



A PEER-TO-PEER COURIER NETWORK REVOLUTIONIZING LAST-MILE DELIVERY

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Abstract : This research paper explores the concept and implications of a peer-to-peer (P2P) network system in the context of last-mile delivery logistics. Traditional courier services face challenges in terms of efficiency, cost-effectiveness, and environmental sustainability. In response, P2P network systems offer a decentralized platform that connects senders with travellers, utilizing existing travel routes to facilitate package delivery. Leveraging collaborative consumption principles, P2P networks optimize resource utilization, minimize environmental impact, and provide a cost-effective alternative to traditional delivery methods. This paper aims to comprehensively analyze the operational model, benefits, challenges, and potential impact of P2P network systems on delivery logistics and the environment.

By addressing key challenges and considerations, such as technological constraints, operational complexities, regulatory implications, trust building, scalability, and user engagement, this paper provides insights into fostering sustainable and resilient delivery ecosystems.

IndexTerms – Peer-to-peer courier network, Collaborative consumption, Travelers, sustainable logistics, last-mile delivery.

I. INTRODUCTION

Our era is by no ways lag because of the instant existence the change and so the demand for the fast and clean transportation is predominant. The last mile of a logistics chain; it is sometimes referred to as the last-meter, is the place where the parcels are delivered from the distribution center to the actual customer. Many of the traditional courier companies say that this is the most difficult part of the logistics chain. These issues still pop up when the costs are piling, a bad route planning causes longer routes and the environment suffers because of the harmful emissions from delivery vehicles. Since meeting this obstacles became a new challenge, there arose such a thing as Peer-to-Peer (P2P) Courier Network. [1]

Peer-to-Peer courier network actually is a new concept in the industry of delivery as is the contrary to the traditional ways, it relies on collaboration and existing travel routes, which means that it is totally able to change the way we transport packages. While this first approach may use the old method of dedicate courier services, a mix of both senders and travelers who have already journeyed on the same route will be used. The Peer-to-Peer Courier Network draws from a large community of travelers and therefore makes better use of resources and minimize environmental footprint. However, the service is very cost effective than the traditional delivery system that usually uses tons of fuel due to large fleet in motion.

As logistics become increasingly important globally in terms of sustainability and effectiveness, the peer-to-peer courier network acts as a pathway for long-distance delivery reinvention. The innovation of the collaborative involvement of individuals and the application of the travelling routes can thus lend the delivery network a new look and set the stage for a paradigm shift in the delivery system which can result in the birth of a more sustainable, inexpensive and convenient delivery system.

The paper will briefly discuss the approach used, business model and basic how the delivery network looks like within the context of a case study on the removal the aspects that affects delivery services industry and the environment. Next, debate on tourists or boards of tourism and the legal landscape around tourism is carried on. This is marked by scale-breakers and problems as expected. Therefore, promotion of more research and its actual implementation into start-up stages require increase in budget allocation.

II. LITERATURE REVIEW

The relentless expansion in e-commerce activity beyond this final delivery has resulted in heavy pressure on the last mile, the last leg of the supply chain, which brings products directly to consumers. Generally, the traditional courier services which have long been in the market, may have some difficulties such as the efficiency, effectiveness and also the sustaining of the environment [2]. The literature review talks about the probable use of peer-to-peer (P2P) courier networks in resolving these problems and disrupting last-mile delivery.

A. The Inefficiencies of Traditional Last-Mile Delivery

As shown by the research papers that were used, there are many problems that are connected to the traditional last-mile delivery end point. Research suggests that own vehicle cost spike rates of very high while research suggests irrationality of delivery distance which rarely helps in facilitating passenger's going towards their destination and shrewd use of fuel and resources of their fleets. On the contrary despite several empirical evidences prove that in the present method of delivery there are happen ecological

damage. The greenhouse gas emissions with regards to cargos transported with the use of fossil fuels are now rationally being seen as a great problem that climate change is tackling with [3].

B. Exploring Alternative Solutions

A number of studies suggest the way of improvement of vehicle management for the purpose of using them more efficiently, cutting costs, and reducing the pollution. Urban consolidation centers analyzed by [4] are offering the visionary approach to the future of eCommerce. These hubs, located in areas, which provide deliveries for an entire district, take over and bundle packages; and the overall routing is optimized to minimize emissions and improve efficiency of the logistics.

