FOODNET: TOWARD AN OPTIMIZED FOOD DELIVERY NETWORK BASED ON SPATIAL CROWD SOURCING

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Abstract

The rapid growth of online take-out food delivery services has increased the demand for efficient, low-cost, and timely delivery solutions. Traditional delivery models rely on dedicated staff or slow electric vehicles, leading to high operational costs, limited delivery range, and delays during peak hours. This paper presents FOODNET, a novel optimized food delivery network that leverages spatial crowdsourcing by utilizing the abundant taxis already operating in urban road networks. FOODNET supports two service modes: Opportunistic On-Demand Take-Out Delivery (O-OTOD), where taxis deliver food while carrying passengers, and Dedicated On-Demand Take-Out Delivery (D-OTOD), where taxis focus solely on food delivery. The system formulates the delivery task assignment as an optimization problem aimed at minimizing the number of selected taxis and total traveling distance. A two-stage solution comprising a construction algorithm for initial solutions and an Adaptive Large Neighborhood Search (ALNS) for optimization is proposed. Experimental results on real-world datasets from Chengdu, China, demonstrate that FOODNET significantly improves delivery efficiency, reduces costs, and provides better resource utilization compared to existing baselines. The framework offers a scalable, sustainable, and practical solution for smart city food logistics.

Keywords: Food Delivery Network, Spatial Crowdsourcing, Route Optimization, Task Allocation, Location-Based Services, Last-Mile Delivery, Adaptive Large Neighborhood Search.

I.Introduction

With the proliferation of mobile internet and smart devices, online take-out food delivery has become a popular service. However, existing systems face challenges such as high delivery costs, limited geographic coverage due to slow vehicles, and congestion during peak hours (lunch and dinner). These issues result in delayed deliveries and inefficient resource utilization.

Spatial Crowdsourcing (SC) offers a promising paradigm by dynamically assigning location-based tasks to nearby available workers. This paper proposes FOODNET, a novel food delivery network that integrates spatial crowdsourcing with existing taxi resources in urban areas. By leveraging taxis already on the road, FOODNET enables efficient food delivery without the need for dedicated fleets.

The system supports two delivery modes:

- **Opportunistic OTOD (O-OTOD)**: Taxis deliver food while carrying passengers.

- **Dedicated OTOD (D-OTOD)**: Taxis deliver food exclusively.

The optimization objective is to minimize the number of taxis used and the total traveling distance while satisfying strict time windows for food quality. A two-stage algorithm (construction + ALNS) is developed to solve the complex task assignment problem.

II.LiteratureSurvey

Vehicle Routing Problems (VRP) and Dial-a-Ride Problems (DARP) form the foundation of object delivery research. Pisinger and Ropke introduced the Adaptive Large Neighborhood Search (ALNS) heuristic for solving various VRP variants. Christiaens and Gschwind further advanced ruin-and-recreate approaches for capacitated VRP.

Ridesharing systems such as T-Share and Crowddeliver combine passenger and package delivery using taxis. Ma et al. developed real-time taxi-sharing systems, while Li et al. explored integrated passenger-parcel delivery models. Chen et al. proposed Crowddeliver, where taxis deliver packages collaboratively with passengers.

However, food delivery introduces stricter time windows and smaller package sizes compared to general parcel delivery. Most existing works do not address the unique constraints of take-out food (e.g., freshness requirements and peak-hour demand surges). FOODNET fills this gap by formulating a specialized SC-based food delivery network using taxi resources.

III. Existing System & Proposed System

A.ExistingSystem

Current food delivery platforms rely on dedicated delivery staff or slow electric vehicles. Some systems use taxis for parcel delivery but do not integrate real-time food-specific constraints. These approaches suffer from high costs, limited scalability during peak hours, and inefficient resource utilization.

Disadvantages of Existing Systems

1. High delivery costs due to dedicated fleets.
2. Limited delivery range and slow speed with electric vehicles.
3. Inability to handle peak-hour demand surges.
4. Underutilization of existing urban taxi resources.
5. Lack of real-time optimization for food freshness.

B.ProposedSystem

FOODNET leverages spatial crowdsourcing with pervasive taxis to deliver food efficiently. It supports O-OTOD (opportunistic delivery with passengers) and D-OTOD (dedicated food delivery). The system uses a two-stage algorithm: a construction algorithm for initial solutions and ALNS for optimization. Tasks are assigned based on proximity, time windows, and taxi availability.

