researching the cost between logistical services, a centrally located distribution facility administered by a subsidiary and the corporate headquarters. Final result demonstrates that the price structure for bilevel programming increases the head office's profit while increasing the subsidiary's logistical costs up to a point. Programming on two levels investigates the deliberate actions of the intended audience using one particular optimization issue, allowing for greater flexibility and realism in predicted demand than traditional utilizing demand. Although there are currently few studies on the cost of logistics that use this strategy.

Scholars have employed different dynamic game approaches for logistics pricing in addition to the conventional game methods described above, depending on their research settings. They are placed here for the purpose of analysis grouped together, regarding additional dynamic games. Following the creation of a dynamic game model, some researchers solved it using the reverse induction method. Furthermore, Caera et al. used the Hotelling paradigm to investigate the price policies of platforms providing logistics services that face competing as well as have different user distance preferences. Using optimal control theory, Carla developed an efficient dynamic pricing model for crowdsourced logistics services.

Because game pricing models are typically constrained, their relevant conditions are limited. Some scholars have employed various game approaches rather than a single game approach to address complex pricing problems. Much research has been conducted on the comparative examination of centralized control over logistics decision-making versus decentralized circumstances. Generally speaking, centralizing decision-making can reach Pareto efficiency, but it is difficult to achieve in practice due to the severe constraints placed on supply-chain actors. When everything is distributed, some study has thoroughly examined the impact of various power arrangements on the ideal pricing pertaining to the supply chain system. For instance, in a two-channel supply chain study by Britney et al. pricing and return decisions were examined either centralized or decentralized (Nash game), as well as scenarios where vendors have a monopoly, supremacy of retailers, as well as TPL supremacy (Stackelberg game). Pareto improvements in supply-chain systems, some research propose coordination contracts based on decentralized decision-making. For instance, Tyron et al. presented two coordination contracts, contracts with unilateral cost as well as profit-sharing

as well as combined rebate and profit-sharing agreements, based on the principle of decentralized decision-making of fresh produce for agriculture (CR&RS). Furthermore, for pricing studies, academics have utilized both cooperative and non-cooperative games. When pricing logistics platforms, Margaret, for example, offered a price Stackelberg-inspired model as well as the theory of negotiation. Furthermore, according to distinct research settings, several researchers have discussed a range of competitive game models. For freight carriers and shippers, Gordon et al. examined a two-level logistics model and developed price models for three rival games, Stackelberg, Collusion, and Cournot. The Stackelberg game was proven to optimize method profit whereas the game of collusion maximized shipper revenue.

3) Influential Factors

The selection of influencing elements for the pricing of logistics services is critical when building a game model. We derive the explanatory elements for the literature review based on each model's intended audience publication then finally classify them into a single group. The game theory-based pricing scheme for logistics takes into account the subsequent aspects: Indicators of cost, service, risk, competition, and sustainability, among other considerations.

The majority of essential aspects influencing logistics pricing is cost. Scholars explored various expenses based on the model design. The most-considered expense category is logistics services. Some studies separate logistics expenses further into transportation costs, warehouse costs, management costs, and so forth. Logistics service expenses for cold chain logistics firms also include refrigeration or preservation expenditures. Some of them include the preservation work is a constant, as well as a quadratic relationship exists between preservation effort and preservation expense. Some academics divide logistics expenses by the costs that are variable and fixed. In their research on crowdsourcing logistics pricing, Diogo, for example, separated logistical service costs from fixed charges as well as unit remuneration of assistance people. They also evaluated the influence of delivery riders salary ratios, the cost and platforms of logistics predicted income. When researching aircraft logistics, Shinn et al. separated logistics service costs into fixed and uncertain costs, with the unknowable expense influenced by oil price, weather, as well as other factors. Some researchers discuss the LSP's investment costs, which change depending on the logistics service efforts, which were made to raise the level of logistical services. Scholars also analyze different expenses in relation to specific logistics scenarios. According to Lewie, the cost of order loss for crowdsourced logistics refers to the loss of orders from the platform's service for crowdsourced logistics as a result of the social delivery staff's low capability for providing adequate service. Because order loss costs exist, platforms for crowdsourced logistics services change the pricing when there is a need for logistical services and inadequate the need for social services professionals in order to encourage the expansion of social delivery services. When social part-time delivery people refuse orders, Earl et al. calculate cost of unit loss for the platform providing crowdsourced logistics services. Furthermore, Cathrine advocated switching costs, or the expenditures that producers must incur when looking for logistical partners. Shan et al. investigated the cost of delays caused by TPL's failure to deliver items on schedule. Johanna evaluated the pricing of logistics-information platform services, they took the platform's running costs into account. Ellie Myra investigated the green investment cost that TPL must bear in order to lessen its environmental effect. Xavier et al. analyzed the price of developing a technique for tracking the safety of a new chain of supplies.

