Crowdsourcing Logistics: A conceptual framework and application

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Abstract. With the rapid development of the logistics industry, customers are paying more and more attention to the service quality and efficiency of terminal distribution. Under this demand, crowdsourcing is introduced into logistics as a new model. And it has been proven that this model can mobilize society's idle resources to meet supply and demand. Therefore, more and more scholars began to study the feasibility of this model and find how to further optimize this model so that it can be better put into use. Although there are many researches related to crowdsourcing logistics up to now, there are still few articles for summarization. Thus, this paper is written to provide a literature review of this field. To make the content of the literature review more representative, this paper uses the co-word clustering method to derive hot words from literature and do a literature review on crowdsourcing logistics' definition, pricing, value creation, as well as existing problems and solutions.

Keywords: Crowdsourcing Logistics, Conceptual Framework, Pricing, Value Creation.

1. Introduction

Recently, the rapid growth of "Internet +" and e-commerce has expanded the scale of Internet users worldwide. As a direct result, online shopping emerged as a popular shopping model for consumers due to its convenience. The transaction volume of online shopping has expeditiously risen, fueling the demand for express delivery. As such, the distribution pressure of full-time couriers is increasing, and the quality and efficiency of distribution are inevitably affected. In efforts to solve the imbalance between personnel distribution capacity and the delivery volume, various entrepreneurs that were inspired by the sharing economy introduced the "crowdsourcing" model into logistics. For example, Walmart outsources some of its orders to customers online and in return, they receive discounts to offset fuel costs. Jingdong and Amazon also openly recruit "couriers" from the community through their platforms.

Crowdsourcing logistics has been proved to be one of the most successful ways to address the "last mile distribution" problem. It takes advantage of available human resources and self-owned vehicles, improves the efficiency and flexibility of goods distribution, and produces greater economic benefits at a lower cost than professional logistics solutions. Hence, it has been a hot topic in recent years. Many Chinese and international scholars have researched various elements of crowdsourcing logistics, including its operation mode, optimization of path planning, logistics assessment, etc. Nevertheless, there are few holistic literature reviews on crowdsourcing logistics. Therefore, the objective of this paper is to review and summarize the relevant literature in this field to inform scholars about crowdsourcing logistics and the existing literature.

This paper is structured as follows: section 1 provides an overview of the background and importance of crowdsourcing logistics, section 2 examines applied research methodology, and section 3 provides a literature review covering crowdsourcing logistics' definition, pricing, value creation, as well as existing problems and solutions, and section 4 concludes with a summary of the major findings of existing research and predicts the future perspectives of research in this area.

2. Methodology

In order to get an overview of recent research findings on crowdsourcing logistics, a systematic literature analysis was applied. Crowdsourcing logistics is a relatively new topic, and to make the

literature review more timely, the papers published during the period from 2015 to April 8th, 2022 were retrieved. Moreover, to ensure the scholarly productions were searched as comprehensive as possible, the following keywords were used: "crowd logistics", "crowdsourced logistics", "crowdsourcing logistics", "crowd delivery", "crowdsourcing delivery" and "crowdsourced delivery". And literature was found using various databases, like Scopus, Elsevier, Taylor & Francis, and IEEE was used to avoid omission. Additionally, the articles written in Chinese were also taken into consideration by using the database named CNKI. Considering that the reference materials for academic research mainly are papers published in a journal or conferences, this analysis only counted papers from these two sources, the dissertations and some comments in the newspaper were not taken into account.

These keywords were searched in the title and judged the relevance between the retrieved articles and the theme of crowdsourcing logistics by checking their abstracts and general content. After excluding both duplicates and articles that are not directly related to crowdsourcing logistics, 473 papers were found in total. The paper volume shows a constant rise from the year 2015 to 2021 in Figure 1.

