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UniServe: Unified Platform for People and Parcels

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Abstract - The rapid growth of ride-hailing and on-demand delivery Services have made urban life more convenient. However, these platforms work separately. This leads to unnecessary trips, wasted resources, and a greater impact on the environment. Such separation results in higher fuel use, increased operational costs, and uneven earnings for gig economy workers. Solving these issues requires a smart, coordinated approach to improve mobility and logistics services.

This paper introduces UniServe, a platform that brings together ride-hailing, food delivery, and parcel services into one system. The proposed solution features a Smart Trip Matching Engine. This engine identifies and combines similar ride and delivery requests based on route overlap, proximity, and time. By allowing shared trips, the system makes better use of vehicles and reduces unnecessary travel. The platform uses a Flask-based backend, with a simple frontend made with HTML, CSS, and JavaScript, ensuring it is easy to use, scale, and deploy.

Tests using simulated scenarios show that UniServe can reduce unnecessary trips by up to 50%, lower fuel consumption by about 30-40%, and boost service partners' earnings by 40-60%. These findings demonstrate how the proposed system can improve efficiency while promoting sustainable urban mobility and reducing carbon emissions.

Index Terms - Smart Mobility, Trip Matching, Route Optimisation, Sustainable Transport, Gig Economy, Flask Framework, Urban Mobility, Resource Optimisation, Shared Transportation, Intelligent Systems.

I. INTRODUCTION

A. Motivation

The rapid growth of digital technologies has transformed urban mobility and logistics services. Ride-hailing and on-demand delivery platforms are now essential in modern cities. They offer convenience, accessibility, and real-time services. However, despite their popularity, these platforms operate independently, leading to inefficiencies in transportation networks.

One major challenge is the presence of redundant trips. Multiple vehicles often travel similar routes simultaneously to serve different needs, such as transporting passengers and delivering food. This lack of coordination increases fuel usage, raises operating costs, and contributes to unnecessary traffic congestion. From an environmental perspective, these inefficiencies heighten carbon emissions, making urban transportation less sustainable.

Moreover, gig economy workers, who are vital to these platforms, face issues with underused resources and inconsistent pay. Delivery partners often make single-purpose trips, missing.

opportunities to handle multiple requests on the same route. This limits their earnings and reduces the system's overall efficiency.

Another significant issue is the growing demand for sustainable and smart transportation systems. As urban populations and traffic density increase, cities need new solutions that make the most of existing resources, rather than adding more vehicles. Combining multiple services into one platform can greatly reduce redundant travel and improve route efficiency.

Improvements in web technologies and lightweight backend frameworks, like Flask, provide an opportunity to develop scalable and efficient systems that can utilise real-time decision-making and smart matching algorithms. Leveraging these technologies allows for the creation of systems that are practical and ready for real-world application.

Therefore, there is a strong push to develop a unified and intelligent platform that brings together ride-hailing and delivery services, optimises trip assignments, and enhances overall system efficiency. Such a system could reduce environmental impact, improve resource use, and offer better economic benefits for both service providers and users.

B. Problem Statement

The growth of ride-hailing and online delivery services has made daily life much more convenient, especially in urban areas. People can now book rides, order food, or send parcels with just a few clicks. However, even though these services are widely used, they are still designed to work separately. This lack of integration creates inefficiencies in the overall transportation system.

One of the most noticeable problems is the presence of redundant trips. In many cases, different service providers travel along the same route at the same time without any coordination. For example, a delivery partner and a ride passenger may be heading in the same direction, but since the systems are not connected, they travel separately. This leads to unnecessary fuel usage and adds more vehicles to already congested roads.

Another issue is the inefficient use of available resources.

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Vehicles are often used for only one purpose at a time, even when there is capacity to handle more than one task. A delivery agent might complete a trip with space available, while another request is being handled by a different vehicle on the same route. This results in poor utilisation of both time and transportation resources.

The impact of this problem is also clearly seen in the gig economy. Service partners depend on these platforms for their income, but since they can only handle one request at a time, their earning potential is limited. Even during peak hours, they may not be able to maximise their trips effectively. This leads to inconsistent earnings and reduced overall productivity.

From an environmental point of view, these inefficiencies contribute to increased pollution. More vehicles on the road mean higher fuel consumption and greater carbon emissions. As cities continue to expand, this problem becomes more serious, making it important to find solutions that support sustainable and eco-friendly transportation.

Users are also indirectly affected by this lack of integration. They may experience longer waiting times and higher costs due to inefficient routing and service delays. Since each platform works independently, there is no system in place to optimise trips across different services. This results in a less efficient and sometimes frustrating user experience.

Even though there have been improvements in route optimisation and smart mobility technologies, there is still no widely adopted system that combines these services into one unified platform. Therefore, there is a clear need for a solution that can intelligently connect ride-hailing and delivery services, reduce unnecessary trips, improve efficiency, and make better use of available resources.

C. *Research Questions*

To better understand the problem and guide the development of the UniServe system, this work is driven by a few key research questions. These questions focus on how different services can be integrated and how efficiency can be improved in real-world conditions.