Another important component influencing logistics cost is the service indicator. Some academics think that the level of logistical service will influence market demand, which would subsequently influence LSPs' optimal pricing decisions. According to Fuller research, varied

pricing schemes for different service qualities benefit not only freight company profitability but also service quality improvement. Hayden et al. also assessed crowdsourcing supply chain management companies' service quality. The distinction includes the standard of service component in determining the pricing logistical services. A greater level of logistical support implies that firms would expend more logistics service efforts, which will result in service expenses. As a result, some researchers argue how well logistics services are provided would affect other than just market demand, besides logistics service costs. Some academics have concentrated their research on a particular metric of service quality. Giacomo et al., for example, evaluated delivery speed to assess logistics providers' service quality. Marius evaluated the service quality of cold chain logistics firms based on their freshness level. The quality of the logistics service is influenced by a wide range of variables, and the value of the service degree of quality is a vector with several dimensions due to the complexity of the service indicators. As a result, computation it is possible to use techniques like hierarchical analysis, fuzzy, and gray analysis.. To gauge the level of customer service offered by subcontracted logistics service providers, Lukas et al. introduced the synthetically expressive degree (SED). They initially utilized an undefined rough set to decrease an early warning system to acquire the most crucial indicators and their weights because SED is influenced by a number of variables and there may be redundant indicators. They next computed the level of service provided by each outsourced logistics provider. Furthermore, Nimra incorporated quality defect rate for logistics services into the analysis, expressing the likelihood that FLSP's superior logistics services falls short of the client's expectations. It is worth noting that some research consider degree of logistical service to be a choice variable in the pricing model.

If not explicitly stated, each participant's preferred level of risk in the simulation game is typically neutral. When determining pricing decisions, some academics weighed risk. When researching the pricing of TPL, Warren et al. took risk preference into account. They came to the conclusion that supply-chain participants' risk preferences are influenced not only by retailer price but also by consumer demand. Ammara Raphta evaluated two risk-averse air freight companies' ideal pricing choices under market conditions. They used mean-variance theory to describe decision-makers' risk aversion. The findings reveal that risk preference has an impact on optimal prices both directly and indirectly. As a result, risk concerns must be considered while making optimal price selections. Preciously built LSI and LSP are in a three-player game format with distinct risk inclinations to study how LSSC makes decisions while coping with a green supply chain's system risk (optimistic, pessimistic, neutral).

Additionally, we looked into how sustainability parameters affected logistics pricing choices. Sustainability indicators are indicators that aid in the promotion of long-term growth of logistics-related activity in the three areas of society, economics, and ecology, as well as the reduction of detrimental externalities associated with logistical activities. The detrimental effects of logistics include primarily manifested in environmental harm during the procedures for storage, packing, and shipping goods, for instance, increased carbon emissions and noise pollution. In the previous years, an increasing number of research have included sustainability indices in pricing models. For instance, in their research, some academics have taken the greenness of logistics services into account. Charlie, for example, believed that the amount of green services in logistics influences not just the market's needs, but logistical costs. Bernard et al. investigated the optimal amount of LSP-design and LSP-delivery green innovation in LSSC. Some researchers have studied the impact of carbon emissions to promote environmental sustainability and increase transportation energy efficiency. Nerd et al. investigated the fresh-food supply chain in the context of carbon cap-and-trade regulations, taking into account the trading price of carbon emission permits. Khein et al.

suggested introducing gasoline taxes into the freight pricing system through government involvement. Performance in terms of corporate responsibility, demand elasticity for CSR and low-carbon goods and services were all examined by Jakub in relation to LSSC. Furthermore, some academics investigated government subsidies or government sanctions for reverse logistics pricing. Chen et al. explored consumer environmental awareness. As consumer environmental consciousness grows, so will the recycling of used products.