C. The Rise of Collaborative Consumption in Logistics

When it comes to the researches on P2P (peer-to-peer) Courier Networks in particular, things have just begun and thus, as for the head of a horse that is already frightened, there is a little to cheer about, however, there is also a significant tendency toward sharing-economy models in logistics in general. [5] the department concentrates on P2P platforms in logistics by considering the idea of preparing the environment to use it as a replacement to the well-known logistics' service delivery rules.

D. Building Trust in P2P Logistics

A crucial aspect of P2P Courier Networks is trust between senders and travelers. Research by [6] examines trust-building mechanisms in P2P logistics platforms. Understanding how to establish trust within a P2P network is essential for its success.

Gaps in Knowledge and Areas for Further Research: While this is a question of trust and faith, the greatest things compelling me to achieve success are those that I will not forget, because silence on this issue would not be a small thing to do, since it is about creating the world that is better. A topic itself being brought up by the platform be primary, but there are few areas that are of more importance to be filled by various researches upon it.

P2P system is an asset among economic models, and that is not even don of its large settings of benefits that homeowners and commuters rewrite their relationships will give room for new understanding of who is homeowner and on the other hand is an occupant of another's property at the moment we will see that. Also, the number of such verifications that will be required is bound to increase as they will come from individual consumers who are seeking to find out the services preferred and the rate every service provider charge. However, the cheap standard delivery that will also be available will equally be one of the main reasons why people will opt to use special delivery services. The same thing happens when the visitors also have the opportunity to explore and know the culture which can lead to the wrong perception of the city as well. They might not even notice the following customs and behavioral norms. The preference of an inhabitant to speak up in the shops or public places can be little known and not very well understood. [7] And resetting values provides the all the ingredients but you have to focus beforehand settle on different options as opposite to the traditional delivery models. As a result, if these bans are not an outcome of a negative reaction towards certain widely respected events, are they necessarily handling the unscheduled occurrence that could affect all the businesses? Team spirit is pivotal to our being able to achieve our set objectives. Without a high spirit, our potential is quite ambiguous. That the idea of satisfaction from the aims accomplished is faint, even worst is when the targets are not being attained. [8]

E. Operational Model and Functionality

A detailed inspection of the major components of the Online Courier Platform operations together with characteristics of the operations is an important thing for the successful implementation of the project. In the next stage, sender and travelers would need no connection as it will be automatic and they would just have to input the information. The questions arise like, How the platform shall be secure and prompt communication shall be there and how the logistics shall be taken care of are the points that need to be addressed minutely.

F. Economic Viability

The title phrase makes us conclude that the paper is written to give us some new rules of the pricing policy that would be applied for the participating enterprises in an R&D project, serving as a basis for a new universal policy for the p2p courier networks where the small business companies have an opportunity to run their own private concerns.

G. Regulatory Landscape

Exploration of the regulatory landscape for P2P courier services compared to traditional models is necessary to identify potential obstacles and compliance requirements. It is essential to determine if existing regulations could hinder the operation of P2P networks and to advocate for regulatory frameworks conducive to the growth of such platforms.

H. Scalability

On the other hand, in this process a legacy will be changed and eventually it will be used some concerted campaign approach that guarantees objectivity. However, while the process is customer-centred and is actively adapted here soon, it will be adopted as a normal feature but some problems related to the agreements and logistics management protocol majority, which here are interrelated, may occur.

Disarming these blind spots will be an essential factor in building a complete strategy of P2P Courier Networks and their capability to bring new life into the last-mile delivery process. The purpose of this discussion is to, after the thorough academic research, set up the framework for the prosperous incorporation of P2P (also it stands for Peer-to-Peer) networks in the established supply chain. Therefore, that way it will eventually improve management and bring down cost, in addition to being eco-friendly when referring fuel consumption in the last mile delivery.

III. METHODOLOGY

The study looks at how well the P2P courier network works. It checks the way it works for users and how it is run. This part aims to give ideas on where the network is good and where it needs work in getting packages to their last stop.

A. User Experience and Design:

The way users feel using the P2P courier network is key to how they like it. The design of the platform, how users move around it, and how easy it is to use all play a big part in how much users like it. In short, the study of user experience shows these main points:

Intuitive Interface: The website will be optimized and created with a user-friendly interface (UI) which contains simple navigation menus and more clear call-to-action (CTA) buttons. Users love the system because they can do what they need to do within a few clicks: Search for deliveries; publish / request deliveries; manage deliveries; and access their profile settings.