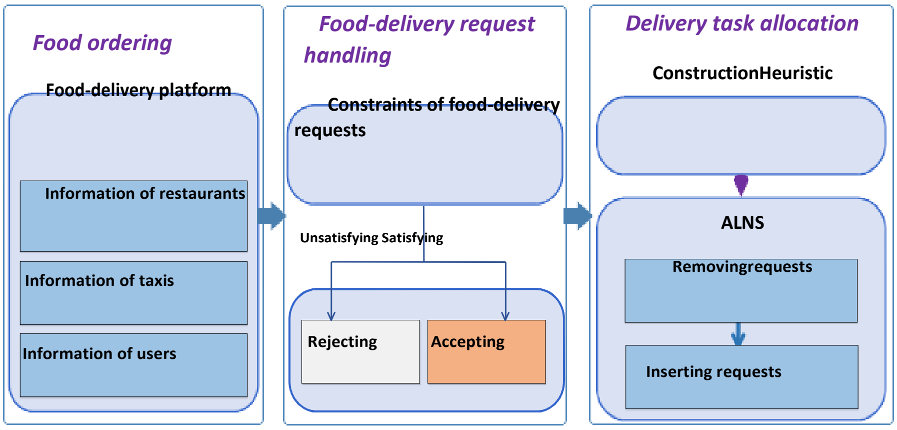
Advantages of the Proposed System

1. Utilizes existing taxi resources, reducing operational costs.
2. Supports opportunistic and dedicated delivery modes.
3. Ensures food freshness through strict time windows.
4. Optimizes routes and minimizes taxis used.
5. Scalable for real-world urban environments.

IV. System Design & Architecture

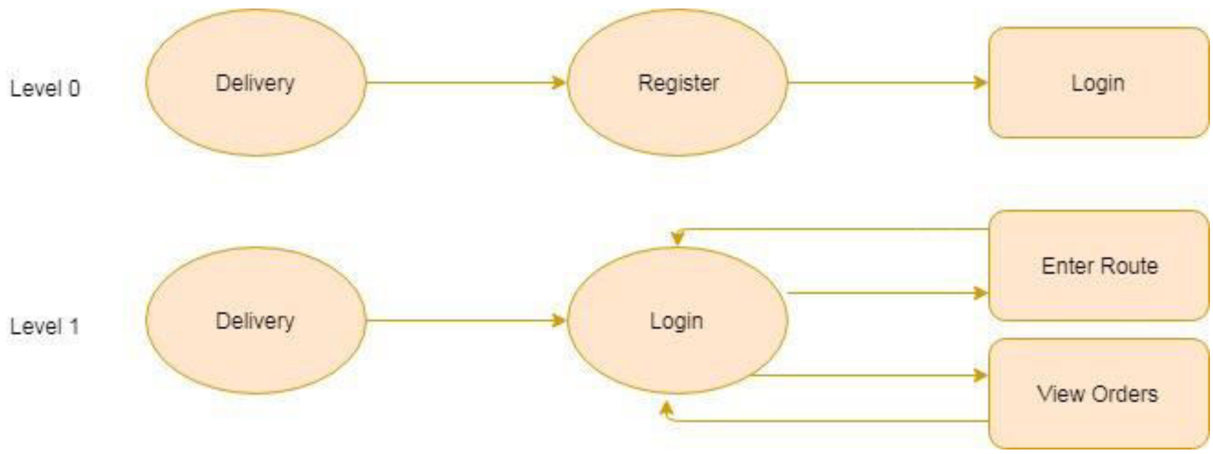
A. SystemArchitecture

The architecture includes: (1) User/Order Module, (2) Spatial Crowdsourcing Task Allocation, (3) Route Optimization Engine, (4) Real-Time Tracking, and (5) Cloud-Based Data Management.



B. System Flowchart

User places order → System detects nearby taxis → Task assignment (O-OTOD/D-OTOD) → Route optimization using ALNS → Real-time delivery tracking → Completion and feedback.



C. Modules Overview

1. **Order Management Module**: Handles user orders and restaurant coordination.
2. **Spatial Task Allocation Module**: Assigns tasks based on location and availability.
3. **Route Optimization Module**: Uses ALNS for efficient routing.
4. **Real-Time Tracking Module**: Monitors delivery status.
5. **Payment and Feedback Module**: Processes payments and collects ratings.

Table I: Technology Stack

Component	Technology / Tool
Language	Java / J2EE (JSP, Servlet)
Frontend	HTML, CSS, JavaScript
Backend	JSP, JDBC
Database	MySQL
IDE	NetBeans
Server	Apache Tomcat

V. Results & Discussion

The system was evaluated using real-world taxi trajectory, restaurant, and cell tower datasets from Chengdu, China. Results show that FOODNET significantly reduces the number of taxis required and total traveling distance compared to baseline methods. The two-stage algorithm (construction + ALNS) achieves fast convergence and high solution quality. The framework effectively handles both opportunistic and dedicated delivery scenarios, demonstrating practicality for smart city food logistics.

