GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING
(Autonomous)
Approved by AICTE & Affiliated to Andhra University, Visakhapatnam from 2022-23
(Affiliated to JNTUK, Kakinada upto 2021-22)
Accredited twice by NAAC with 'A' Grade with a CGPA of 3.47/4.00
Madhurawada, Visakhapatnam - 530048

GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING

DESIGN THINKING & INNOVATION LAB

Department of CSE (AI &ML)

Year: 2nd year

Semester: 3rd semester

GVPCE-A

Kommadi, Visakhapatnam.

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CERTIFICATE

This is to certify that this Design Thinking and Innovation report entitled "ROUTE OPTIMISATION" being submitted by

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In the partial fulfilment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering (AI & ML) During the academic year 2024-2025.

Internal Guide

Dr. R. Velumani

Associate Professor

Department of CSE

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ACKNOWLEDGEMENTS

It brings me great pleasure for an opportunity to work and submit my report

On Design Thinking and Innovation.For example we sincerely thank **Dr. A. B. Koteswara Rao.** Principal of Gayatri Vidya Parishad College of Engineering (Autonomous) for his providence in Design thinking and innovation.

We Would like to pay my heartfelt gratitude and respect to **Dr. Ravi Saripalle**, Director, Centre for innovation, GVPCE(A) for sharing his wisdom and experience in this field.

We would like to thank our faculty coordinator Dr. R. Velumanai (Associate Professor,CSE) and J. Atchiyamma (Assisstant Professor, CSE) who encouraged and guided us throughout the semester.

By

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TITLE: ROUTE OPTIMISATION

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INDEX

ABSTRACT

In India, where bustling cities and extensive road networks define daily life, the escalating challenges of the traffic system demand urgent attention. Traffic is a major problem in India. Due to the we have many that are incomplete and surely will face the consequences of it. Based on this we have designed a project that helps to solve this problem. We have designed this to suggest an alternative for routes to reduce the traffic problems. Route optimization involves high-level planning and preparation steps that set the foundation for successful optimization. Not only traffic problem, we can also reduce fuel costs. It can be performed by analysing the real time data analytics. Identifying constraints such as delivery time windows and vehicle capacities. Customizing and refining algorithms to fit the specific requirements follows, ensuring they can handle the unique aspects of the route optimization problem. Finally, the model and algorithms undergo validation using historical data or small test scenarios to ensure they provide reliable and accurate results. This thorough preparation ensures that when the detailed optimization begins, it is both efficient and effective, ultimately leading to significant improvements in operational efficiency and cost savings.

INTRODUCTION

Route optimization in India is essential for transforming the logistics and transportation sectors to overcome the unique challenges posed by the country's vast and diverse geography. By effectively planning and optimizing routes, businesses can significantly reduce travel time, lower fuel consumption, and enhance overall operational efficiency. This process begins with defining the primary objectives, such as minimizing travel costs and ensuring timely deliveries, while considering constraints like vehicle capacities and varying road conditions. Accurate data collection and preparation are crucial, reflecting the diverse landscape and traffic patterns of urban and rural areas. Selecting suitable mathematical models and algorithms, such as genetic algorithms or ant colony optimization, tailored to India's specific needs, is vital for addressing dynamic traffic conditions and infrastructure quality. Preliminary analyses and feasibility checks help identify potential issues, generating initial solutions that serve as a baseline. Customizing and validating these algorithms using historical data ensures their effectiveness in real-world scenarios, such as navigating peak traffic during festivals or coping with monsoon season impacts. Ultimately, route optimization in India leads to significant cost savings, improved customer satisfaction, and environmental sustainability, fostering more efficient and reliable logistics operations across the country.

DEFINE PHASE

- PRESENT ROUTE OPTIMISATION TECHNIQUES

Google Maps offers a sophisticated navigation experience by seamlessly integrating GPS technology, real-time traffic data, advanced algorithms, and user feedback. It begins by accurately pinpointing your location using GPS and constantly updates your position as you move. When you enter a destination, Google Maps calculates the best route by analysing various factors, including distance, traffic conditions, road restrictions, and travel time. The app dynamically adjusts the route based on real-time traffic data from road sensors, user devices, and live traffic reports, ensuring you avoid congestion and reach your destination as efficiently as possible.