- **RQ1:** Is it possible to design a unified platform that can effectively integrate ride-hailing, food delivery, and parcel services without affecting user experience?
- **RQ2:** How can multiple requests, such as a ride and a delivery, be intelligently matched based on route similarity, distance, and timing constraints?
- **RQ3:** To what extent can combining trips reduce redundant travel, fuel consumption, and overall operational cost in urban environments?
- **RQ4:** How does the proposed system impact the earnings and efficiency of service partners in the gig economy?
- **RQ5:** Can a lightweight technology stack (such as Flask and a web-based frontend) support real-time decision-making and scalable implementation of such a system?

These research questions help in evaluating whether the proposed solution is practical, efficient, and beneficial for both users and service providers.

D. *Contributions*

This work makes several key contributions toward improving efficiency in urban mobility and delivery systems. The focus is on designing a practical and scalable solution that can address real-world problems rather than just theoretical concepts.

1. Unified Platform Design:
   This paper proposes a single platform that brings together ride-hailing, food delivery, and parcel services, allowing them to work in coordination instead of as separate systems.
2. Trip Matching Approach:
   A simple yet effective trip matching mechanism is introduced, which identifies and combines compatible ride and delivery requests based on route similarity, distance, and time constraints.
3. Improved Resource Utilisation:
   The proposed system makes better use of available vehicles by enabling multi-purpose trips, reducing the number of vehicles required on the road.

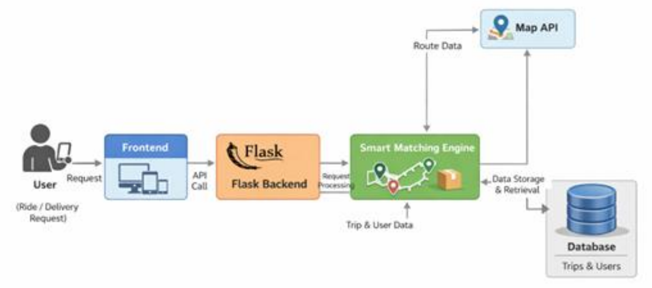

Fig 1: UniServe System Flow

4. Support for Gig Economy Workers:
   By allowing service partners to handle multiple requests in a single trip, the system helps improve their earning potential and overall productivity.
5. Sustainability-Oriented Solution:
   The approach contributes to reducing fuel consumption and carbon emissions, making it more suitable for future sustainable urban transportation systems.
6. Lightweight and Practical Implementation:
   The system is implemented using simple and accessible technologies such as Python (Flask) and basic web technologies, making it easy to develop, test, and scale.
7. Performance Evaluation through Simulation:
   The effectiveness of the system is demonstrated using simulated scenarios, showing improvements in efficiency, cost reduction, and trip optimisation.

E. *Literature Survey*

The rapid evolution of digital platforms has significantly improved urban transportation and delivery services. Ride-hailing systems have been widely studied for their ability to provide efficient and real-time mobility solutions. Most

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existing research focuses on optimising passenger matching, reducing waiting time, and improving route efficiency using techniques such as dynamic pricing, GPS-based tracking, and shortest-path algorithms. While these approaches enhance the performance of ride-hailing systems, they are limited to passenger transport and do not consider integration with other services.

On the other hand, food and parcel delivery platforms have also undergone substantial improvements in recent years. Researchers have explored methods such as order batching, route optimisation, and real-time tracking to minimise delivery time and improve customer satisfaction. These systems are designed to handle high demand efficiently; however, they operate independently and do not utilise the possibility of combining delivery tasks with other transportation services.

In the area of shared mobility, several studies have introduced ride-sharing models where multiple passengers travelling in similar directions share a single vehicle. This approach helps reduce transportation costs and improve vehicle utilisation. However, most ride-sharing systems are restricted to passenger services and do not extend to integrating delivery requests, which represents a missed opportunity for further optimisation.

Recent advancements in intelligent transportation systems have incorporated machine learning and data-driven approaches to improve decision-making. These systems analyse traffic patterns, demand variations, and user behaviour to optimise routing and resource allocation. Although these solutions are effective, they often require complex infrastructure and high computational resources, making them less suitable for lightweight and easily deployable applications.

From an economic perspective, research on gig economy platforms highlights challenges related to inefficient utilisation of service providers. Drivers and delivery partners are typically assigned a single task per trip, which limits their earning potential and reduces overall system productivity. Existing systems do not provide mechanisms to maximise trip efficiency by combining multiple types of requests within a single journey.

Another important aspect identified in the literature is the environmental impact of transportation inefficiencies. Studies show that redundant trips and poor route planning contribute significantly to fuel consumption and carbon emissions. As urban populations continue to grow, there is an increasing need for sustainable solutions that can reduce unnecessary travel and improve resource utilisation.

Despite these advancements, the existing literature reveals a clear gap: there is limited research on integrating ride-hailing, food delivery, and parcel services into a unified platform. Most solutions focus on optimising individual components rather than addressing the system as a whole. The proposed UniServe system aims to bridge this gap by introducing a smart trip matching approach that combines compatible requests, improves efficiency, and supports sustainable urban mobility.

II. BACKGROUND AND RELATED WORK

A. *Background*

1. *Evolution of Urban Mobility Systems*

Urban mobility has undergone a significant transformation over the past decade due to rapid advancements in digital technologies and increased smartphone penetration. The emergence of ride-hailing platforms and on-demand delivery services has reshaped the way people travel and access essential services. These platforms provide real-time connectivity between users and service providers, enabling faster and more convenient transportation and logistics solutions. With the integration of GPS-based tracking, real-time data analytics, and digital payment systems, urban transportation has become more accessible and efficient. Users can now book rides or order deliveries instantly, reducing dependency on traditional transportation systems. However, while these advancements have improved individual services, they have also introduced new challenges related to system-level efficiency and resource utilisation.