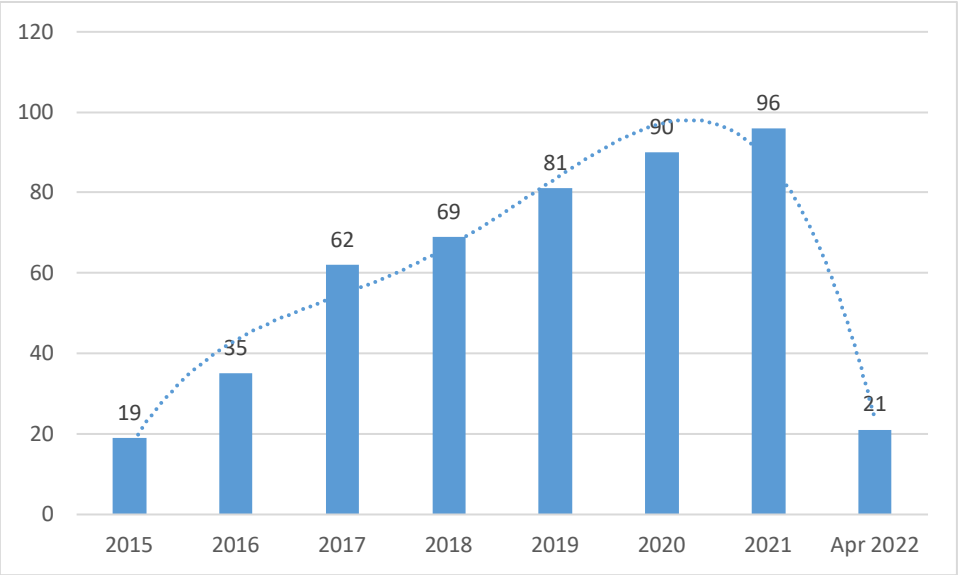

Figure 1. Number of Publications over Time

To evaluate and analyze which area most scholars show their interests in, a co-word clustering analysis was conducted. In the literature selection process, the high-frequency words combined with the keyword in the title are "pricing", "last mile solution", "environment"(can be summed up as "value creation") and "optimization". Therefore, this literature review would be written covering these significant aspects.

3. Relevant Researches of Crowdsourcing Logistics

3.1 The definition of crowdsourcing logistics

Jeff Howe (2006) coined the word "crowdsourcing" in the title of a story posted in Wired magazine [1]. In June of the same year, Jeff Howe gave a detailed definition of this term: crowdsourcing means that the service company outsources some of its professional work to the public through an open way [2]. Subsequently, crowdsourcing has been widely used in fields such as journalism, astronomy and health care, and related academic research also emerged. In the field of logistics, although companies such as Uber and Walmart have tried out adapting the ideas of crowdsourcing to the field of logistics to create "crowdsourcing logistics" mode, the term was first defined in detail academically in 2015. By studying 59 related cases, Mehmann et al. (2015) defined crowdsourcing logistics as: enterprises outsource their logistics services to numerous participants, and support coordination through technical infrastructure, thereby creating economic benefits [3]. In the same year, Mladenow et al.

(2015) introduced the location-based crowdsourcing (LBCS) research, dissecting the differences between traditional logistics and crowdsourcing logistics that rely on communication and information technologies, and proposed that there is an emerging trend in the logistics industry to borrow external human resources. However, research in this field is still in its early stages [4]. Carbone V et al. (2017), through a review and analysis of 57 logistics websites, explained crowdsourcing logistics as: it utilizes idle resources of people and underutilized logistics capacity through mobile applications and online platforms [5]. Rai H B et al. (2017) defined crowdsourcing logistics as a medium that matches the supply and demand of society with undefined external personnel through information connection, who are willing to invest time to obtain corresponding rewards [6]. Although there are nuances in the definition of crowdsourcing logistics among many scholars, several factors were repeatedly mentioned: outsourcing, information platform, human resources and returns. Therefore, it can be roughly summarized that: crowdsourcing logistics is a new logistics model in which logistics companies outsource a certain business to a crowd through an information platform, and personnel invest time and other resources to obtain returns.

3.2 Research on the pricing of Crowdsourcing Logistics

The pricing approach of the crowdsourcing logistics platform is the key factor for its successful operation. Overpricing crowdsourcing tasks can lead to higher costs and lower profits for task publishers. Conversely, low pricing will affect the willingness of the crowd to participate and the quality of task completion. Therefore, the pricing of crowdsourcing logistics is a hot research topic in this field. Lin et al. (2018) sought to maximize the efficiency of the urban crowdsourcing distribution system while minimizing costs, and adopted a roulette algorithm to analyze the matching problem between task and crowd, suggesting that crowdsourcing platforms should implement differentiated pricing to stimulate the willingness of the crowd to participate as couriers [7]. Yildiz and savelsbergh (2019) studied the optimal service area and capacity management of crowdsourcing delivery platform and concluded that the compensation available to couriers plays a key role in the service area and the platform's profits [8]. Considering the uncertainty of social distribution capability, Wang et al. (2019) designed an optimal dynamic surge pricing model for crowdsourcing logistics companies during peak delivery periods based on the Bertrand price competitive environment and dynamic optimization theory. The model combined factors such as time, demand and competition among logistics service providers to explore the optimal pricing, and the calculation results concluded as follows: the intense price war among logistics companies will lead to a gradual reduction in the optimal pricing of logistics services, resulting in a decline in the overall profitability of the market, but this decline will slow down as the price competition lasts for a longer period of time [9]. Ran and Zhou (2020) considered that crowdsourcing logistics service platforms regulate the supply-demand balance through dynamic pricing methods. They used Mathematica simulation to further explore the impact of subsidy policies for couriers on platforms' revenue [10]. Le T V et al. (2021) first combined WTP(willingness to pay) with ETP(expected to be paid) to consider the matching and route selection problem of crowdsourcing delivery. They put four alternative pricing and compensation strategies to the test in five different supply and demand situations to help crowdsourcing logistics platforms develop optimal prices and optimal compensation to retain customers and couriers [11]. Rechavi and Toch (2022) used modeling to examine auction-based pricing and courier strategy in the context of the sharing economy, and found that infrequent couriers receive greater fees for services than recognized and frequent couriers [12].