Turn-by-turn navigation provides detailed directions with voice prompts and visual cues, guiding you every step of the way. The inclusion of user feedback, such as reports of accidents or road closures, allows Google Maps to refine its guidance and offer alternative routes in real-time. Additional features like Street View and satellite imagery give users a visual understanding of their route and destination, enhancing the overall navigation experience. This comprehensive and interactive approach makes Google Maps an indispensable tool for efficient and reliable travel, ensuring users get to their destinations with minimal delays and optimal routes.

- DISADVANTAGES IN GOOGLE MAPS

Despite its immense utility, Google Maps does have several disadvantages that users should be aware of. Firstly, the accuracy of data on Google Maps can sometimes lag, leading to outdated information on road layouts, business locations, or newly developed areas, which can cause navigational issues. The app's reliance on internet connectivity means that in areas with poor network coverage, users may struggle to receive accurate, real-time updates. This dependency also leads to significant battery drainage, potentially leaving users stranded without a charged device. Privacy concerns are notable as well, with Google tracking and storing extensive location data, raising questions about data security and user privacy. An over-

reliance on Google Maps can also erode traditional navigation skills, making users less capable of finding their way without technological aid. Occasionally, the app's algorithms may generate suboptimal routes, directing users through inconvenient or unsafe areas. Moreover, the continuous use of the app can consume a substantial amount of mobile data, which can be costly for users on limited data plans. Lastly, there is a potential for commercial bias, where sponsored locations or advertisements might influence the routes and search results presented to the user. While these issues are significant, many users find that the benefits of using Google Maps outweigh these disadvantages, making it an indispensable tool for modern navigation.

- HOW ROUTE OPTIMISATION TECHNIQUE SOLVES THE PROBLEM

Route optimization can effectively address many of the disadvantages associated with Google Maps by providing more precise, reliable, and customized navigation solutions. Firstly, it ensures data accuracy and timeliness by integrating real-time traffic and road condition updates from multiple sources, thus reducing the likelihood of outdated or inaccurate information. Additionally, advanced route optimization tools often offer offline capabilities, minimizing the dependency on continuous internet connectivity and reducing battery consumption through efficient resource use. Privacy concerns are mitigated by allowing users greater control over data sharing and tracking. Moreover, route optimization systems empower users by improving their navigation skills through clear, alternative route options and step-by-step directions. These systems also offer more reliable directions by avoiding misleading routes and incorporating user feedback to enhance algorithm accuracy. Data consumption is optimized by minimizing the amount of data required for updates, ensuring cost efficiency. Lastly, route optimization tools prioritize user preferences and efficiency over commercial interests, ensuring that the most effective and safe routes are selected. This comprehensive approach makes route optimization a robust solution for overcoming the limitations of Google Maps.

EMPATHY PHASE

Aspect	Description
What	Focuses on understanding and incorporating the needs and constraints of all stakeholders, such as drivers, customers, and businesses, to ensure that route planning is efficient and considerate of human factors.
Why	Balances operational efficiency with the well-being and satisfaction of all parties involved, ensuring routes are practical, humane, and lead to better overall outcomes.
Who	Stakeholders include drivers, customers, and businesses.
How	-Understanding Stakeholder Needs: Gathering feedback from drivers, customers, and logistics managers. - Integrating Constraints: Considering factors like driver breaks and customer delivery windows. - Communication: Ensuring transparent communication and providing training. - Iterative Improvement: Regularly updating routes based on feedback.
When	Integrated into the initial stages of route optimization and continually revisited to ensure that routes remain efficient and considerate of evolving needs.
Where	Applies to all areas where route optimization is needed, including urban and rural deliveries, field service management, and other logistics operations