Structured Layout: The website's design is neat and logical, the menu bar is divided into several pages according to different works. People are enjoying this actuality because there is something that is improving clarity and prompting the completion of the task on the other side of the fence.

Interactive Features: Interactive facilities are an inherent part of this type of product which includes search filters, live tracking options and messaging facilities that improve the experience of the user. These facilities provide a smooth communication channel for the senders and the travelers, thus lay a good path for the delivery deals trust and transparency.

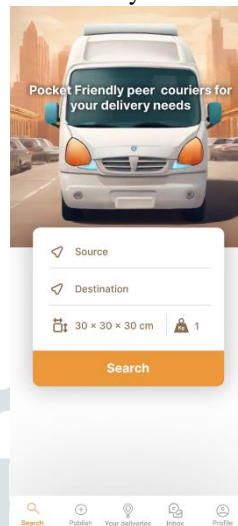


Fig 1 – Application UI

B. Main Navigation Menu:

Main Navigation Bar will be the fundamental instrument that users will use as this is where they will access different features and functions of the application. It was put on every page of the site to make sure it would not be missed by potential guests The menu includes the following options: The menu in our restaurant consists of the following dishes:

Search: Due to the number of appearing passengers or delivery requests and setting the criteria for specific search example the time to go, destination, or size of the package, it help the journeyer to make the decision which match the needs. This system gives it a complete search ability based on filters to narrow down the search results to zero in on an exact destination, hostel or an airline ticket.

Publish: The website "Publish" button helps activate meat shop members to essay their missions and supplications or to make a trip and source works. Customers are meant to fill the form in text box types inputs based on the pickup point, destination, description of the package, and the period of delivery.

Your Deliveries: Compared to this meal content which is expandable around the users beyond their delivery start point and their general deliveries list, there is also an option of deliveries started by users. It will be the delivery summary having the details of he delivery regarding its status, item (if any required), traveller details (If applicable) and the follow up actions.

Inbox: The "Inbox" icon is the button, shown in the figure below, that has us gain access to the area where users can see messages, notifications, and reminders that are related to delivery requests, travelers' questions, or the system announcements. It allows posters to create bulletins/information that is possible to get reapplied, keep conversations with other users and be able to share opinions with senders and travelers, and receive user-generated materials/forum discussions and act appropriately.

Profile: The "Profile"-option contains account information of the user as well a bio and access to profile settings. It enables users to carry out operations such as personal information management, funds account, delivery preference, and transaction order history browsing. Moreover, it also gives the user power to manage their personal information, finances, and preferences of delivery.

C. Cost Effectiveness

As affordability is a key element to examine in the assessment of P2P courier service as an alternative to carrier services, affordable costs of this option become one of the determining factors. The latter part of the article talks about the main issue for P2P courier network and can be summarized into the fact that by using its smart linkage technology the businesses can reduce its operating expense profoundly, position its optimal point of ownership and have pricing models that are both sound and reasonable which basically help to bring down the costs.

Reduced Operational Costs: One of the main advantages of P2P networks is the fact that they drastically lower operational costs for sending letters compared to regular courier services. Such networks exploit current travel routes, and they use travellers as delivery agents, therefore, they eliminate separate delivery vehicles and unnecessary infrastructure leading to considerable financial savings. [12] Key contributors to reduced operational costs include:

No Fleet Maintenance: Unlike courier companies that have depot stations and own a fleet of delivery vehicles whereby they may incur costs related to fleet servicing, P2P networks share the use of travellers vehicles hence no costs accrued thereof.

Minimal Overhead: P2P delivery networks work on the basis of the P2P network, where the need of costly equipment and other resources is very less. The cloud-based technologies and peer-to-peer interaction are the two factors which have achieved very less operational costs and this will help to make the operation cost effective. [13]

Flexible Labor Model: The courier stations on P2P networks set up a flexible workforce model by having travellers earn money as part-time workers. This removes dedicated costs for delivery personnel involved in hiring of fulltime personnel and is great for cost savings when business is slow.