For pricing studies, most scholars gave suggestions for dynamic pricing in crowdsourcing logistics considering the fluctuations in market demand. When it comes to the subjects in the crowdsourced logistics structure, scholars prefer to study how the impact of pricing on the willingness of the courier (i.e. the receiver) to participate spills over into the profitability and efficiency of the entire crowdsourcing process.

3.3 Value creation

The benefits brought by crowdsourcing logistics are mainly concentrated in three aspects: society, economy and environment. In terms of society, McKinnon (2016) pointed out that crowdsourcing logistics provides a platform for people to collaborate and share services and resources using the social network for their benefits as well as for the greater good of the community [13]. Carbone V et al. (2017) proposed that compared with traditional business logistics, crowdsourcing logistics can connect individuals with companies and use available human resources and capabilities in the society [5], and the crowd can convert time and skills into cash, flexibly adjusting their workload and income [14]. On the economic side, crowdsourced logistics has clear economic advantages over traditional logistics in that it can achieve reduced costs and increased profits. Botsman (2014) suggested that crowdsourcing logistics companies do not need warehouses, fleets, or hired drivers, which means that compared to traditional logistics companies, the costs are much lower and they tend to take more market sharing [15]. The last-mile distribution in the supply chain is the least efficient and accounts for a very high proportion of the total cost. Y. Wang et al. (2016) found that the crowdsourcing delivery model can effectively reduce costs and parcel turnaround time by using citizen workers to complete the last-mile delivery tasks [16]. The environmental benefits of crowdsourcing logistics are mainly reflected in its significant reduction of carbon emissions compared with the traditional logistics model. Paloheimo et al. (2016) did a study on using crowdsourcing to library deliveries to minimize detours in the transportation process, thus minimizing the consumption of natural resources and the associated environmental impact of transportation. It was demonstrated that each crowdsourcing delivery reduces the distance driven by car by an average of 1.6 km, with a corresponding significant reduction in carbon emissions [17]. Chen et al. (2018) found in a report that traffic congestion generates significant tailpipe emissions, and the implementation of crowdsourced logistics can help alleviate congestion and thus reduce carbon emissions [18]. With the increasing emphasis on environmental protection, crowdsourcing logistics has a long-term development prospect due to its environmental benefits.

3.4 Existing problems and solutions

As a newly emerged industry, crowdsourcing logistics has no more development experience for reference. Therefore, numerous scholars have analyzed the existing problems and provided corresponding solutions to help crowdsourcing logistics to improve and develop continuously. Devari et al. (2017) pointed out that consumers attach great importance to their privacy and the reliability and liability tracing of crowdsourcing services. If couriers have some kind of emotional connection with their clients, the stability and security of crowdsourcing services will be greatly improved [19]. Marzano et al. (2019) also found in the literature review that all the papers they analyzed highlighted the data privacy risks of crowdsourcing logistics and therefore data should be randomized to avoid direct access to the personal information of data providers [20]. Luo et al. (2019) argued that crowdsourcing logistics has problems of imperfect rules and poor quality of deliverers, so relevant laws and regulations should be established and perfected. In addition, technologies such as big data and AI should be combined to improve the quality of crowdsourcing logistics services [21]. Le T V et al. (2019) reviewed the practice and literature on crowdsourcing operations from three aspects: supply, demand, operation and management, and suggested that if the hidden trust and security risks of crowdsourcing logistics are to be addressed, the government should formulate policies to clarify the operational boundaries of crowdsourcing logistics and supervise them [22]. Meng et al.(2022) proposed that service quality is a major problem limiting the development of crowdsourcing logistics. The implementation of a reasonable penalty policy will promote the service quality of receivers, and the profits of the crowdsourcing logistics platform will also increase [23].

For the analysis of the existing problems of crowdsourcing logistics, most scholars have mentioned that crowdsourcing logistics has security risks such as privacy leakage, as well as the lack of good quality and reliability of personnel services. When it comes to solutions, researchers are inclined to

formulate sound laws or rules by companies and governments to restrict and guide the behavioural norms of participants (mainly the receivers) in the delivery process.

4. Conclusions

This paper examines the concept and application of the current emerging logistics model, crowdsourcing logistics, and draws the following conclusions. This study reveals that the research on the concept of crowdsourcing logistics has become increasingly mature. Many scholars have affirmed the benefits of crowdsourcing logistics could bring, including economic, social and environmental aspects. Also, many scholars also put forward suggestions on the development and shortcomings of crowdsourcing logistics to promote its application. The research shows that another hotspot of crowdsourcing logistics is pricing. In order to better reduce costs and increase revenue, operators will adopt dynamic pricing. Finally, the existing problems and solutions are studied. As an emerging industry, it attracts much attention.

Scholars' research on crowdsourcing logistics has achieved some very valuable results, but there are still some shortcomings in general. In pricing, most of the articles are from the perspective of the receivers, considering other subjects may become a major direction for future research. In terms of solutions, most of the suggestions are to issue the regulations, and other solutions are yet to be proposed by further research. This study also has certain limitations. In terms of data collection, this study used a specific database, which may have resulted in some articles relevant to the research topic being overlooked.

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