1.lntroduction

The road based transportation system has become the most important part of the infrastructure in almost developed countries. It is not only important as the physical social improvements of the sociely, but also as the foundation for 9 year Social and economic development. Through I years, most attention has been focused improvement the traffic system on behalf of private transportation. The auto traffic is though causing problems. ‹most of all in forms of congestions and environment impacts.

1.2 Object and Contributes

In this,we focus on strategic and practical planning of an integrated public

transport system. The main objective is to present a framework for evaluation and design of such a system. General guidelines of how to implement and operate an integrated public transport service shall also be give,

this is continous the area of public transport planning in the following ways. The thesis

• gives a survey of modeling of integrated public transport services. When special emphasizes on Iike use of optimization and elimulation models.

• presents a framework for evaIuation and design of an integrated public trans' port system, This framework consists of a geographical information sts\em. optimization tools an0 simulation tools.

2.Farming of Public Transportation

This chapter describes how planning of public transport is performed both for fixed route seances and for demand responsive services. We also discuss how operations research is of help in the planning process. Operations research uses mathematicaI models. stasis ic s and algorithms to aid in decision- making. It is 1 year of applied mathematics, most often used to analyze complex real worse systems. The goal is generally to improve or optimize the performance of the studied system.

2.2 The Planning Process

When planning a public transport system, or any other public service, the planning must be made front several aspects such as efficiency, effectiveness anc! equity, for example described in Savas ( 1978). These aspects should be put together to formulate the objective of the planning. No matter we learn about objective is, planning of public transport always involves a number of difficult, coimbinatorial problems, where operations research in general and optimization in particular, is of highest importance and can be a really useful tool. To understand the role of operations research in planning of an integrated public transport system, it is necessary to first understand the different problems involved in the process of planning public transport in general. A planning process can usually be described at strategic, practical or operation level. In this, we do not distinguish between strategic and practical planning. The planning process will in this way only be divided into strategic planning and operational planning.

The strategic and operational planning of fixed route services can be described as a systematic decision process, first presented in Ceder & Wilson (1986)

3 Planning of Integrated Services

A lot of work is done on how to plan both fixed route services as well as demand responsive services separately. This service is intended to be used in urban traffic systems and the service should suit a wide range of customers from different market segments. Both the category of elderly and disabled as well as any other public transport customer shall be able to use the service.

Road Network:

The network representing the town of gave consists of 4087 nodes and 9384 directed links. The area covered is approximately 130 km. The description of the network was then modified in the way needed to represent it in LITRES 2.

Conclusions and Future Research:

We have described how a framework for planning of an integrated service should be designed. The importance of a connection between a GIS, simulation tools and optimization tools has been emphasized.

The evaluated mode4ng tool LITRES 2 has improve to be a useful tool for simulating multi nodal public transport journeys. It offers a unique opportunity to study markens response to changes in the range of transpon services. What is missing is the possibility to plan an integrated public transport system fully from the operator’ respectively. Performed simulations have given some guidelines of how to operate an integrated service. They have shown that small vehicles can efficiently be used in an integrated public transport service operated door to door.The exact model of how to assign passengers to vehicles in an integrated public transport system has been tested on several cases and proven to work as intended. It has also shown that it is possible to solve small instances of the integrated dial- a-ride problem to optimality. The literature review shows that more work has to be done on effective planning of journeys in integrated services. Also research on systems for planning and design of such services are needed, as well as to study the effects of an integrated service, to passengers, operators and society.

One focus on future research within this area should be on how to develop more efficient methods to plan integrated journeys.

Problem Definition and Design thinking about Public Transport Optimization

Optimizing public transport using sensors involves the strategic deployment of sensor technologies to enhance various aspects of public transportation systems. Here are some key areas where sensors can be applied to improve public transport:

1. Passenger Counting Sensors:

- Infrared sensors, cameras, or weight sensors can be used to track the number of passengers boarding and alighting from vehicles. This data helps in optimizing route planning and resource allocation.

