

Crowdsourced Logistics: A Review of Research

Weichen Wang

College of Management, Shanghai University, Shanghai, China

Abstract: Crowdsourced logistics is a logistics mode developed under the backdrop of the "Internet+" era. In this mode, companies delegate the logistics and distribution tasks, originally performed by employed personnel, to the idle workforce in society. This approach helps companies alleviate the last-mile delivery issue, reduce costs, and facilitate the reallocation of social resources, attracting considerable attention from scholars. This paper provides a brief overview of the research in the field of crowdsourced logistics, summarizing four major research directions and related research findings. It is observed that research in crowdsourced logistics still lacks in addressing service issues, quality evaluation systems, and quality optimization.

Keywords: Crowdsourced logistics; Review; Service; Quality.

1. Introduction

Crowdsourcing is a realization of the sharing economy facilitated by internet platforms, under the development of information technology. Through this, the traditional logistics industry transfers the logistics services, originally assigned to professional couriers, to the general public via online platforms. Eligible individuals only need to register to participate in logistics distribution services as part-time couriers and receive corresponding remuneration. Compared to traditional logistics modes, the crowdsourcing logistics based on online platforms efficiently integrates idle resources in society, to some extent, addressing the last-mile delivery issue. Additionally, it helps companies save costs and increase profitability.

Against this background, to continuously promote the development of the crowdsourced logistics industry, this paper will review and analyze existing research literature in the field of crowdsourced logistics to understand the shortcomings of current research and provide insights for future research directions.

2. Research Overview

The concept of "crowdsourcing" was initially introduced in the American magazine "Wired," referring to a practice where businesses or organizations outsource tasks originally performed by employees to a voluntary online crowd^[1]. By adopting this mode, businesses or organizations can engage various talents from society to achieve higher quality and efficiency in task completion. Simultaneously, for the general public, this model offers opportunities to participate in work during leisure time, leading to both spiritual and material benefits. Thus, crowdsourcing enables the efficient redistribution and utilization of various societal resources, creating greater value. This novel business model, capable of generating value, holds significant development prospects and has garnered considerable attention and research interest from scholars.

The application outcome of the crowdsourcing mode in the logistics industry is the emergence of crowdsourced logistics. Distinguished from traditional logistics modes, crowdsourced logistics involves outsourcing logistics delivery tasks, originally performed by hired employees, to the idle workforce in society. This mode presents a promising solution

to the "last-mile" problem prevalent in the logistics industry. Furthermore, it aids logistics companies in enhancing delivery efficiency and contributes to the reallocation of societal resources. Consequently, scholars worldwide have initiated research on crowdsourced logistics. Presently, research in the field of crowdsourced logistics mainly focuses on four aspects: user participation behavior, order allocation, vehicle routing issues, and service studies. The subsequent sections will delve into these specifics.

2.1. User Participation Behavior

The majority of scholars have investigated the motivations for public participation or the factors influencing participation in crowdsourced logistics from the perspective of the receivers, i.e., the crowd, to understand how to encourage ongoing user involvement in crowdsourced logistics.

Guo and Wang[2] based on an integrated model of Technology Acceptance and Use Theory, proposed a research model on the factors affecting public participation in crowdsourced logistics. Through data collection and analysis, they found that facilitating conditions are a key influencing factor, with expected benefits and social expectations having a positive effect, while perceived risk has a negative impact. Liang et al.[3], based on the PAM-ISC and TPB models, further discovered that job satisfaction has a significant positive effect on the willingness to participate, whereas the self-affirmation of the contractor has no impact on the willingness to continue participation. Ta et al[4], based on Social Identity Theory, found that the disclosure of identity information of crowdsourced delivery personnel, especially in terms of racial information, influences user participation behavior in crowdsourced delivery. Huang et al[5], using the Push-Pull-Anchoring Theory to build their model, discovered that the enjoyment of the previous job and barriers to entry into the work have a negative impact on the willingness to continue participating. Meanwhile, trust plays a mediating regulatory role between monetary incentives and the willingness to continue participating. Dai et al[6], through face-to-face interviews, found that a portion of the public chooses to participate in crowdsourced logistics delivery work due to its environmental protection effects.