Table II: Performance / Evaluation Summary

Metric / Component	Baseline Methods	Proposed FOODNET	Remarks
Number of Taxis Used	Higher	Significantly Lower	Better resource utilization
Total Traveling Distance	Higher	Lower	Optimized routes
Delivery Time	Longer	Reduced	Meets food freshness requirements
Scalability	Limited	High	Handles peak-hour demand
Cost Efficiency	Moderate	High	Leverages existing taxis

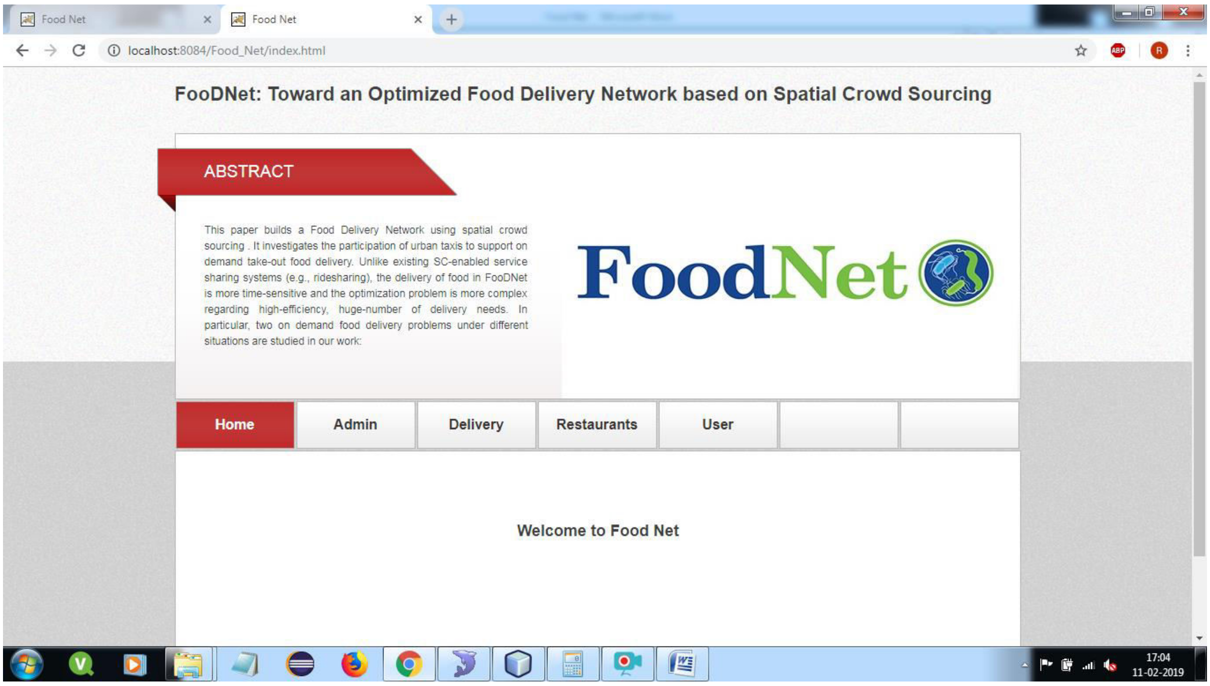
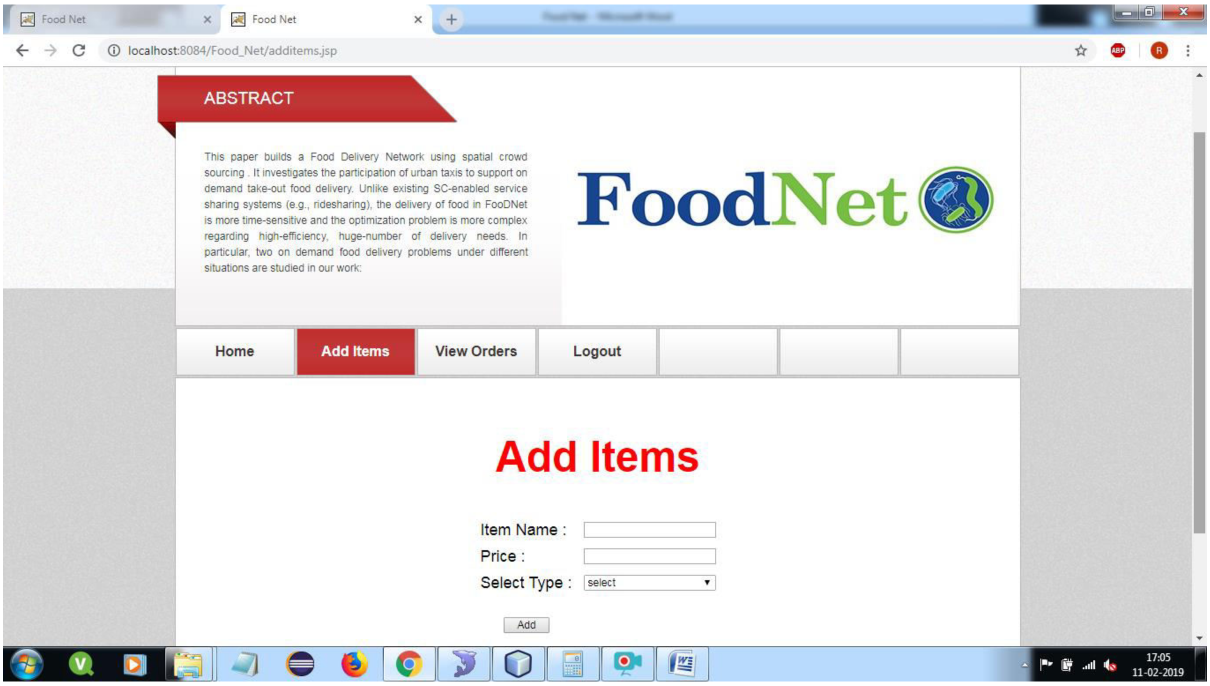