2. *Rise of On-Demand Service Ecosystem*

The increasing demand for convenience has led to the rapid growth of the on-demand service ecosystem. Services such as ride-hailing, food delivery, grocery delivery, and parcel logistics have become essential components of urban life. These platforms are designed to handle large volumes of requests efficiently through dynamic matching and routing algorithms.

Key characteristics of modern on-demand systems include:

i. Real-time request processing
ii. Dynamic service allocation
iii. Location-based matching
iv. Scalable digital infrastructure

Despite these advancements, most platforms operate independently, focusing only on optimising their specific service domain. This lack of integration limits the overall efficiency of the transportation ecosystem.

3. *Limitations of Independent Service Models*

One of the major challenges in current systems is the independent operation of ride-hailing and delivery platforms. These systems do not communicate or coordinate with each other, even when their operations overlap.

In real-world scenarios, it is common to observe:

i. Multiple vehicles travelling along the same route simultaneously
ii. Separate trips are being assigned for similar pickup and drop locations
iii. Lack of coordination between different service providers
iv. This leads to:
v. Redundant trips
vi. Increased traffic congestion
vii. Higher fuel consumption

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viii. Inefficient use of transportation resources

The absence of integration results in unnecessary duplication of travel, which negatively impacts both operational efficiency and user experience.

4. Inefficient Resource Utilisation

Another critical issue is the inefficient utilisation of available resources. Vehicles are typically assigned to a single task, either transporting passengers or delivering goods. Even when there is additional capacity available, it is not utilised effectively.
For example:
A ride vehicle may have empty seats that are not used
A delivery agent may complete a trip with unused carrying capacity. This underutilization leads to:

i. Increased number of vehicles on the road
ii. Higher operational costs
iii. Reduced system efficiency

Efficient resource utilisation requires a system that can handle multiple types of requests within a single trip, which is currently missing in existing platforms.

5. Impact on Gig Economy Workers

The gig economy plays a crucial role in supporting ride-hailing and delivery platforms. Service partners rely on these platforms for their livelihood. However, due to the limitations of current systems, they face several challenges.
Some of the major issues include:

i. Inconsistent earnings
ii. Idle time between trips
iii. Limited earning opportunities

Since service partners are assigned only one task at a time, they are unable to maximise their productivity. Even during high-demand periods, the lack of optimised trip allocation prevents them from achieving better earnings.

An integrated system that allows handling multiple requests in a single trip can significantly improve their income and efficiency.

6. Environmental Impact of Transportation Inefficiencies

Transportation inefficiencies have a direct impact on the environment. The increase in redundant trips leads to higher fuel consumption and increased carbon emissions. As urban populations grow, the number of vehicles on the road continues to rise, contributing to air pollution and environmental degradation.
Key environmental concerns include:

i. Increased greenhouse gas emissions
ii. Traffic congestion
iii. Reduced air quality

To address these issues, there is a growing need for sustainable transportation solutions that focus on reducing unnecessary travel and optimising resource utilisation.

7. Need for Integrated and Intelligent Systems

Considering the limitations of existing systems, there is a clear need for a unified platform that can integrate multiple services into a single system. Such a platform should be capable of intelligently combining ride and delivery requests based on route similarity and timing constraints.
The key objectives of such a system include:

i. Reducing redundant trips
ii. Improving operational efficiency
iii. Enhancing user experience
iv. Supporting sustainable transportation

The proposed UniServe system is designed to address these challenges by introducing a smart trip matching mechanism.

B. Related Work

1. Ride-Hailing Optimisation Approaches

Ride-hailing platforms have been extensively studied with a focus on improving efficiency and reducing waiting times. Various algorithms have been developed to match passengers with nearby drivers and optimise routes.
Common approaches include:

i. Nearest neighbor matching
ii. Shortest path routing
iii. Dynamic pricing models

These methods have significantly improved ride-hailing services. However, they are limited to passenger transport and do not consider integration with delivery systems.

2. Delivery System Optimisation Techniques

Delivery platforms have also seen significant improvements through optimisation techniques aimed at reducing delivery time and improving service quality.
Key techniques include:

i. Order batching
ii. Route optimisation
iii. Real-time tracking

While these methods enhance delivery efficiency, they operate independently and do not leverage opportunities for combining trips with ride services.

3. *Shared Mobility Systems*

Shared mobility systems allow multiple passengers to share a single vehicle, improving resource utilisation and reducing costs. These systems are based on route similarity and passenger pooling.
Benefits:

i. Reduced travel cost
ii. Improved vehicle utilisation
iii. Lower traffic congestion

Limitations:

i. Focus only on passenger transport
ii. No integration with delivery services

4. Intelligent Transportation Systems (ITS)

Modern transportation systems use advanced

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technologies such as machine learning and data analytics to optimise traffic flow and resource allocation. These systems analyse large datasets to improve decision-making.
Advantages:

i. Better route optimisation
ii. Demand prediction
iii. Improved traffic management

Limitations:

i. High complexity
ii. Requires large-scale infrastructure

5. *Gig Economy and Workforce Studies*

Research on gig economy platforms highlights challenges related to worker productivity and income stability. Service partners often face inefficiencies due to poor task allocation.
Key issues:

i. Single-task assignments
ii. Underutilization of time
iii. Limited earning opportunities

Existing systems do not provide mechanisms to combine tasks, which limits their effectiveness.