Aspect	Drivers	Customers	Logistics Managers
Says	"These routes are too long." "I need more breaks." "Traffic is unbearable at this hour."	"When will my delivery arrive?" "Why is my delivery late?" "Can I change my delivery time?"	"We need to cut down delivery times." "How can we reduce fuel costs?" "Customer satisfaction is our priority."
Thinks	"I hope this route is safe and efficient." "Will I get home on time?" "Why can't we avoid this traffic?"	"I want my delivery on time." "I hope nothing gets damaged." "This service should be more reliable."	"Are we maximizing our efficiency?" "How can we improve our routes?" "Is our fleet being utilized effectively?"
Does	Follows the given route. Takes necessary breaks. Reports issues encountered on the road	Tracks the delivery status. Provides feedback on service. Adjusts their schedule for deliveries.	Analyzes route performance. Implements new routing strategies. Communicates with drivers and customers
Feels	Frustrated with traffic and long routes. Tired due to insufficient breaks. Concerned about meeting delivery deadlines safely.	Anxious about delivery timing. Frustrated with delays. Satisfied when service meets expectations.	Pressured to improve efficiency. Concerned about operational costs. Pleased when customer feedback is positive

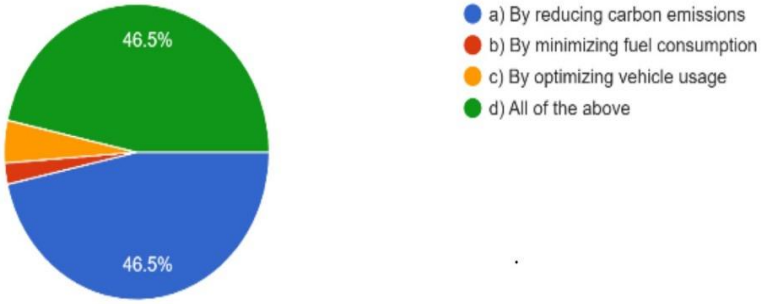
PRIMARY SURVEY

After surveying 44 participants, we gathered valuable insights that will help improve and refine our project, showcasing a diverse array of perspectives and opinions.

How can route optimization contribute to environmental sustainability?

Copy chart

43 responses



What is the primary benefit of implementing route optimization in logistics?

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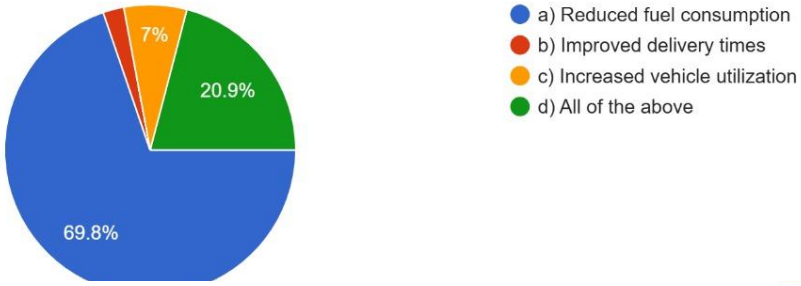
43 responses



Do you currently use any route optimization tools or software?

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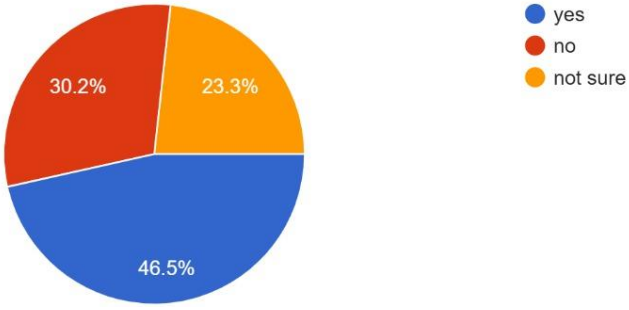
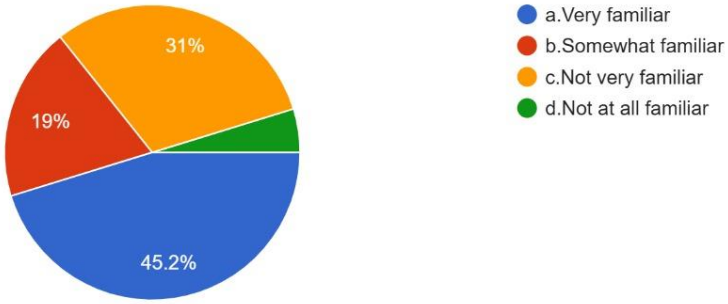
43 responses



1.How familiar are you with the concept of route optimization?