Scholars have also investigated from the perspective of companies, studying the motivations and influencing factors for companies to implement crowdsourced logistics, thus providing practical suggestions for companies adopting the

crowdsourced logistics mode. For example, Bin et al.[7], based on the Push-Pull-Anchoring Theory framework, found that logistics operation models, external incentives, and internal benefits have a positive effect on companies' adoption of crowdsourced logistics, while security has a negative effect.

2.2. Order Allocation

In the context of crowdsourcing where tasks are delegated to the public for completion, scholars have conducted research on the problem of order allocation to achieve optimal efficiency.

In the early stages, Chen et al.[8] addressed urban logistics tasks by considering expected trajectories of the crowd and proposed the TRACCS, a complex integer programming model. They utilized heuristic algorithms to solve the problem. Wang et al.[9] viewed the problem as a minimum cost flow problem, but found the scale of the problem to be too large. Therefore, they proposed several strategies to reduce the network scale, thereby lowering the difficulty of problem solving. Karger et al.[10] formulated a general model for crowdsourced logistics with the objective of minimizing total costs. They proposed a new algorithm based on belief propagation and low-rank matrix approximation to solve the optimal order allocation problem.

The aforementioned studies primarily focused on static order allocation problems. With the advancement of research, some scholars began considering dynamic order allocation problems. Allahviranloo and Baghestani[11] developed a dynamic optimization model using a rolling horizon approach, requiring both the contracting and contracting parties to adjust trips and change bids respectively. This addressed the problem of demand fluctuations in crowdsourced logistics tasks, achieving optimal matching of orders. Dayarian and Savelsbergh[12] considered a highly dynamic and stochastic delivery environment, and developed two rolling horizon methods for decision making, addressing the order allocation problem for real-time delivery in crowdsourced logistics.

2.3. Vehicle Routing

Crowdsourced logistics, as compared to traditional logistics, presents distinct challenges in vehicle routing, such as time window constraints and simultaneous pickup and delivery requirements. Consequently, numerous scholars have conducted research on this issue.

In terms of problem investigation, Archetti et al.[13] were among the early researchers to explore vehicle routing problems in crowdsourced logistics. They considered this problem as a variant of capacitated vehicle routing problem and devised a multi-start heuristic algorithm to solve it. Subsequently, Macrina et al.[14] extended their research by incorporating time windows for customers and drivers, as well as the issue of multiple deliveries by drivers, thus making their study more universally applicable. Yu et al.[15] further investigated vehicle routing problems in crowdsourced logistics allowing simultaneous pickup and delivery. They formulated the problem as a mixed-integer linear programming model and utilized heuristic algorithms for solution.

Regarding solution methodologies, Behrend et al.[16] proposed an exact solution method to generate feasible crowdsourced routes, considering vehicle capacity constraints. Compared to previous methods, their approach provided more precise solutions under the same constraints. Feng et al.[17], while studying vehicle routing problems in

crowdsourced logistics, considered heterogeneous vehicle capacities and time window constraints, and introduced a novel evolutionary multi-task algorithm for solution. Wang et al.[18] addressed both order allocation and routing problems jointly, optimizing the problem through a data-driven column generation algorithm.

2.4. Crowdsourcing Logistics Services

With the development of crowdsourcing logistics, scholars have begun to focus on crowdsourcing logistics services themselves, investigating issues including pricing and quality. However, overall, the literature in this area is not abundant, and its content is not comprehensive.

Crowdsourcing logistics platforms must control pricing strategies reasonably to maximize enterprise benefits. Regarding pricing issues in crowdsourcing logistics services, Cachon et al.[19] conducted an in-depth analysis of the process by which crowdworkers choose platforms and, through comparative studies of centralized pricing methods, derived the optimal crowdsourcing service pricing strategy. Hu et al.[20] considered platform backgrounds under scenarios of supply-demand balance and supply-demand imbalance and studied the impact of unified commission contracts on logistics revenue for crowdsourcing platforms. Wang et al.[21] considered the intensely competitive background among crowdsourcing platforms and established an optimal pricing model for platforms engaged in price competition. Liang and Wu[22], under monopolistic and competitive market structures, considered incentive and restrictive policies adopted by the government in the crowdsourcing logistics market and studied pricing strategy issues for crowdsourcing logistics platforms.