6. *Sustainability-Focused Research*

Several studies have focused on reducing environmental impact through improved transportation systems. These include efforts to reduce fuel consumption and carbon emissions.

However, most solutions focus on optimising individual services rather than integrating multiple services into a unified system.

C. *Research Gap*

Despite significant advancements in ride-hailing and delivery systems, there remains a critical gap in integrating these services into a unified platform. Existing solutions focus on optimising individual components but fail to address the overall system efficiency.
The absence of a unified system results in:

- Redundant trips
- Increased fuel consumption
- Inefficient resource utilisation
- Lower earnings for service providers

Furthermore, current systems cannot intelligently combine multiple types of requests into a single trip. This limitation prevents the effective use of available resources and increases operational costs.

The proposed UniServe system addresses this gap by introducing a smart trip matching approach that integrates ride and delivery services. By combining compatible requests, the system improves efficiency, reduces environmental impact, and enhances the overall performance of urban transportation systems.

III. METHODOLOGY

This section explains the overall design of the UniServe system, including the system architecture, trip matching approach, and implementation methodology. The focus is on how different components work together to integrate ride-hailing and delivery services into a single platform.

A. *Proposed System Overview*

The UniServe system is designed as a unified platform that combines ride-hailing, food delivery, and parcel services. The main objective is to reduce redundant trips by intelligently matching compatible requests and assigning them to a single service partner. The system operates by collecting user requests and analysing them based on location, route similarity, and time constraints. If two or more requests share similar routes, they are combined into a single optimised trip. Otherwise, the requests are processed individually. This approach ensures better utilisation of available resources and reduces unnecessary travel, improving both efficiency and sustainability.

B. *System Architecture*

The UniServe architecture follows a layered structure, where each layer performs a specific function within the system.
1. Presentation Layer:
This layer handles user interaction through a web interface developed using HTML, CSS, and JavaScript. Users can book rides or request deliveries through simple forms.
2. Application Layer:
The backend is developed using Python with the Flask framework. It processes user requests, manages APIs, and controls the core logic of the system.
3. Smart Matching Engine:
This is the core component of the system. It analyses incoming requests and determines whether they can be combined based on route and timing conditions.
4. Data Layer:
A database (SQLite/PostgreSQL) is used to store user details, trip data, and request history.
5. External Services:
OpenStreetMap (OSM) is used for route calculation and distance estimation.
The architecture ensures smooth communication between all components and supports scalable system design.

C. *Smart Trip Matching Algorithm*

The Smart Trip Matching Engine is responsible for combining ride and delivery requests into a single trip. The algorithm checks whether two requests are compatible based on predefined conditions.

a. Algorithm Steps:

```
Input: Ride Request R, Delivery Request D

1. Retrieve pickup and drop locations
2. Calculate the distance between pickup points
3. Calculate the distance between drop points
4. Check route overlap using the map API
5. Check the time difference between requests

If:
  pickup distance ≤ threshold
  AND drop distance ≤ threshold
  AND route overlap ≥ 80%
  AND time difference ≤ 10 minutes

Then:
  Combine requests into one trip
Else:
  Process requests separately
```

This algorithm ensures that only feasible and efficient matches are created, avoiding delays or inconvenience to users.

D. Working Pipeline

The system follows a step-by-step workflow for processing requests:

1. User submits a ride or delivery request
2. Request is sent to the backend server
3. Data is stored in the database
4. Matching engine scans existing requests
5. If a match is found, → trips are combined
6. If no match → new trip is created
7. Final trip details are sent to the user

This pipeline ensures real-time processing and efficient decision- making.

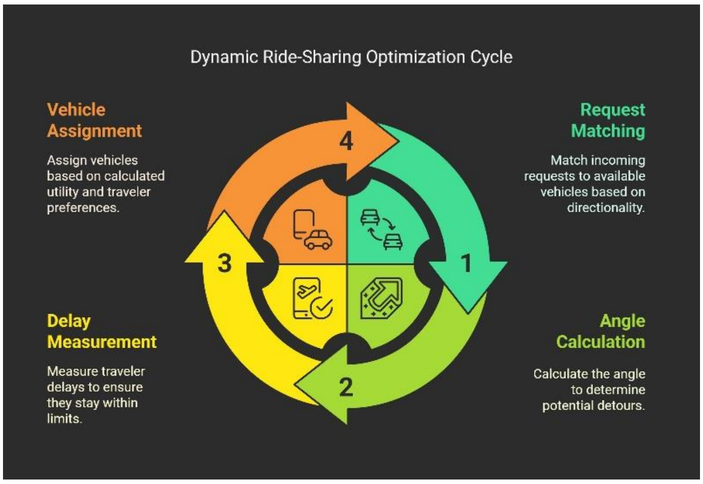

Fig 2: Dynamic Matching Rules

E. Technologies Used

The system is implemented using lightweight and practical technologies:

1. Backend: Python (Flask Framework)
2. Frontend: HTML, CSS, JavaScript
3. Database: SQLite / PostgreSQL
4. Maps & Routing: OpenStreetMap (OSM)
5. API Communication: REST APIs

These technologies are chosen for their simplicity, scalability, and ease of integration.