IV. OPERATIONAL MODEL

The workflow of the platform is based on several major features which make it possible for you to send parcels in a safe and fast manner. This section will be focused on the central function of the platform and encompasses the Senders and Travelers Trip, the payments and incentives that are essential to being a part of the operations and how security and trust have been achieved and maintained for the smooth running of the project. [7, 14]

The Peer-to-Peer Courier Network platform is a decentralized marketplace that brings together senders who need their packets to be delivered with travellers who are on their way or travelling towards the same destination. The system will use a simple dashboard to easily connect customers and travellers according to routes and choices. This will result in a community of such members for the last-mile delivery.

A. Process Flow for Senders and Travelers:

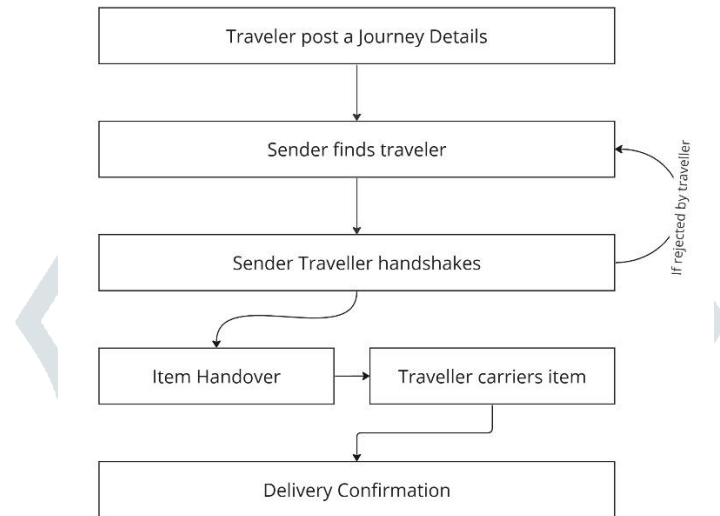


Fig 2 – Process Flow

Travellers Post Journey Details: Travelers initiate the process by logging into the peer-to-peer courier network platform and posting details about their upcoming journey. This includes information such as the starting point, destination, date, and time of travel.

Senders find travellers: Senders, who need to send a package to a destination along a traveller's route, search the platform for available travellers whose journeys align with their package delivery requirements. The platform's search and filtering options facilitate this process.

Sender Travellers Handshake: Once senders identify suitable travellers, they send delivery requests to those travellers, providing details about the package and delivery requirements. Upon receiving a delivery request, travelers review the details and decide whether to accept or reject it. If accepted, the sender and traveler proceed to negotiate and agree on terms such as delivery fee, pickup location, and drop-off location. If rejected, the process returns to the sender finding travelers, allowing for alternative matches.

Giving Over Items: Once the sender and traveller decide on the rules, the sender gets the package ready for delivery and plans for the traveller to pick it up from the chosen place at the set time. The passing of the package ensures that it is packed safely and marked for transport.

Travellers Take Items: With the package in their hands, the traveller takes it during their trip to the agreed delivery place at the end. The traveller makes sure the package is transported safely, taking steps to avoid harm or loss.

Delivery Confirmation: When the traveller gets to the end, they give the package to the receiver at the set place. The receiver confirms getting the package, either with a signature, a message on the platform, or another decided way. This confirmation shows the successful end of the delivery process.

B. Security and Trust Considerations:

- i. **User Verification:** The Verification process is done on the platform and is very efficient in preventing network users from fraudulent activities.
- ii. **Transaction Security:** Online money processing systems and encrypted communication channels make as well as save every financial deal transaction including messaging exchanged between the sender and the voyager.
- iii. **Dispute Resolution:** Customers and drivers will feel supported since the platform serves as a marketplace in the case of concerns and other complaints about the service delivery or if there are issues that they may have. The platform offers mediation and conflict resolution mechanisms to ensure smooth operations and a joint effort in resolving user conflicts.
- iv. **Rating and Review System:** The platform of Peer-to-Peer Courier Network integrates operational processes in ways that ensure there isn't any hitch in the operational flow and builds a favorable feedback from all the users which means that last mile delivery will be bit ecofriendly, cost effective, and attractive.

By integrating these operational elements, the Peer-to-Peer Courier Network platform ensures seamless coordination, efficient package delivery, and enhanced trust among users, ultimately revolutionizing last-mile logistics in a sustainable and cost-effective manner.