Regarding the quality of crowdsourcing logistics services, scholars have researched related topics such as quality evaluation and quality management. For example, in the evaluation of crowdsourcing logistics service quality, Klumpp[23], combining real-life cases, considered the stability and participation level of crowdsourcing logistics quality and established an evaluation scheme for crowdsourcing logistics service quality. Li[24], based on customer experience, considered the uncontrollability and security risks in crowdsourcing logistics services and established a quality evaluation index system for crowdsourcing logistics services. In terms of crowdsourcing logistics service quality management, Yildiz et al.[25] studied the interactive effects among crowdsourcing service scope, service quality, and delivery capability, providing guidance for crowdsourcing logistics service quality management. Meng et al.[26] considered penalty mechanisms and cost-sharing contracts, established a crowdsourcing logistics service quality control model, and studied how platforms and contractors control service quality. Liu et al.[27], in the context of cold chain logistics, constructed a model to measure the relationship between crowdsourced logistics costs, satisfaction, and historical service quality, and, combined with vehicle routing problems, solved them to help improve service quality in crowdsourced cold chain logistics distribution.

3. Summary

Through the compilation and summarization of literature in the field of crowdsourced logistics, the following research areas with significant shortcomings and considerable research space have been identified.

The research on service issues in crowdsourced logistics is insufficient. As crowdsourced logistics services have developed, scholars have gradually begun to focus on this issue, including research on pricing and quality of crowdsourced logistics services. However, compared to literature in other aspects, research on crowdsourced logistics services is still relatively scarce in terms of quantity and quality due to the limited time of development. Specifically, research on pricing dominates, while studies on service quality remain insufficiently extensive and comprehensive.

There is a lack of consensus in the evaluation system for crowdsourced service quality. Due to the high uncertainty inherent in crowdsourced logistics based on internet platforms, traditional evaluation methods are not entirely applicable. Currently, research on the quality evaluation system of crowdsourced logistics services is still in the exploratory stage and is subjective, lacking consistent opinions.

Research on quality optimization in crowdsourced logistics is limited and incomplete, with insufficient attention given to crowdsourced couriers. Research on quality optimization remains limited and incomplete, with insufficient attention paid to crowdsourced couriers. The level of attention in research on quality optimization remains inadequate, with existing literature primarily focusing on business models and different platform strategies, resulting in relatively thin content. Furthermore, there is a notable lack of attention to the primary providers of crowdsourced logistics services—the crowdsourced couriers.