Scholars have looked into various other signs, in addition to the ones mentioned above. For instance, Lero et al. analyzed consumers' preferences for logistics service platforms based on spatial distance. They contended customer sensitivity to spatial distance since the greater the distance, longer wait times for services. Thalia George assessed LSP's repute and duration. They anticipated that consumers would prefer LSPs with a higher reputation or that had been in business for a longer period of time. Liu et al. hypothesized that LSSC members prefer loss aversion. Husein Alphonso also specified a random variable with a probability density function, the severity of product flaws f (.) in addition to a cumulative distribution function f. (.). Zhang et al. examined the impact of financing interest rates on TPL pricing decisions using financing services.

4. RESULTS AND DISCUSSION

The above three views can be used to assess the study on the price of game-theoretic logistics services. In terms of bibliometric analysis, this part employs statistical approaches research to discuss findings of both tendencies.

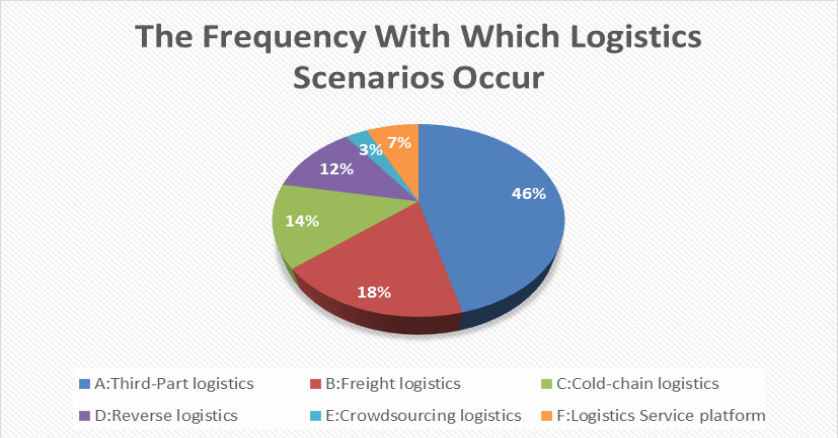

Figure 4. The frequency with which logistics scenarios occur.

The percentage of literature for each logistical scenario is depicted in Figure 4. TPLs (46%), freight logistics (18%), cold chain logistics (14%), and reverse logistics (12%) are the most popular research scenarios for logistics price. The study of TPL pricing decisions is mostly centered on a two- or three-tier supply-chain structure consisting of suppliers, third-party logistics providers, and manufacturers. Furthermore, price issues with a supply chain for logistics services constituted of LSI and FLSP is a hot subject, particularly LSI and FLSP's internal pricing decisions. Research in the future should focus on the price strategy of LSSC throughout multilayer supply networks made of producers and suppliers, as well as the pricing policy of 3PL in marketplaces with intense competition. Scholars When it comes to freight logistics, they are increasingly apprehensive about the cooperative rate of road freight forwarders and the difficulty in determining prices for multimodal transportation. We can keep concentrating on these things in the future multimodal transportation pricing policy, particularly certain revolutionary multimodal transportation techniques, as well as the comparison among multimodal parties working separately as well as collaboratively.

Furthermore, with the advancement of global economization, the price of a method of flying travel merits greater consideration. Logistics in the cold chain and logistics in the reverse price scenarios have moderately stable participants. The foundation of cold chain logistics pricing, among other things, is to arrange for the costs of service providers for logistical cold storage while maintaining the freshness of the goods. The price strategy of reverse logistics, on the other hand, is linked to the qualities of the product itself. Pricing tactics are used by businesses to increase the rate of product recovery. There is now a research vacuum in the costing for crowdsourced logistics as well as informational systems for logistics.