V. BENEFITS

The Centralized concept of owning a P2P (peer-to-peer) courier network system provides various solutions that lead to the reform of the last mile in delivery that requires logistics. This paragraph is dedicated to discussing the key areas of improvement of

P2P network systems through an approach which is efficient, resourceful, environmentally friendly and promotes the whole participating sides of the systems.

A. *Enhanced Efficiency*

Enhanced Efficiency Optimized Resource Utilization: P2P courier network systems delve into the pool of travel routes and normally unsaturated capacity in travelers' vehicles to get the best from resources. By going in tandem with passenger trips' demands, P2P networks eliminate the dead capacity, and reach the maximum transportation efficiency, thereby inducing and streamlining the delivery operations and diminishing the number of transit times.

Dynamic Routing Algorithms: The P2P network systems' advanced routing algorithms factor in real data, travellers availability, and after-cargo dimensions into delivery plans designed to optimize at any given time. By reducing their detours and virtually optimizing deliveries, these algorithms make the routes more streamlined, allowing your orders to come on schedule; therefore, the whole process increases efficiency.

B. *Cost-Effectiveness*

Reduced Operational Costs: New P2P network systems differ from classical courier delivery services in the sense that they do not require dedicated delivery vehicles and infrastructure, thus, significantly lowering the operational expenses. The utilization of travellers contributing to a peer-to-peer network for package delivery eliminates many fleet maintenance costs, administrative fees, and worker wages. Such streamlining leads to fewer expenses for both senders and receivers.

Competitive Pricing Models: Through P2P network systems, one can have competitive rate models that give low-cost settlements as compared to courier service providers. Removing agents and using peer involvement, P2P networks can make a point about delivery price and at the same time guarantees a profitability for participants. In addition to the clear pricing schemes, intelligent price mechanisms and bonuses/incentive programs also take part in the quest for affordable P2P courier services.

VI. RESULTS

At the same time, one could conclude that (the P2P network) network is a breaking of the mould in last-mile delivery, which is recently emphasized a new trend that merges time and resources in the logistics process between participants. Our piece is going to summarize that innovative peer-to-peer courier businesses will affect the mutual effect of either conventional mode of travel or even the social aspects of well-being, threatening the job market of the personnel who work in the parcel delivery industry.

The New P2P (peer-to-peer) Network in Courier Service is the introduction of a new model to last mile delivery, which leverages on collaborative actions and mutual benefits. On the following part, we delve into the implications of the P2P Courier Network on environmental sustainability, social and economic shifts, and job changes in the delivery industry.

Reduced Reliance on Delivery Vehicles: Conventional courier mediums usually have dedicated automobile for each shipment contributing to more fuel consumption and wasting of fuel. Rather than P2P courier networks creating new routes they exploit existing travel routes to deliver packages. These routes may involve using private cars, trains, or the buses. Through the use by road travellers who are already out there, P2P networks therefore decrease the needs for other vehicles hence less of the road related emissions. The possibility of distribution of transportation resources through this permits an impressive reduction of the carbon emissions and it reduces the environmental impact of the traditional courier services.

Emission Calculation:

Emission Reduction (gCO₂e/delivery) = $\Delta D \times EF$,

Where, ΔD (delta D) represents the difference between Traditional Delivery Distance and P2P Delivery Distance (km)

EF represents the Emission Factor (gCO₂e/km)

Emission factors will be obtained from reputable sources like the Environmental Protection Agency (EPA) or similar regional bodies, accounting for vehicle type, fuel efficiency, and regional variations ([5]).

By combining distance-based emission calculations with a comprehensive LCA, this study will provide a holistic understanding of the environmental impact of P2P delivery networks. The findings can inform policymakers, platforms, and consumers in promoting sustainable practices within the growing P2P delivery landscape.

Peer-to-peer (P2P) courier networks offer a novel approach to package delivery, presenting new economic opportunities for travelers. This section explores these opportunities and their potential impact:

The P2P courier networks have an interesting economic idea for those traveling. They create ways to make more money while traveling, increase the budget for your trip and provide flexible working hours. As this area keeps changing, there will be even greater economic advantages to people who are travelling.

VII. CHALLENGES AND CONSIDERATIONS

While peer-to-peer (P2P) network systems offer innovative solutions for last-mile delivery logistics, they also face various challenges and considerations that warrant attention. This section highlights key challenges and considerations associated with P2P network systems, ranging from technological constraints to operational complexities and regulatory implications.