References

- [1] Howe J. The rise of crowdsourcing[J]. *Wired* (San Francisco, Calif.), 2006, 14 (6): 176.
- [2] Guo, J., & Wang, J. Research on the influencing factors of mass participation behavior in crowdsourced logistics based on the UTAUT perspective[J]. *Operations Research and Management*, 2017, 26(11), 1-6.
- [3] Liang, X., Huang, L., & Jiang, J. Study on the influencing factors of the sustained participation intention of contractors in crowdsourced logistics [J]. *Business Economics and Management*, 2017, 309(07), 5-15.
- [4] Ta H, Esper T, Hofer A. Designing crowdsourced delivery systems: The effect of driver disclosure and ethnic similarity[J]. *Journal of Operations Management*, 2018, 60 (1): 19-33.
- [5] Huang L, Xie G, Blenkinsopp J, et al. Crowdsourcing for Sustainable Urban Logistics: Exploring the Factors Influencing Crowd Workers' Participative Behavior[J]. *Sustainability*, 2020, 12 (8): 3091.
- [6] Dai Q, Jia H, Liu Y. Private vehicle-based crowdshipping for intercity express transportation: Feasibility assessment [J]. *International Journal of Distributed Sensor Networks*, 2020, 16 (2): 1550147720908203.
- [7] Bin, H., Wang, H., & Xie, G. Study on the influencing factors of enterprise implementation of crowdsourced logistics under the sharing economy[J]. *Management Review*, 2019, 31(08), 219-229.
- [8] Chen C, Cheng S-F, Gunawan A, et al. Traccs: a framework for trajectory-aware coordinated urban crowd-sourcing [C]. *Proceedings of the AAAI Conference on Human Computation and Crowdsourcing*, 2014: 30-40.
- [9] Wang Y, Zhang D, Liu Q, et al. Towards enhancing the last-mile delivery: An effective crowd-tasking model with scalable solutions[J]. *Transportation Research Part E: Logistics and Transportation Review*, 2016, 93: 279-293.
- [10] Karger D R, Oh S, Shah D. Budget-optimal task allocation for reliable crowdsourcing systems[J]. *Operations Research and Management Science*, 2014, 62 (1): 1-24.
- [11] Allahviranloo M, Baghestani A. A dynamic crowdshipping model and daily travel behavior[J]. *Transportation Research Part E: Logistics and Transportation Review*, 2019, 128: 175-190.
- [12] Dayarian I, Savelsbergh M. Crowdshipping and same-day delivery: Employing in-store customers to deliver online orders[J]. *Production and Operations Management*, 2020, 29 (9): 2153-2174.
- [13] Archetti C, Savelsbergh M, Speranza M G. The Vehicle Routing Problem with Occasional Drivers[J]. *European Journal of Operational Research*, 2016, 254 (2): 472-480.
- [14] Macrina G, Di Puglia Pugliese L, Guerriero F, et al. The vehicle routing problem with occasional drivers and time windows [C]. *Optimization and Decision Science: Methodologies and Applications: ODS, Sorrento, Italy, September 4-7, 2017*, 2017: 577-587.
- [15] Yu V, Aloina G, Jodiawan P, et al. The vehicle routing problem with simultaneous pickup and delivery and occasional drivers [J]. *Expert Systems with Applications*, 2023, 214: 119118.
- [16] Behrend M, Meisel F, Fagerholt K, et al. An exact solution method for the capacitated item-sharing and crowdshipping problem[J]. *European Journal of Operational Research*, 2019, 279 (2): 589-604.
- [17] Feng L, Zhou L, Gupta A, et al. Solving generalized vehicle routing problem with occasional drivers via evolutionary multitasking[J]. *IEEE transactions on cybernetics*, 2019, 51 (6): 3171-3184.
- [18] Wang L, Xu M, Qin H. Joint optimization of parcel allocation and crowd routing for crowdsourced last-mile delivery [J]. *Transportation Research Part B: Methodological*, 2023, 171: 111-135.
- [19] Cachon G, Daniels K, Lobel R. The role of surge pricing on a service platform with self-scheduling capacity[J]. *Manufacturing Service Operations Management*, 2017, 19 (3): 368-384.
- [20] Hu M, Zhou Y. Price, wage, and fixed commission in on-demand matching[J]. Available at SSRN 2949513, 2020.
- [21] Wang, W., Chen, Y., & Jiang, S. Optimal pricing strategy for crowdsourced logistics social distribution services considering platform competition [J]. *Operations Research and Management*, 2020, 29(10), 11-20.
- [22] Liang, Y., & Wu, L. Research on pricing strategy of crowdsourced logistics based on government policy regulation. *Operations Research and Management*, 2023, 32(01), 206-212.
- [23] Klumpp M. Crowdsourcing in logistics: An evaluation scheme[C]. *Dynamics in Logistics: Proceedings of the 5th International Conference LDIC, 2016 Bremen, Germany*, 2017: 401-411.
- [24] Li, M. Construction of a customer experience-based evaluation index system for crowdsourced logistics service quality[J]. *China Business Review*, 2021, 834(11), 27-29.
- [25] Yildiz B, Savelsbergh M. Service and capacity planning in crowd-sourced delivery[J]. *Transportation Research Part C: Emerging Technologies*, 2019, 100: 177-199.
- [26] Meng, X., Yang, J., & Wu, Y. Optimal control of crowdsourced logistics service quality considering reward mechanism and cost sharing[J]. *Chinese Journal of Management Science*, 2021, 30(11), 182-195.

[27] Liu, C., Wang, J., & Li, J., et al. Simulation and optimization analysis of cold chain logistics distribution model under

crowdsourcing mode[J]. Computer Integrated Manufacturing Systems, 2019,25(10), 2666-2675.