Copy chart

42 responses



What are your biggest concerns about implementing route optimization technology?

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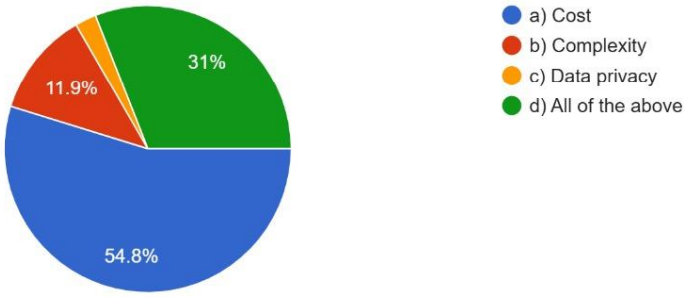
42 responses



Would you be interested in using AI-powered route optimization tools?

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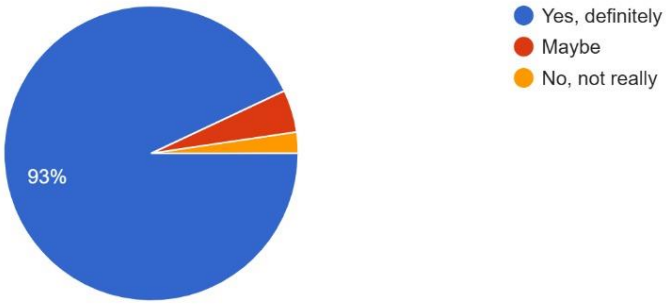
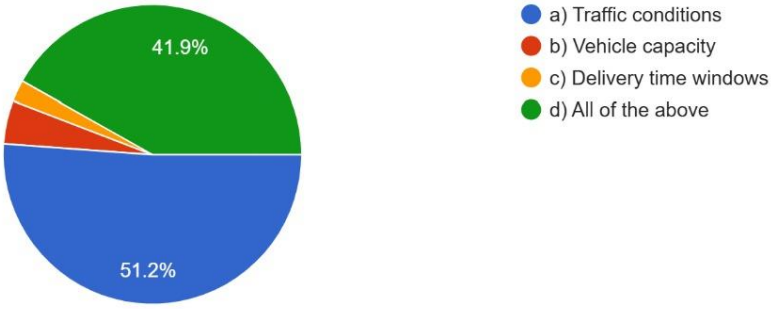
43 responses



Which of the following factors significantly impacts route optimization?

Copy chart

43 responses



How would rate our idea towards speed control ?

2.97
Avg. Response

68
Responses

Data	Response	%
★★★★★	4	6%
★★★★☆	18	26%
★★★☆☆	24	35%
★★☆☆☆	16	24%
★☆☆☆☆	6	9%

LITERATURE SURVEY

Link:https://www.researchgate.net/publication/376575915_The_Use_of_Artificial_Intelligence_to_Optimize_the_Routing_of_Vehicles_and_Reduce_Traffic_Congestion_in_Urban_Areas

Year: 2023

Authors: Srishti Dikshit , Areeba Atiq, Mohammad Shahid, Vinay Dwivedi, Aarushi Thusu

TITLE OF THE PAPER:

The Use of Artificial Intelligence to Optimize the Routing of Vehicles and Reduce Traffic Congestion in Urban Areas