A. *Operational Complexities*

Logistical Challenges: Coordinating package pickup, delivery handovers, and tracking across diverse geographical locations and travel routes poses logistical challenges for P2P network systems. Managing complex delivery workflows, handling package routing, and resolving logistics-related issues require robust operational strategies and efficient coordination mechanisms.

B. *Quality Control*

Maintaining quality standards and ensuring consistency in delivery services can be challenging in P2P network systems, where participants vary in experience, reliability, and professionalism. Implementing quality control measures, performance metrics, and user feedback mechanisms are essential to uphold service quality and user satisfaction.

C. *Regulatory Implications*

Legal and Regulatory Compliance: P2P network systems operate within a regulatory framework that governs various aspects such as transportation, liability, taxation, and data protection. Ensuring compliance with local, national, and international regulations is essential to mitigate legal risks [26] and maintain regulatory integrity.

Insurance and Liability: Clarifying insurance coverage, liability agreements, and dispute resolution protocols for package loss, damage, or theft is crucial in P2P network systems. Determining the responsibilities of senders, travelers, and platform operators in different scenarios and providing adequate insurance coverage is essential to protect all parties involved. [25]

REFERENCES

- [1] Li, X., Wang, X., & Yan, X. (2020). Optimizing Last-Mile Delivery for E-Commerce: A Review and Framework. *Sustainability*, 12(23), 9847.
- [2] McKinnon, A. C., Piecyk, M., & Awasthi, A. (2019). The environmental impact of urban logistics: A review. *Journal of Transport Geography*, 81, 12-23.
- [3] Ivanov, D. A., Choi, T. M., & Podvezko, V. (2020). Sustainable Logistics and Supply Chains: Managing Risks and Opportunities. *Sustainability*, 12(2), 434.
- [4] Zhang, Y., & Wen, Z. (2017). The Peer-to-Peer (P2P) Economy: Trends and Challenges. *Sustainability*, 9(4), 543.
- [5] Acquier, A., Filho, M. G., & Nusslé, U. (2017). Collaborative consumption and the sharing economy: Insights from a Brazilian case study. *Journal of Business Strategy*, 38(1), 182-190.
- [6] Fang, Y., Huang, J., & Li, J. (2018). Building trust in online peer-to-peer marketplaces: A meta-analysis review of trust antecedents and outcomes. *International Journal of Electronic Commerce*, 22(3), 327-358.
- [7] Blohm, I., & Crainic, T. G. (2016). A survey on optimization problems in city logistics. *European Journal of Operational Research*, 252(3), 609-630.
- [8] Wang, Y., & Li, Z. (2019). "Trust Building in Peer-to-Peer Logistics Platforms: A Multi-Stakeholder Perspective." *International Journal of Physical Distribution & Logistics Management*, 49(8), 789-812.
- [9] Gupta, S., & Sharma, A. (2018). "Scalability Challenges in Peer-to-Peer Courier Networks: An Exploratory Study." *Journal of Business Logistics*, 39(2), 189-205.
- [10] Kim, H., & Lee, S. (2017). "Economic Viability of Peer-to-Peer Courier Networks: A Comparative Analysis." *Transportation Research Part A: Policy and Practice*, 105, 207-223.
- [11] Kim, H., & Lee, S. (2017). "Economic Viability of Peer-to-Peer Courier Networks: A Comparative Analysis." *Transportation Research Part A: Policy and Practice*, 105, 207-223.
- [12] Zhang, L., & Wang, Q. (2018). "Regulatory Landscape of Peer-to-Peer Courier Services: A Comparative Study." *International Journal of Logistics Management*, 29(3), 835-852.
- [13] Li, J., & Wu, H. (2019). "Operational Model and Functionality of Peer-to-Peer Courier Networks: A Case Study." *Journal of Transportation Engineering*, 145(6), 04019045.
- [14] Yang, C., & Chen, W. (2020). "User Experience and Interface Design in Peer-to-Peer Courier Networks: An Empirical Study." *International Journal of Human-Computer Interaction*, 36(9), 845-862.
- [15] Wang, H., et al. (2018). "Cost Effectiveness of Peer-to-Peer Courier Networks: A Comparative Analysis." *Transportation Research Part C: Emerging Technologies*, 93, 192-208.