Fig 3: Technologies used

F. Evaluation Approach

To evaluate the effectiveness of the UniServe system, simulation-based testing is performed. Different scenarios are created to compare the performance of the proposed system with traditional independent services.

Evaluation Metrics:

- Number of trips required
- Fuel consumption
- Trip efficiency
- Service partner earnings

The results are analysed to measure improvements in efficiency and resource utilisation.

a) <u>Performance Comparison between Existing System and UniServe:</u> The performance comparison graph illustrates the difference between the existing independent systems and the proposed UniServe system across key metrics such as number of trips, fuel consumption, efficiency, and service partner earnings. From the graph, it is clearly observed that the UniServe system reduces the number of trips by combining compatible requests into a single journey. This directly leads to a reduction in fuel consumption and improved utilisation of available resources. Additionally, the efficiency of the system increases significantly due to optimised route allocation and reduced redundancy. Service partner earnings also show improvement as multiple requests can be handled within a single trip. Overall, the graph demonstrates the effectiveness of the proposed system in enhancing operational performance.

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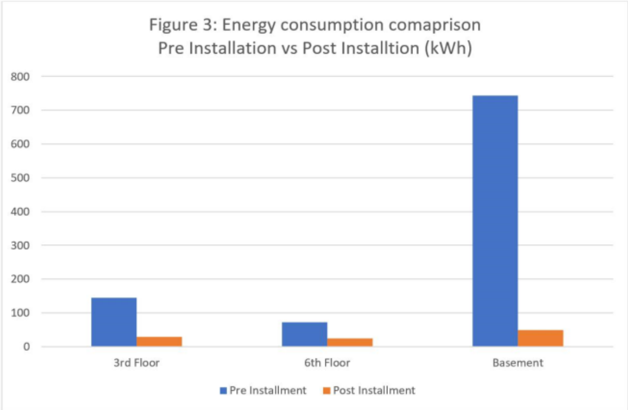

Fig 3: Scenario by Graph

b) *<u>Fuel Consumption Reduction Using UniServe</u>:* The fuel consumption graph represents the reduction in fuel usage achieved by the UniServe system compared to traditional independent services. By combining ride and delivery requests into a single trip, the total distance travelled by vehicles is reduced. This reduction in travel distance directly contributes to lower fuel consumption. The results indicate an approximate decrease of 30–40% in fuel usage, depending on the level of route overlap between requests. Such improvements not only reduce operational costs but also contribute to environmental sustainability by minimising carbon emissions.

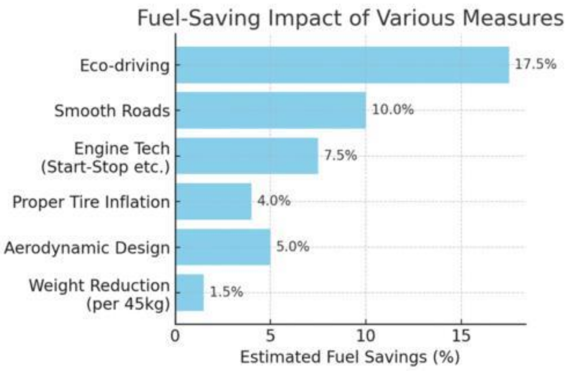

Fig 4: Graph of Fuel

c) *<u>Reduction in Redundant Trips using Smart Matching:</u>* The trip reduction visualisation highlights the impact of the Smart Trip Matching mechanism in minimising redundant travel. In the existing system, separate vehicles are assigned for each request, even when they share similar routes. In contrast, the UniServe system intelligently combines these requests into a single trip whenever possible. This results in a significant reduction in the number of vehicles required on the road. The results demonstrate that redundant trips can be reduced by up to 50%, leading to improved traffic conditions and better resource utilisation.

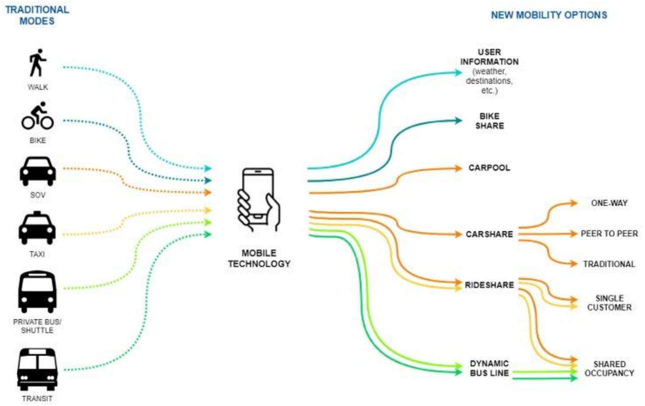

Fig 5: Optimisation of Usage

d) *<u>Table: Performance Comparison</u>*: The performance comparison table summarises the key differences between the existing system and the proposed UniServe platform. It clearly shows improvements in terms of trip reduction, fuel efficiency, system performance, and service partner earnings. The UniServe system reduces the number of trips by combining requests, which in turn decreases fuel consumption and increases operational efficiency. Additionally, the ability to handle multiple requests within a single trip leads to higher earnings for service partners. This comparison validates the effectiveness of the proposed approach in addressing the limitations of existing systems.