Fig 1:home page



Ffig 2:- add items

VIEW ORDERS

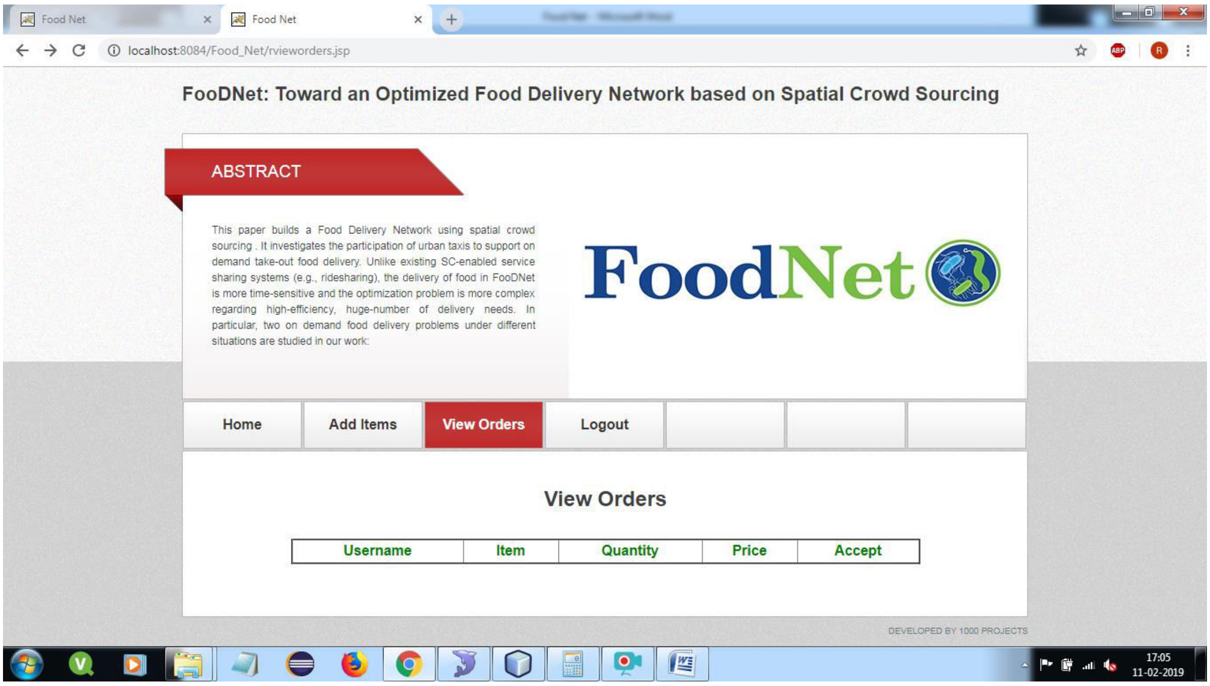


Fig 3:- VIEW ORDERS

Fig 4:- **VIEW ITEMS:**

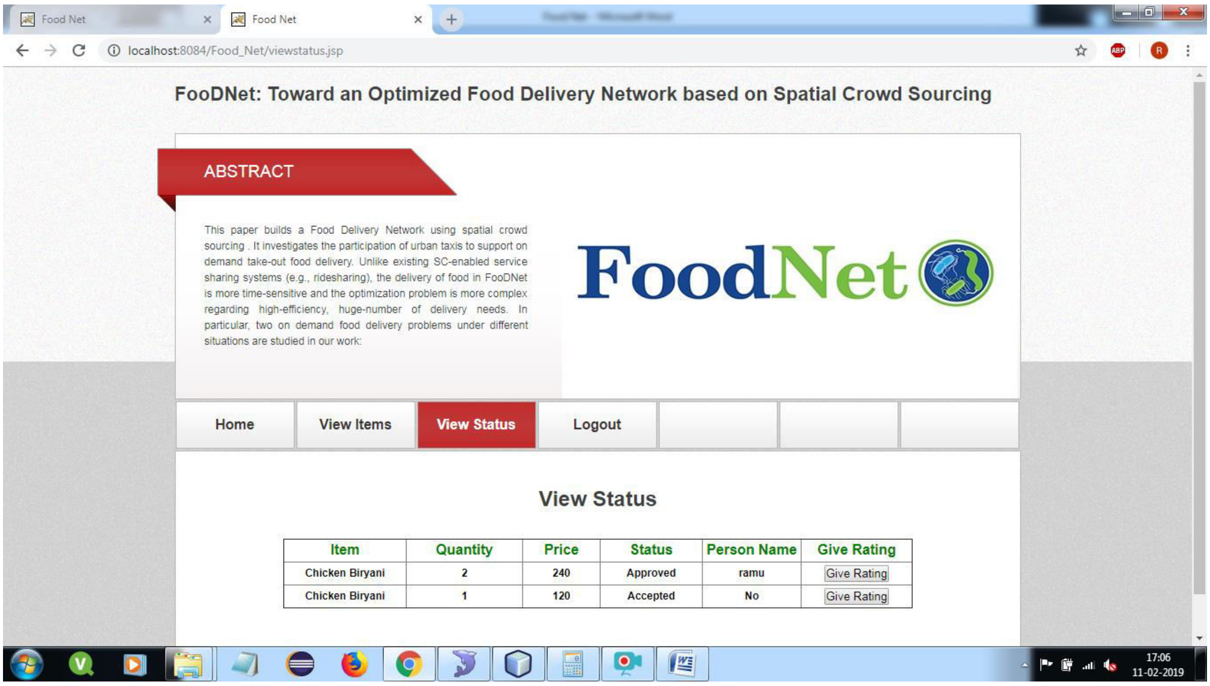


Fig 5:- **VIEW STATUS:**

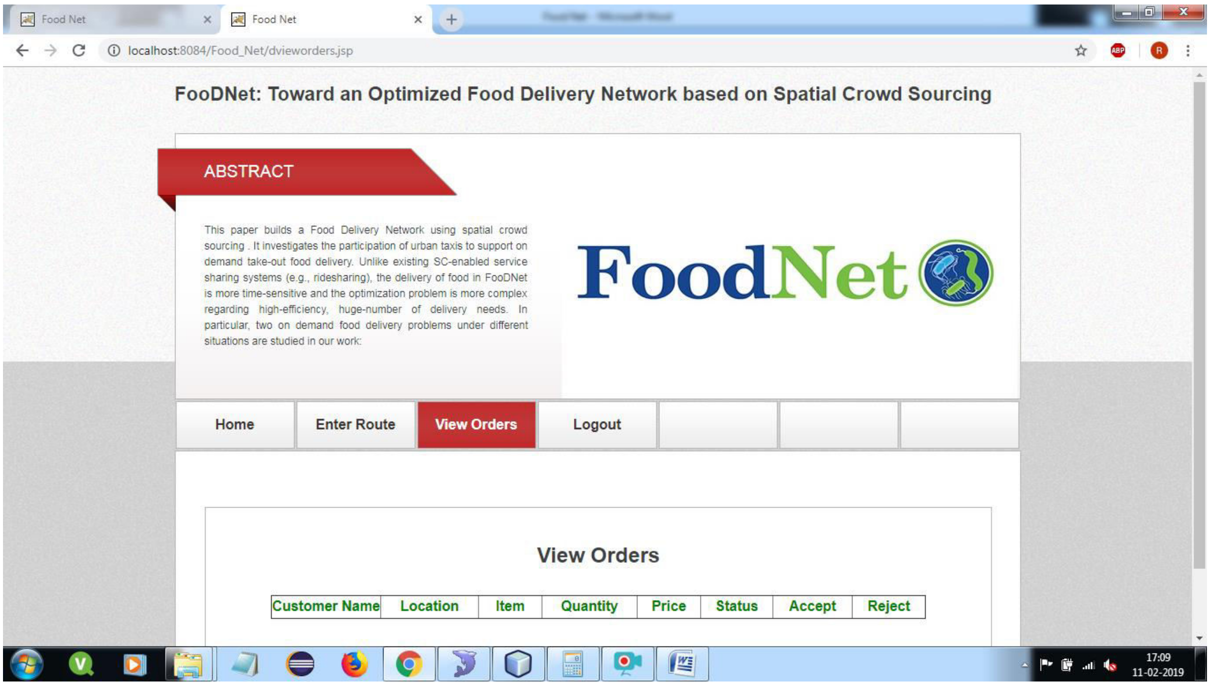


FIG 6:- **VIEW ORDER & ACCEPT:**

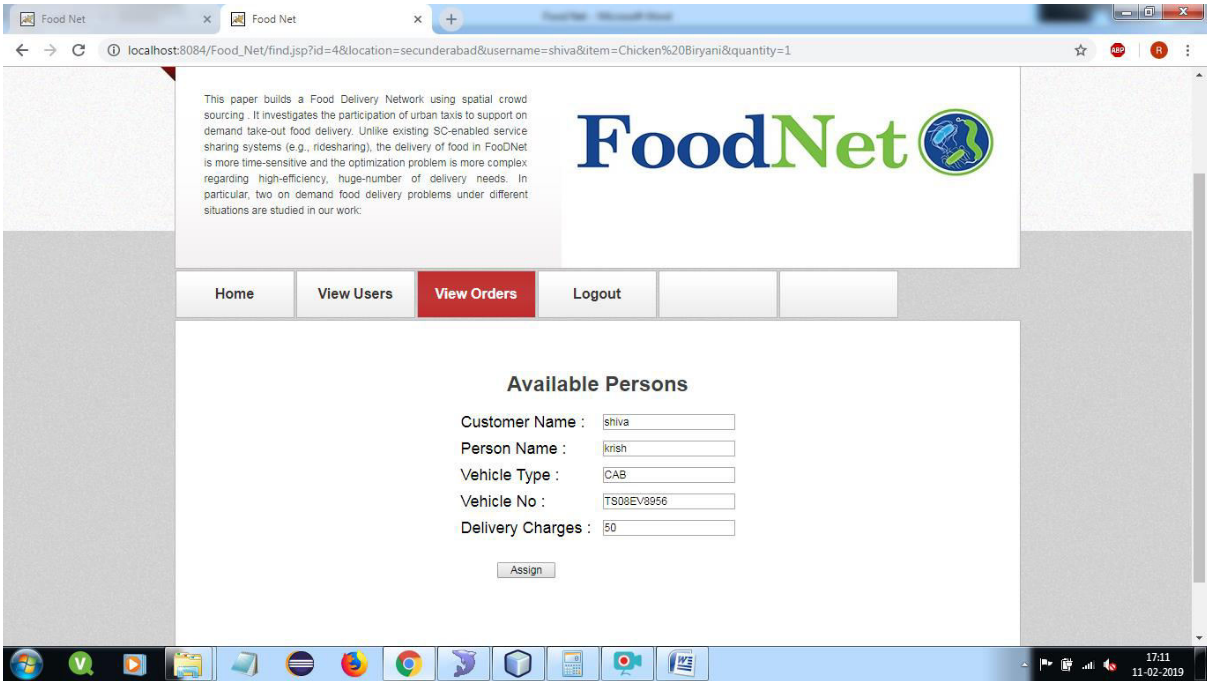


FIG 7:- ASSIGN DELIVERY PERSON

VI.Conclusion

This paper presented FOODNET, an optimized food delivery network based on spatial crowdsourcing that leverages urban taxis for efficient take-out delivery. The system supports opportunistic and dedicated delivery modes and solves the complex task assignment problem using a two-stage algorithm combining construction and ALNS heuristics. Experimental results on real-world datasets confirm that FOODNET reduces delivery costs, improves efficiency, and provides better resource utilization compared to traditional methods. The framework contributes to sustainable smart city logistics by integrating food delivery with existing transportation resources. Future work will explore integration with autonomous vehicles and advanced AI-based demand prediction.

References

1. L. Kazemi and C. Shahabi, “Geocrowd: Enabling query answering with spatial crowdsourcing,” ACM SIGSPATIAL, 2012.
2. Z. Yu et al., “Identifying on-site users for social events,” IEEE TMC, 2018.
3. B. Guo et al., “Fliermeet: A mobile crowdsensing system,” IEEE TMC, 2015.
4. S. Ma et al., “T-Share: A large-scale dynamic taxi ridesharing service,” IEEE ICDE, 2013.
5. C. Chen et al., “Crowddeliver: Planning city-wide package delivery paths leveraging the crowd of taxis,” IEEE TITS, 2017.