ABSTRACT

The swift urbanization of cities has given rise to an unparalleled surge in vehicular traffic, leading to substantial congestion, heightened pollution, and a diminished quality of life. This investigation explores the capacity of artificial intelligence (AI) to transform urban mobility by optimizing vehicle routing and alleviating traffic congestion. The objective is to create AI-powered solutions that augment transportation efficiency, diminish travel times, and mitigate environmental repercussions. This paper thoroughly scrutinizes existing AI algorithms, vehicle routing, and traffic management techniques. The study integrates real-time traffic data, road network characteristics, and individual travel patterns to formulate intelligent routing strategies. The proposed AI system adjusts to dynamic traffic conditions through machine learning and optimization algorithms, pinpointing optimal routes and redistributing traffic flows to minimize congestion hotspots. To assess the effectiveness of the AI-driven approach, extensive simulations and case studies are conducted in representative urban areas. Performance metrics, including travel time reduction, fuel consumption, and emissions reduction, are employed to quantify the impact of the proposed system on traffic congestion and environmental sustainability. Furthermore, the study evaluates the scalability, feasibility, and economic viability of implementing AI-based traffic management solutions on a larger scale. The outcomes of this research provide valuable insights into the potential advantages of AI in reshaping urban mobility. By optimizing vehicle routing and diminishing traffic congestion, the proposed AI-driven system has the potential to elevate overall transportation efficiency, reduce energy consumption, and contribute to a healthier urban environment. The findings

carry substantial implications for policymakers, urban planners, and transportation authorities seeking innovative solutions to tackle the challenges of contemporary urbanization while promoting sustainable development.

Keywords: Artificial Intelligence, Vehicle Routing, Traffic Congestion, Urban Mobility, Sustainability, Machine Learning,

Optimization, Transportation Efficiency

Board theme of Paper:

In conclusion, while significant progress has been made in using AI to optimize vehicle routing and alleviate urban traffic congestion, this field remains dynamic and ripe for innovation. The research outlined here offers a foundation upon which future studies can be built. With interdisciplinary collaboration, a commitment to ethical AI practices, and a focus on sustainability, we can work towards realizing the full potential of AI in creating more efficient, eco-friendly, and accessible urban transportation systems. As we move forward, researchers, policymakers, and industry stakeholders must continue to invest in AI-driven solutions to tackle the challenges of urban traffic congestion and shape a suitable and unconsisted area.

Link:https://www.researchgate.net/publication/356293595_A_Case_Study_of_Vehicle_Route_Optimization

Year: 2023

Authors: Veronika Lesch, Maximilian Konig, Samuel Kounev, Anthony Stein

TITLE OF THE PAPER:

A Case Study of Vehicle Route Optimization

ABSTRACT:

In the last decades, the classical Vehicle Routing Problem (VRP), i.e., assigning a set of orders to vehicles and planning their routes has been intensively researched. As only the assignment of order to vehicles and their routes is already an NP-complete problem, the application of these algorithms in practice often fails to take into account the constraints and restrictions that apply in real-world applications, the so called rich VRP (rVRP) and are limited to single aspects. In this work, we incorporate the main relevant real-world constraints and requirements. We propose a two-stage strategy and a Timeline algorithm for time windows and pause times, and apply a Genetic Algorithm (GA) and Ant Colony Optimization (ACO) individually to the problem to find optimal solutions. Our evaluation of eight different problem instances against four state-of-the-art algorithms shows that our approach handles all given constraints in a reasonable time.

KeyWords:

Rich Vehicle Routing Problem, Ant-Colony Optimization, Genetic Algorithm, Real-World Application, Logistics

Board Theme of Paper:

This work tackles the rich Vehicle Routing Problem (rVRP)and its transfer to a real-world application. We assess a multi-objective capacitated VRP with pickup and delivery (PD) stops and time windows (TW) and propose a two-staged strategy where the first step assigns the orders to the vehicles, and the second step optimizes the tours of each vehicle. This diverse set of constraints delimits our work from other state-of-the-art approaches since these hardly cover a small set of these constraints. We apply a six-dimensional cost function and propose a timeline algorithm to match the given TWsand fixed pause times. To solve the problem instances on both stages, we apply a Genetic Algorithm (GA) and Ant

Colony Optimization (ACO).

Link: https://doi.org/10.1016/j.trpro.2021.09.100

Year: 2022

Authors:Alexey Terentyev , Maria Karelina , Vladimir Egorov , Andrey Andre ev , Kazem Reza Kashyzadeh

TITLE OF THE PAPER:

Model for determining optimal routes in complex transport systems

ABSTRACT:

The paper analyzes standard algorithms and software based on them to determine the optimal routes for cargo transfer in road transport systems. It was found that one of the urgent issues related to routing is to find a solution to the optimization problem by several efficiency criteria, including the reduction of computational procedures. As a result of the study, we propose an original solution to this problem.