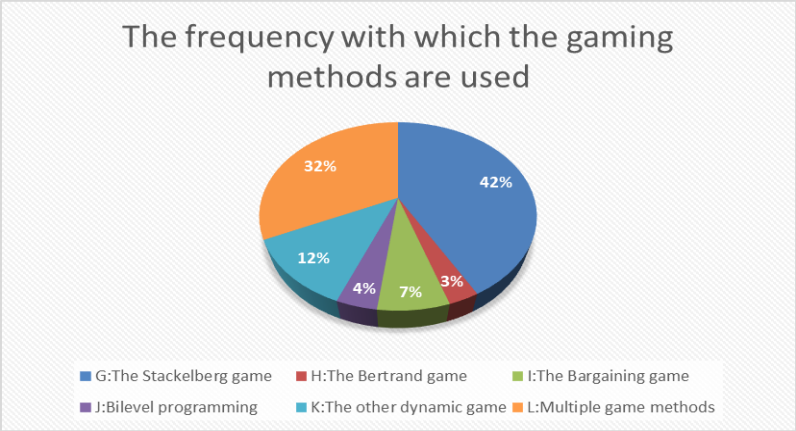

Figure 5. The frequency with which the gaming methods are used.

Figure 5 depicts the percentage of writing for each game strategy. According to the assessment of the literature and current research have used dynamic gaming techniques to construct model prices for logistics. They view logistics pricing strategy as the outcome of a game with several levels. Although a 2008 study described this game as static, the results served simply to highlight the TPLs' favorable price as well as were given in the study with repeated games for the logistics pricing outcomes (dynamic games). The Stackelberg game is used in 42% of the literature to build the pricing model. This suggests that the majority of experts feel that LSPs compete considering the pricing scenarios in an asymmetric market. The majority of this research contends that TPL, or the price taker, has no priority in supply chain pricing. The second most popular strategy is to combine different gaming methods (32%). Pricing logistics services covers many intriguing topics, and the decision-making process is challenging. It is beneficial to compare and analyze several sorts of game models in order to identify a more appropriate pricing technique. Multiple game models are typically built with three goals in mind: (1) to study price strategy in centralization and decentralization scenarios; (2) for the purpose of researching pricing tactics in both cooperative and competitive games; and (3) to investigate pricing strategy in various competitive patterns. Pricing-strategy study of supply networks under various power configurations is a popular topic for independent decision-making. The goal is to achieve Pareto optimality, it is also necessary to investigate price-coordination strategies based on decentralized decision-making. Scholars have already conducted research on this subject. We believe that future studies should be focused on these two views. Furthermore, some researchers have used bilevel programming to build the pricing model, in which the upper-level decision maker and lower-level decision maker specify their choice objectives separately. Currently, little research has employed this strategy, but we believe it is one to pursue.

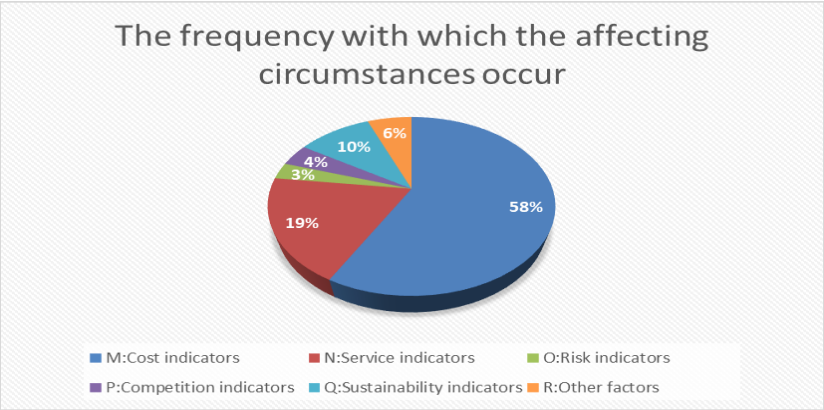

Figure 6. The frequency with which the affecting circumstances occur.