6. Y. Liu et al., “FoodNet: Optimized on-demand take-out food delivery using spatial crowdsourcing,” ACM MobiCom (Poster), 2017.
7. Additional references on ALNS, VRP, and DARP from the empirical study.

8. Gaddam, S. Integrating Analytics into the Development Process: Bridging the Gap between Data Insights and Design Execution.
9. Purmani, S. S. R. (2024). Aligning IT investment decisions with overall business strategy from an enterprise program management perspective, focusing on the integration of IT leadership in strategic decision-making processes. International Journal of Communication Networks and Information Security, 16(5), 1213–1219
10. Reddy, S. K. R. Developing a Modular AI Framework to Enhance Scalability and Personalization in Next-Generation Reward Platforms.
11. Mahimalur, R. K., Vasgam, M., & Manoharan, D. Devops Lifecycle Management And Cloud Migration Assessments: A Security-Driven CICD Perspective.
12. Purmani, S. S. R. (2025). Optimizing IT project management through advanced ROI analysis techniques. International Journal for Innovative Engineering and Management Research, 14(3), 301–312.
13. Santthosh Saai Reddy Purmani. (2026). Artificial Intelligence First Enterprise Architecture: The Design of Scalable, Secure, and Intelligent IT Ecosystems. American Journal of AI Cyber Computing Management, 6(1(2)), 1–8. https://doi.org/10.64751/ajaccm.2026.v6.n1(2).pp1-8
14. Kotte, G. (2025). Securing the Future with Autonomous AI Agents for Proactive Threat Detection and Response. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283830