Keywords

Routing, road transport system, optimization algorithm, multi-criteria problem ,software

Board Theme of Paper:

At this stage of studying routing models and algorithms in the RTS, an optimization analytical model of object oriented control and algorithms based on it were developed (Nitsevich et al. 2017, Terentyev 2019, Terent'ev et al. 2017). The following two main algorithms and software based on them were developed as well. 1. The algorithm and software for solving the dynamic programming problem, implementing the Bellman principle, and making it possible to determine the optimal trajectory (route) of cargo transfer in the RTS. 2. The algorithm and software for determining the Pareto-optimal options in the case of multicriteriality in the studied RTS. The main tasks of further research were determined: 1. Integration of the developed algorithms and software into a single software package. 2. Testing of the developed software package using a local data sample on the transfer of a given number of cargo lots in the RTS given several transshipment complexes and with account for several efficiency criteria.

IDEATE PHASE

 Identify Objectives: Clearly define the goals of route optimization, such as reducing travel time, minimizing fuel consumption, improving delivery accuracy, or enhancing customer satisfaction.

 Gather Data: Collect relevant data, including customer locations, vehicle capacities, delivery schedules, traffic patterns, and road conditions.

 Brainstorm Solutions: Engage a team of experts to brainstorm potential solutions. This can include using advanced algorithms, real-time data analysis, predictive analytics, and other innovative approaches.

 Evaluate Ideas: Assess the feasibility and potential impact of each idea. Consider factors such as cost, implementation time, and expected benefits.

 Select Best Ideas: Choose the most promising ideas to develop further. These ideas should align with the objectives and offer significant improvements over current methods.

 Prototype Solutions: Create prototypes or models of the selected ideas. This can involve simulations, pilot tests, or small-scale implementations to evaluate performance.

 Refine and Iterate: Based on feedback and test results, refine the solutions. Make necessary adjustments to optimize performance and address any issues.

 Implement Solutions: Roll out the optimized routes and monitor their performance. Ensure that the new routes are integrated smoothly into existing operations.