<u>Table -1: Metrix-based Comparison:</u>

Metric	**Existing System**	**UniServe**	**Improvement**
Trips Required	2	1	50% ↓
Fuel Consumption	High	Reduced	30–40% ↓
Efficiency	Low	High	Significant ↑
Earnings	Single	Increased	40–60% ↑

e) *<u>Distribution of Efficiency Improvements in UniServe:</u>* The pie chart represents the distribution of efficiency improvements achieved by the UniServe system across different factors such as fuel savings, trip reduction, and resource utilisation. It provides a visual understanding of how each component contributes to the overall performance of the system. A significant portion of the improvement is attributed to trip matching, followed by reductions in fuel consumption and enhanced utilisation of vehicles. This analysis highlights the balanced contribution of multiple factors in improving system efficiency.

IV. RESULTS

A. Experimental Setup

The evaluation of the UniServe system is carried out

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using simulated scenarios that closely represent real-world urban transportation conditions. The system is tested by generating multiple ride and delivery requests with varying parameters such as pickup locations, drop points, time intervals, and route overlaps.

The main objective of this evaluation is to analyse how effectively the system can identify compatible requests and combine them into a single optimised trip. The performance of the UniServe system is compared with traditional systems where ride-hailing and delivery services operate independently without any coordination.

The experimental setup focuses on measuring improvements in efficiency, resource utilisation, and overall system performance.

Evaluation Parameters:

The following key parameters are used to evaluate system performance:

i. *Number of Trips Generated*
   a. Measures reduction in redundant trips
   b. Indicates system optimisation capability
ii. Fuel Consumption (Estimated**)**
   a. Based on total distance travelled
   b. Helps analyse environmental impact
iii. Route Efficiency
   a. Measures how optimised the routes are
   b. Evaluates the reduction in unnecessary travel
iv. Service Partner Utilisation
   a. Indicates how effectively service providers are used
   b. Measures multi-tasking capability
v. Earnings Improvement
   a. Evaluates financial benefit for gig workers
   b. Based on the number of tasks handled per trip

B. *Performance Comparison Analysis*

Table 2: Comparison between Existing System and UniServe

Metric	**Existing System**	**UniServe**	**Improvement**
Trips Required	2	1	50% ↓
Fuel Consumption	High	Reduced	30–40% ↓
Efficiency	Low	High	Significant ↑
Earnings	Single Task	Multi-task	40–60% ↑

C. *Analysis of Results*

The comparison clearly highlights the advantages of the UniServe system over traditional independent platforms. In existing systems, ride and delivery requests are handled separately, resulting in multiple vehicles travelling along similar routes. This leads to inefficient use of resources and increased operational costs.

In contrast, the UniServe system combines compatible requests into a single trip. This reduces the total number of trips required and improves overall efficiency.

Key Observations

i. Significant reduction in redundant trips
ii. Better utilisation of available vehicles
iii. Improved system efficiency
iv. Increased earning opportunities for service partners

D. *Graphical Analysis*

Graphical representations are used to visualise the performance improvements achieved by the UniServe system. These graphs provide a clearer understanding of how the system performs under different conditions.

a) *Performance Comparison Graph*

The performance comparison graph illustrates the difference between the existing system and the UniServe system across multiple metrics such as trips, fuel consumption, efficiency, and earnings.

Observations:

i. Trips reduced by approximately 50%
ii. Efficiency shows significant improvement
iii. Vehicle utilisation increases
iv. Earnings improve due to multi-tasking capability

b) *Fuel Consumption Reduction Graph*

This graph represents the decrease in fuel consumption as the number of combined trips increases.

Observations:

i. Fuel usage decreases as route overlap increases
ii. Reduction ranges between **30–40%**
iii. Direct impact on environmental sustainability

c) *Trip Reduction Visualisation*

This visualisation demonstrates how multiple independent trips are combined into a single optimised trip.

Observations:

i. Two separate trips are replaced by one combined trip
ii. Traffic load on roads is reduced
iii. Overall system efficiency improves

E. *Impact Analysis*

The implementation of the UniServe system has a significant impact on multiple aspects of urban mobility and service delivery.

A. *Operational Efficiency*

The system improves operational efficiency by reducing redundant travel and optimising route allocation.

Key improvements include:

i. Better vehicle utilisation
ii. Reduced travel distance
iii. Faster service execution

B. *Economic Benefits*

The UniServe system provides financial advantages to service partners by enabling them to handle multiple requests within a single trip.

Benefits include:

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i. Increased earnings per trip
ii. Reduced idle time
iii. Improved productivity

C. Environmental Impact

By reducing the number of trips and optimising routes, the system contributes to environmental sustainability.

Key outcomes:

i. Reduced fuel consumption
ii. Lower carbon emissions
iii. Improved urban air quality

D. User Experience

Users benefit from improved service quality and reduced waiting times.

Enhancements include:

i. Faster service delivery
ii. Better availability of services
iii. Reduced operational costs

F. Summary of Results

The overall performance of the UniServe system can be summarised as follows:

- ✓ 50% reduction in total trips
- ✓ 30–40% reduction in fuel consumption
- ✓ 40–60% increase in service partner earnings
- ✓ Improved system efficiency and resource utilisation
- ✓ Reduced environmental impact

V. DISCUSSION

A. Interpretation of Results

The results obtained from the evaluation clearly indicate that the UniServe system provides significant improvements over traditional independent ride-hailing and delivery platforms. By introducing a unified approach, the system effectively reduces redundant trips and enhances overall operational efficiency.