Figure 6 depicts the frequency percentages of the affecting elements. The cost indication is the most important component, accounting for 58% of all considerations. Except for one study, which assumed zero platform-operating expenses for convenience of analysis, all studies included cost indicators. Service indicators are the second most significant factor. According to academics, the level of logistics service has an impact on price by affecting the cost of logistics services or market demand. Quadratic functions are commonly used in research to describe the nonlinear relationship between service costs and service levels. Service signs arise in the group with a 20% frequency and require more attention. Furthermore, some models took into account sustainability indicators (10%), risk indicators (3%), competition indicators (4%) and other aspects (6%). As can be observed, with the emphasis on the negative externalities of logistical activities, researchers have paid more attention to sustainability indices. Appropriate logistics pricing methods can help to ensure the long-term viability of logistics operations. The impact factors' bubble plots are created for a thorough investigation. Figure 7 depicts the impacting factors' cross-frequency. The size of the bubble represents the frequency with which the pricing models' impact factors for the horizontal and vertical coordinates co-occur. It is clear that 18 studies take into account both cost and service variables, accounting for 32% of the entire literature assessed. This suggests that the importance of service and cost factors in logistics pricing is being recognized in a growing number of studies. Furthermore, the vacant spaces may generate fresh research ideas in the future. For example, in the future, we can analyze price decisions in light of the combined influence of service and sustainability criteria. Figure 8 depicts the number of parameters discussed in the studies. When developing pricing models, the majority of the literature only takes into account one or two sorts of characteristics. The more elements considered in the pricing of logistics services, the fewer articles discovered. The findings indicate that modeling in this subject is quite tough.

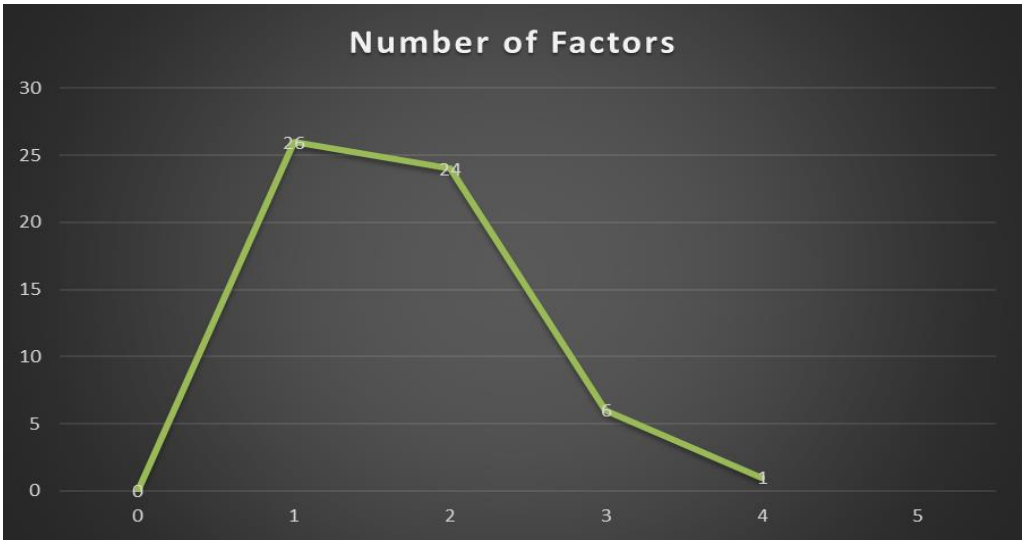

Figure 7. The number of components contained in the paper.