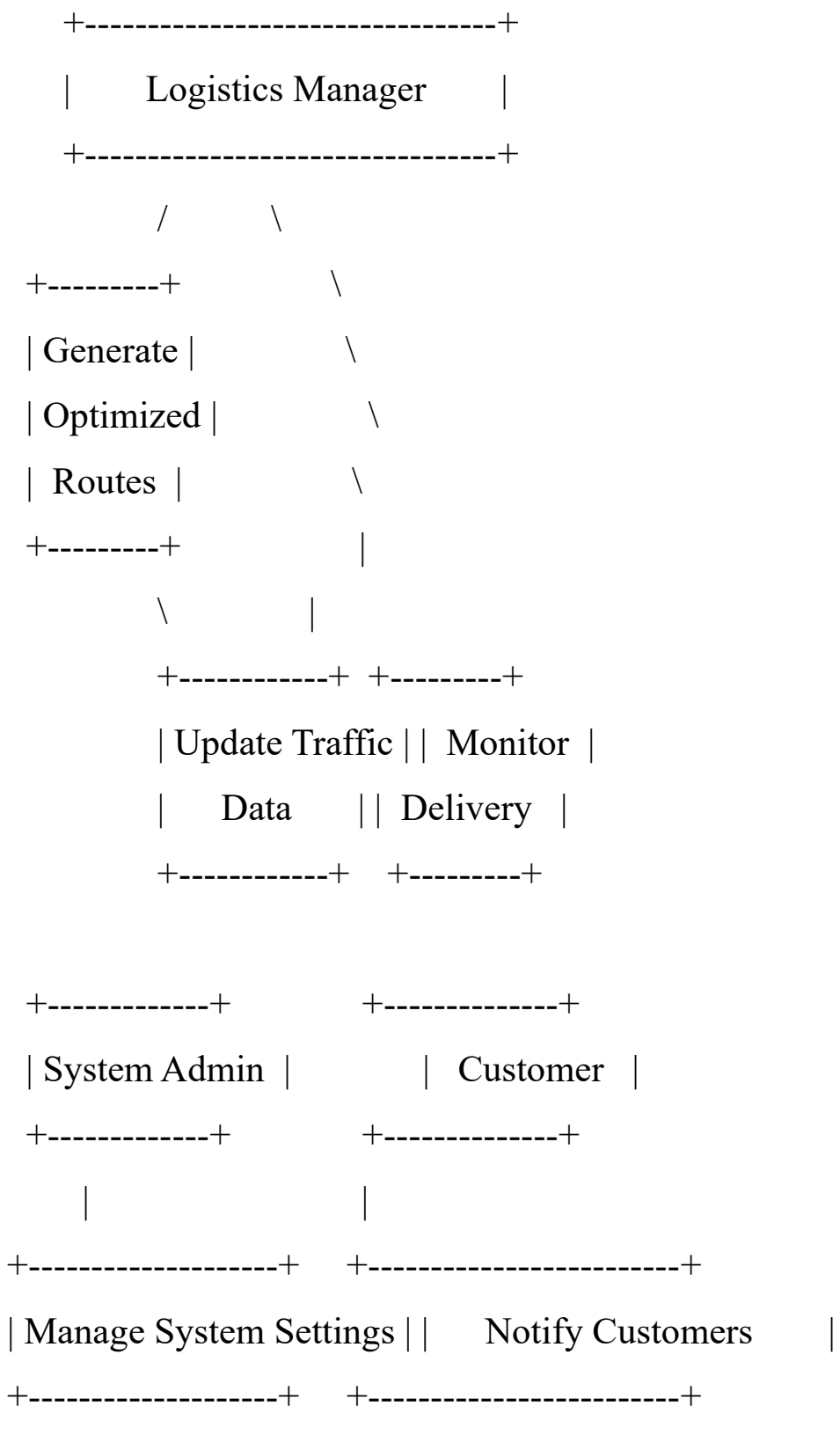
 Continuous Improvement: Regularly review and update the routes based on new data, changing conditions, and feedback from drivers and customers.

Example

Imagine a delivery company wants to reduce fuel costs and improve delivery times. During the ideate phase, they might brainstorm ideas like:

- Using GPS tracking to get real-time traffic updates and adjust routes on the fly.
- Implementing dynamic routing algorithms that can adapt to changes in delivery schedules and traffic conditions.
- Optimizing delivery schedules to ensure that vehicles are fully loaded and routes are planned efficiently.

USECASE DIAGRAM



PROTOTYPE PHASE

1.Data Collection and Integration in route optimization.

Algorithm development and testing

In this technique we can observe the traffic.

TESTING PHASE

The testing phase in route optimization is crucial to ensuring that the algorithms and strategies developed during the prototype phase work effectively in real-world conditions. Here's an overview of the key steps and activities involved in this phase:

Key Steps in the Testing Phase

1. Simulation Testing:
    - Use simulated environments to test the optimized routes under various conditions. This helps identify potential issues before real-world implementation.
2. Pilot Testing:
    - Conduct small-scale tests in controlled environments with a limited number of routes and deliveries. This allows for real-world validation without disrupting full-scale operations.
3. Feedback Collection:
    - Gather feedback from delivery drivers, logistics managers, and other stakeholders involved in the pilot tests. This feedback is crucial for identifying strengths and weaknesses in the optimized routes.
4. Performance Metrics:
    - Measure key performance metrics such as delivery time, fuel consumption, route efficiency, and customer satisfaction. Use these metrics to evaluate the effectiveness of the optimized routes.
5. Iterative Refinement:
    - Based on the feedback and performance metrics, make necessary adjustments to the routes. This may involve tweaking the algorithms, refining data inputs, or making changes to the delivery schedules.
6. Real-World Testing:
    - Once the routes have been refined, implement them in real-world operations on a larger scale. Monitor the performance closely to ensure that the routes meet the desired objectives.
7. Continuous Monitoring:

- Continuously monitor the performance of the optimized routes and make adjustments as needed. This ensures that the routes remain efficient and effective over time.