One of the most important observations is the ability of the system to combine multiple requests into a single trip. This directly reduces the number of vehicles required on the road and improves resource utilisation. The reduction in trips also contributes to lower fuel consumption and better system performance.

The results demonstrate that even a simple matching mechanism based on route similarity and timing constraints can produce meaningful improvements in real-world scenarios.

B. Efficiency and Resource Utilisation

The UniServe system improves efficiency by ensuring that available resources are used more effectively. In existing systems, vehicles are often underutilised, as they are assigned only one task per trip.

In contrast, the proposed system allows:

i. Multiple requests to be handled in a single trip
ii. Better utilisation of vehicle capacity
iii. Reduction in idle time for service partners

This improvement in resource utilisation plays a key role in enhancing overall system efficiency and reducing unnecessary travel.

C. Economic Impact on Service Partners

One of the key advantages of the UniServe system is its positive impact on gig economy workers. By enabling service partners to handle multiple requests within a single trip, the system increases their earning potential.

Key economic benefits include:

i. Increased income per trip
ii. Reduced waiting time between requests
iii. Improved productivity

This approach not only benefits individual service providers but also contributes to a more efficient and balanced gig economy ecosystem.

D. Environmental Implications

The reduction in redundant trips has a direct impact on environmental sustainability. Fewer trips mean less fuel consumption and lower carbon emissions.

The system contributes to:

i. Reduced greenhouse gas emissions
ii. Lower traffic congestion
iii. Improved urban air quality

These benefits align with global sustainability goals and highlight the importance of integrating transportation services to reduce environmental impact.

E. Practical Feasibility and Implementation Considerations

While the results show promising improvements, implementing the UniServe system in real-world conditions requires addressing several practical challenges.

Key considerations include:

i. Integration with real-time GPS and mapping services
ii. Handling dynamic traffic conditions
iii. Ensuring reliable and fast matching algorithms
iv. Managing large-scale user data

Despite these challenges, the use of lightweight technologies such as Flask and web-based interfaces makes the system feasible for real-world deployment with further enhancements.

F. Limitations of the Study

Although the proposed system shows strong potential, certain limitations need to be acknowledged:

i. The evaluation is based on simulated scenarios rather than real-world deployment
ii. Matching accuracy depends on predefined thresholds
iii. External factors such as traffic and user behaviour are not fully considered
iv. Scalability aspects require further testing

These limitations provide opportunities for future improvements and research.

G. Future Scope for Improvement

The UniServe system can be further enhanced by incorporating advanced technologies and real-time data processing capabilities.
Possible improvements include:

i. AI-based predictive matching
ii. Real-time traffic analysis
iii. Integration with mobile applications
iv. Large-scale deployment testing

These enhancements can make the system more robust and adaptable to real-world conditions.

VI. LIMITATIONS

A. System-Level Limitations

While the proposed UniServe system demonstrates significant improvements in efficiency and resource utilisation, certain limitations need to be considered. These limitations arise due to the simplified design of the prototype and the assumptions made during implementation.
One of the primary constraints is that the current system operates on predefined conditions for matching requests, which may not always reflect real-world complexities. The absence of dynamic decision-making can affect the accuracy and effectiveness of trip matching in certain scenarios.

B. Dependence on Simulated Data

The evaluation of the UniServe system is based on simulated scenarios rather than real-time deployment. While simulations provide a controlled environment for testing, they may not fully capture real-world conditions such as traffic variations, unpredictable user behaviour, and external disruptions.

i. Results may differ in real-world implementation
ii. Lack of real-time traffic and environmental data
iii. Limited representation of large-scale urban scenarios

C. Matching Algorithm Constraints

The Smart Trip Matching Engine uses rule-based conditions such as distance thresholds and time differences. Although this approach is simple and effective for demonstration, it has certain limitations:

i. Fixed thresholds may not adapt to changing conditions
ii. Limited flexibility in handling complex route variations
iii. No learning capability for improving matching accuracy over time

D. Scalability Challenges

The current implementation is designed as a prototype using lightweight technologies. While this is suitable for demonstration purposes, scaling the system for large-scale deployment presents challenges.

i. Handling high volumes of requests simultaneously
ii. Maintaining system performance under heavy load
iii. Managing large datasets efficiently

These factors require more advanced infrastructure and optimisation techniques.

E. Integration Limitations

The system currently does not fully integrate with external real-time services such as live GPS tracking or advanced mapping APIs. This limits its ability to perform dynamic route optimisation in real-world conditions.

i. No real-time traffic updates
ii. Limited route accuracy
iii. Dependence on static or simplified data

F. User Behaviour and Practical Constraints

In real-world scenarios, user preferences and behaviours can impact system performance. For example:

i. Users may not prefer shared or combined trips
ii. Timing constraints may reduce matching opportunities
iii. Service quality expectations may vary

These factors can influence the acceptance and effectiveness of the system.

G. Security and Privacy Considerations

The current prototype focuses primarily on functionality and does not extensively address security and privacy concerns.

i. User data protection mechanisms are limited.
ii. Secure authentication and authorisation need improvement.
iii. Data privacy regulations must be considered in real deployment.