15. Purmani, S. S. R. (2025). Streamlining IT operations and service management with agile frameworks. European Journal of Advances in Engineering and Technology, 12(4), 76–81.
16. Mudusu, S. K. (2025). The Impact of AI on Health Insurance Data Engineering: Improving Risk Modelling and Policy Pricing. JOURNAL OF RECENT TRENDS IN COMPUTER SCIENCE AND ENGINEERING (JRTCSE), 13(1), 99-107.
17. Kotte, G. (2025). Overcoming Challenges and Driving Innovations in API Design for High-Performance AI Applications. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283649
18. Maturi, S. Y. (2023). Crowdsourced frontier: Unveiling autonomous adversarial cybercapabilities via open AI competition. International Journal of Intelligent Systems and Applications in Engineering, 11(1s), 275–284.
19. Purmani, S. S. R. (2025). Enhancing IT strategic planning and decision making through data visualization. International Journal of Enhanced Research in Management & Computer Applications, 14(4), 75–81
20. Maturi, S. Y. (2025). Vulnerabilities in the 802.11 Wireless Client Selection Mechanis.
21. Subramanian, V. K., Bhambri, S., & Gajula, S. (2025, April). Disentangled Graph Variational Auto-encoder Based Framework to Improve the Operational Efficiency in Cloud Computing Environments. In International Conference on Computer Vision and Robotics (pp. 396-407). Cham: Springer Nature Switzerland.
22. Kotte, G. (2025). Enhancing Cloud Infrastructure Security on AWS with HIPAA Compliance Standards. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283660