In pricing analyses for TPLs, cost indicators are the most important consideration, followed by service, sustainability, other considerations, risk, and competitive indicators. In the research of TPL pricing, only one study provides risk indicators. This is not to say that scholars haven't looked into market competitiveness in TPLs. For example, Du et al. employed the Stackelberg game to mimic competition between two LSPs without including a competition signal in the pricing model. Overall, the cross-analysis of price study situations and affecting factors provides several research suggestions. On the one hand, a larger bubble suggests a stronger association between the two, and scientists should examine both elements in future research. Pricing models for TPLs, for example, should take into account cost and service metrics. The reverse logistics pricing model should prioritize cost and sustainability parameters. As previously said, the unfilled section may provide future study directions. We should focus more on TPLs', cold chain logistics', and reverse logistics' competitive pricing challenges in the future. Meanwhile, the impact of risk mindset on cold chain logistics and reverse logistics pricing strategy should be investigated.

TPL pricing is sufficiently sophisticated that numerous game models can be used. We can observe that the Stackelberg game is the most commonly utilized methodology, followed by a combination of different game types. Bilevel programming, in particular, is currently utilized solely to investigate the pricing problem of TPLs. All preceding research have used the Stackelberg game to price cold chain logistics (including the literature that adopts multiple game methods). To start with, the sample size may be modest because there have been few studies in this field. As opposed to that, it suggests how accurate the Stackelberg game is best suited for cold chain logistics pricing research. Following the determination of the logistics price study scenario, According to the bubble plot, Figure 10 can be used as a guide for the selection a potential game approaches.

5. CONCLUSION

In today's social and economic structure, logistics is crucial. Using the right pricing methods for logistics assists LSPs in competing in the marketplace as well as promoting the long-term growth of logistics activities. In recent years, a slew of logistics pricing studies based on game theory have developed. As we can see, several game techniques have been used to deal with pricing for logistics difficulties under a variety of circumstances as well as

diverse influencing factors. We evaluate the relevant literature in three domains, using content analysis and bibliometric methods: logistical scenarios, game models, and influencing variables. To fill the void left because there isn't any actual research done on logistics pricing, this study aims to make pricing tactics in logistics clear scenarios, determine gaps as well as flaws in previous research, and contribute to the creation of new scientific approaches and models. The following study paths, according to us, should also be considered going forward.

First, more extensive research on logistical scenarios is required. The primary topics of pricing research in logistics are TPLs and freight logistics. Scholars focus on the price of intermediate or secondary supply chains, It encompasses vendors, TPLs, and merchants. Future studies on TPLs should concentrate on both the pricing of TPLs in the competitive market and LSSC pricing in a multi-tier supply chain made up of suppliers and merchants. Future research should focus on the cost of air travel and multimodal transportation in the context of freight logistics. Additionally, coordinating prices based on maintaining product freshness is essential for pricing in cold chain logistics. To boost the product recovery rate, a price strategy must be developed because the characteristics of the product determine reverse logistics pricing. In contrast to other situations, crowdsourcing logistics pricing must take into account the delivery workers' service capability and bargaining power. There is little research on crowdsourcing logistics pricing.

Second, multi-objective and multi-type game pricing methods should be created. All pricing logistics game models employ the dynamic game methodology. Furthermore, an asymmetry in logistics partners is crucial to pricing model research. Logistics activities include an increasing number of interesting subjects as logistics requirements become more complex. Pricing logistics services has become a difficult task due to the need to balance everyone's wants and interests. The traditional single-game pricing scheme makes meeting this need nearly impossible. Future pricing research trends include employing multiple-game methods for price analysis as well as developing game-pricing models with many objectives. Because the majority of logistics pricing is based on future research can concentrate on how pricing strategies alter in the presence of various supply chain power arrangements. Furthermore, an important area for future research is developing price coordinating strategies that can better support the Pareto principle.based on decentralized decision-making.

Third, pricing strategies should be investigated in light of various elements like service, competition, markers of sustainability and risk. The majority of the pricing structures now in use are built around one influential factor. The most important factors influencing logistics pricing are cost indicators and service indicators. However, the pricing of logistics can also be impacted by LSPs' risk-taking behavior and market competitors' involvement. Sustainable development indicators that lessen the unfavorable effects of logistics settings are additionally considered whenever choosing a price, especially as the general public's worry over logistics operations' sustainability grows. As a result, it is critical to consider the impact of a variety of factors on pricing methods. Although studying numerous elements in model creation is tough, scholars should take all factors into account when doing research.

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