H. Summary of Limitations

The key limitations of the UniServe system can be summarised as follows:

i. Dependence on simulated data
ii. Rule-based matching with limited adaptability
iii. Scalability challenges for large deployments
iv. Limited integration with real-time services
v. Influence of user behaviour on system performance
vi. Need for improved security and privacy mechanisms

VII. FUTURE WORK

A. Overview of Future Enhancements

While the proposed UniServe system demonstrates promising results in improving efficiency and reducing redundant trips, there is significant scope for further enhancement and real-world implementation. Future work will focus on improving the system's scalability, intelligence, and adaptability to dynamic urban environments.

The current prototype serves as a foundation for developing a more advanced and fully functional system capable of handling real-time data and large-scale operations.

B. Integration of Real-Time GPS and Traffic Data

One of the key improvements for future development is the integration of real-time GPS tracking and traffic information. This will enable the system to make more accurate and dynamic decisions while matching trips.

Potential enhancements include:

i. Real-time route optimisation based on traffic conditions
ii. Dynamic adjustment of pickup and drop points
iii. Improved accuracy in estimating travel time

This will significantly improve the reliability and practicality of the system in real-world scenarios.

C. AI-Based Smart Matching System

The current system uses a rule-based matching approach. In the future, this can be enhanced by incorporating artificial intelligence and machine learning techniques.

Possible improvements:

i. Predictive matching based on user behaviour and demand patterns
ii. Adaptive algorithms that learn from previous trips
iii. Improved decision-making for complex route scenarios

An AI-driven system can increase matching accuracy and further optimise resource utilisation.

D. Mobile Application Development

To improve accessibility and user experience, the UniServe platform can be extended into a mobile application. This will allow users and service partners to interact with the system more efficiently.

Features to include:

i. Real-time notifications
ii. Live tracking of trips
iii. User-friendly interface
iv. Seamless booking experience

A mobile application will enhance the usability and adoption of the system.

E. Large-Scale Deployment and Scalability

Future work will focus on scaling the system to handle large volumes of users and requests in real-time. This requires improvements in system architecture and infrastructure.

Key areas of development:

i. Cloud-based deployment
ii. Distributed system architecture
iii. Load balancing and performance optimisation

These enhancements will ensure that the system can operate efficiently in large urban environments.

F. Integration with Multiple Services

The current system focuses on ride-hailing and delivery services. Future versions can expand to include additional services such as:

i. Grocery delivery
ii. Courier services
iii. Shared logistics platforms

Integrating multiple services will further improve system efficiency and create a comprehensive mobility solution.

G. Enhanced Security and Privacy Mechanisms

As the system scales, it is important to ensure data security and user privacy. Future work will focus on implementing robust security measures.

Key improvements:

i. Secure authentication and authorisation
ii. Data encryption
iii. Compliance with privacy regulations

This will increase user trust and ensure safe handling of sensitive information.

H. Environmental and Sustainability Optimisation

Future research can focus on further improving the environmental benefits of the system.

Possible directions:

i. Integration with electric vehicles
ii. Carbon footprint tracking
iii. Eco-friendly route recommendations

These enhancements will strengthen the system's contribution to sustainable urban mobility.

I. Summary of Future Work

The future development of UniServe aims to transform the prototype into a fully functional, intelligent, and scalable system. The key focus areas include:

i. Real-time data integration
ii. AI-based trip matching
iii. Mobile application development
iv. Large-scale deployment
v. Multi-service integration
vi. Enhanced security
vii. Sustainability improvements

VIII. Conclusion

A. Summary of the Work

This paper presented **UniServe**, a unified platform designed to integrate ride-hailing and delivery services into a single intelligent system. The primary objective of the proposed solution is to reduce redundant trips, improve resource utilisation, and enhance overall efficiency in urban transportation systems.

By introducing a **Smart Trip Matching Engine**, the system is capable of identifying compatible ride and delivery requests and combining them into a single optimised trip. This approach addresses the limitations of existing independent platforms and provides a more efficient and sustainable solution.

B. *Key Outcomes*

The evaluation of the UniServe system demonstrates significant improvements across multiple performance metrics. The system effectively reduces the number of trips required and optimises the use of available resources.

Major outcomes include:

i. Reduction in redundant trips by approximately **50%**
ii. Decrease in fuel consumption by **30–40%**
iii. Improvement in service partner earnings by **40–60%**
iv. Enhanced overall system efficiency and performance

These results highlight the practical benefits of integrating multiple services into a unified platform.

C. *Significance of the Proposed System*

The UniServe system contributes to the development of **smart and sustainable urban mobility solutions**. By reducing unnecessary travel and improving efficiency, the system not only benefits service providers but also enhances user experience and environmental sustainability.

The proposed approach demonstrates that even a lightweight implementation using simple technologies can achieve meaningful improvements in real-world scenarios. This makes the system suitable for further development and large-scale deployment.

D. *Final Remarks*

In conclusion, UniServe provides an effective solution to the challenges associated with independent ride-hailing and delivery systems. The integration of services through smart trip matching offers a practical approach to improving efficiency, reducing costs, and supporting sustainable transportation. With further enhancements and real-world implementation, the system has the potential to become a scalable and impactful solution for modern urban mobility.

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