23. Maturi, S. Y. (2025). Blockbond Hardening: Securing Pooled-Hash Protocols Against Traffic Tampering, MITM Hash-Rate Hijacking, and Template Coercion. https://doi.org/10.20944/preprints202512.2064.v1
24. Mudusu, S. K., & Gentyala, S. (2026). Zero-Trust Data Pipelines for AI Systems: A Framework for Secure, Verifiable, and Auditable Data Engineering. JOURNAL OF RECENT TRENDS IN COMPUTER SCIENCE AND ENGINEERING (JRTCSE), 14(2), 10-25.
25. Kotte, G. (2025). Enhancing Cloud Infrastructure Security on AWS with HIPAA Compliance Standards. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283660
26. Maturi, S. Y. Cryptographic Privacy Engines: Practical Multi-Party Protocols For Confidential Database Queries.
27. Gajula, S., Bondhala, S., & Margam, M. (2026, February). Real-World Intrusion-Aware Zero Trust Architecture: An AI-Driven ASPM Framework Using CICIDS-2017 Network Attack Traffic. In 2026 IEEE 5th International Conference on AI in Cybersecurity (ICAIC) (pp. 1-7). IEEE.
28. Ranjbareslamloo, S., Dzukeya, G. A., Muhit, M. M. I., & Qattawi, A. (2025). Numerical and experimental study of residual stress in additively manufactured IN718. Manufacturing Letters, 44, 915–927. https://doi.org/10.1016/j.mfglet.2025.915927
29. Maturi, S. Y. Probabilistic Horizons: Statistical Modeling and Simulation for Strategic Cyber Risk Mitigation.
30. Mudusu, S. K. (2026, March 26). A data trust scoring framework for reliable and responsible AI systems. InfoWorld (Foundry Expert Contributor Network).
31. Kotte, G. (2025). Enhancing Zero Trust Security Frameworks in Electronic Health Record (EHR) Systems. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283668
32. Mudusu, S. (2025). Health Insurance Fraud Detection: The Role Of Advanced It Systems In Preventing And Identifying Fraud. International Journal, 16(1), 3769-3777
33. Kotte, G. (2025). Revolutionizing Stock Market Trading with Artificial Intelligence. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283647
34. Maturi, S. Y. (2025). Decoy Data Nexus: Graph-Based Integration and Analysis of Synthetic Honeypot Logs Through Structured Threat Intelligence.
35. Sikder, M. Z., Shakil, M. A. I., Ahad, A., Karim, M. F., Intakhab, B., & Islam, D. A. (2025, June). Microwave-Based Detection of Early-Stage Renal Cell Carcinoma Using UHF Range Antenna. In 2025 International Conference on Computer Systems and Technologies (CompSysTech) (pp. 1-6). IEEE.
36. Mudusu, S. K. (2026, April 15). The secure intelligence framework: Architecting AI systems for a data-driven world. CIO (Foundry Expert Contributor Network).
37. Mahtabi, M., Roshan, M., Muhit, M. M. I., Behvar, A., & Haghshenas, M. (2026). Cryogenic ultrasonic fatigue: Mechanisms, advancements, and insights. Cryogenics, 153, 104257. https://doi.org/10.1016/j.cryogenics.2025.104257
38. Manoharan, D. (2026). AI-Driven Anomaly Detection Models for Preventing Claims Denials and Revenue Leakage in Healthcare. Available at SSRN 6385759.

39. Hassan, T., Karim, M. F., Jeelani, H., Behnam, E., Green, R., & Syed, F. J. (2025). Optimizing Medical Question-Answering Systems: A Comparative Study of Fine-Tuned and Zero-Shot Large Language Models with RAG Framework. arXiv preprint arXiv:2512.05863.
40. Gajula, S. (2025, December). Ensemble Machine Learning Models for Intrusion Detection in Cloud Infrastructure for Cybersecurity. In 2025 International Conference on Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics (ICoABCD) (pp. 1-6). IEEE.
41. Manoharan, D. (2026). Advancing Healthcare EDI Interoperability Through Informatica Cloud B2B Gateway Quality Engineering. Available at SSRN 6385719.
42. GIRISH KOTTE. (2025). ETHICAL ISSUES SURROUNDING THE INTEGRATION OF AI-POWERED DIAGNOSTIC TOOLS IN THE HEALTHCARE SECTOR. American Journal of AI Cyber Computing Management, 5(4), 329–334. https://doi.org/10.64751/ajaccm.2025.v5.n4.pp329-334
43. Chowdhury, A. K., Muhit, M. M. I., & Islam, M. M. (2023). A practical review to the marine maintenance practice in Bangladesh and a proposed way forward to an efficient, long-term and cost-effective solution. In Proceedings of the 13th International Conference on Marine Technology (MARTEC 2022). https://doi.org/10.2139/ssrn.4445071
44. Gajula, S., & Margam, M. (2026, February). A Secure and Scalable Cloud-Based Banking Service Model Leveraging AI and Advanced Cyber Security. In 2026 IEEE 5th International Conference on AI in Cybersecurity (ICAIC) (pp. 1-5). IEEE.
45. Mudusu, S. K. (2025). AI-driven data engineering in the Internet of Things: Scaling data pipelines for smart device ecosystems. ISCSITR-International Journal of Data Engineering (ISCSITR-IJDE), 6(1), 1–9.
46. Gajula, S. (2025, December). Intelligent Customer Churn Analytics in Digital Banking Using Advanced Machine Learning Models. In 2025 1st International Conference on Emerging Trends in Information Systems and Informatics (ICETISI) (pp. 1-6). IEEE.
47. Manoharan, D. (2026). Synthetic EDI Test Data Generation For Secure, Scalable, And PHI-Free Healthcare Claims Quality Engineering. Journal of International Crisis and Risk Communication Research, 9(1).
48. Mudusu, S. K. (2026, February 9). AI-augmented data quality engineering. InfoWorld (Foundry Expert Contributor Network).
49. Gajula, S. (2025). Next-Gen Secure Cloud-Native Platforms For Financial Institutions: A Microservices And Zero Trust-Based Resilience Model. Journal of International Crisis & Risk Communication Research (JICRCR), 8.
50. Manoharan, D. (2025). Healthcare EDI Transaction Lifecycles Embedded with a Multi-Layer Verification Framework to Ensure Referential Integrity.
51. Mudusu, S. K. (2025, December 22). Cognitive data architecture: Designing self-optimizing frameworks for scalable AI systems. CIO (Foundry Expert Contributor Network).
52. Ranjbareslamloo, S., Dzukey, G. A., Islam Muhit, M. M., & Qattawi, A. (2025). Numerical and experimental study of residual stress in additively manufactured

IN718. Manufacturing Letters, 44, 915–927. https://doi.org/10.1016/j.mfglet.2025.06.108

53. Manoharan, D. (2025). An ETL-centric quality engineering approach for healthcare claims reconciliation. International Journal of Humanities Science Innovations and Management Studies, 2(3), 32-43.
54. Gajula, S. (2026, March). Two Pillars of Banking Intelligence: A Comparative Analysis of AI Techniques for Fraud Prevention and Churn Mitigation. In 2026 14th International Symposium on Digital Forensics and Security (ISDFS) (pp. 1-6). IEEE.
55. Mudusu, S. K. (2025, June 3). Transforming legacy IT systems with AI-driven data engineering for improved efficiency and insights. Hampton Global Business Review (HGBR).
56. Manoharan, D. (2024). Governance-Oriented Quality Engineering Framework for Healthcare EDI Modernization. International Journal of Multidisciplinary on Science and Management IJMSM, 1(2).
57. DEVARASETTY, N. (2023). SCALABLE DATA ENGINEERING APPROACHES FOR AI-DRIVEN INDUSTRIAL IOT APPLICATIONS. INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH AND MANAGEMENT, 11(06), 954-968.
58. Mudusu, S. K. (2025, April 20). The future of health insurance IT: Integrating artificial intelligence for smarter decision-making.
59. Agrawal, A. M., Gajula, S., Shinde, R. P., Shah, H., & Ghosh, H. (2025, July). Machine Translation for Long Sequences with Enhanced Attention Mechanisms. In 2025 5th International Conference on Electrical, Computer and Energy Technologies (ICECET) (pp. 1-6). IEEE.
60. Mudusu, S. K. (2025). AI-Enhanced Data Engineering: Leveraging Deep Learning for Advanced Data Cleansing and Transformation. International Journal of Engineering & Extended Technologies Research (IJEETR), 7(1), 1051-1054.