2. Real-time Location Sensors:

- GPS or RFID sensors can provide real-time location data for buses, trains, or trams, allowing passengers to track the exact location and arrival times. This improvespassenger convenience and reduces wait times.

3. Traffic and Congestion Sensors:

- Traffic sensors and cameras at intersections can provide data on traffic flow and congestion, enabling public transport operators to optimize routes and schedules to avoid delays.

4. Environmental Sensors:

- Sensors can monitor air quality and emissions to assess the environmental impact of public transport systems. This information can be used to implement eco-friendly initiatives.

5. Maintenance Sensors:

- Sensors in vehicles can monitor their health and performance, allowing operators to schedule maintenance proactively and reduce breakdowns, leading to more reliable services.

6. Contactless Payment Sensors:

- NFC (Near Field Communication) and RFID sensors enable contactless ticketing payment systems, simplifying fare collection and enhancing the passenger experience.

7. Security and Surveillance Sensors:

Surveillance cameras and sensors can enhance passenger safety and deter criminal activity on public transport vehicles and at stations.

8. IoT Sensors for Predictive Analytics:

- Internet of Things (IoT) sensors can collect a wide range of data, which can be using predictive analytics to improve efficiency and safety, from predicting vehicle breakdowns to optimizing energy consumption.

9. Passenger Comfort Sensors:

- Temperature, humidity, and occupancy sensors can help maintain comfortable conditions within vehicles, ensuring a pleasant journey for passengers.

10. Noise and Vibration Sensors:

- Sensors can monitor noise levels and vibrations, ensuring that public transport remains within acceptable limits for passenger comfort and safety.

Designing and implementing an effective sensor-based public transport optimization system requires a comprehensive strategy, data analysis capabilities, and collaboration with technology providers, transportation authorities, and the public. The collected data should be used to make informed decisions and continuously improve the quality and efficiency of public transportation services.

Loading and Preprocessing dataset in design and thinking about Public Transport Optimization

Loading and preprocessing datasets for public transport optimization is a complex task with many considerations.

1. Data Sources:

Identify sources such as ticketing systems, GPS, traffic sensors, and user surveys.

2. Data Collection:

Gather real-time and historical data on routes, stops, vehicles, and passenger counts.

3. Data Quality:

Ensure data accuracy and reliability through validation and cleaning.

4. Data Granularity:

Decide on the level of detail required, from individual trips to system-wide trends.

5. Data Integration:

Merge data from multiple sources to create a comprehensive dataset.

6. Time Granularity:

Determine the time intervals (e.g., seconds, minutes, hours) for data aggregation.

7. Spatial Granularity:

Define the geographical units (e.g., stops, zones) for data analysis.

8. Data Compression:

Reduce data size while retaining essential information to improve processing speed.

9. Data Transformation:

Normalize, scale, or transform variables to facilitate modeling.

10. Feature Selection:

Identify the most relevant attributes for optimization algorithms.

11. Missing Data Handling:

Develop strategies to deal with missing values, such as imputation.

12. Outlier Detection:

Identify and handle anomalies that can skew analysis results.

13. Data Preprocessing Tools:

Utilize software libraries or custom scripts to automate data cleaning and transformation.

14. Data Privacy:

Ensure compliance with data protection regulations and anonymize sensitive information.

15. Time Series Analysis:

Apply time series techniques to understand temporal patterns in public transport data.

16. Geospatial Analysis:

Use GIS tools to analyze the spatial aspects of routes and stops.

17. Data Visualization:

Create visualizations to explore data, uncover trends, and communicate findings.

18. Passenger Behavior Analysis:

Investigate passenger preferences, boarding patterns, and trip durations.

19. Environmental Factors:

Consider the impact of weather, traffic conditions, and other external factors.

20. Demand Forecasting:

Predict future passenger demand to optimize vehicle allocation and schedules.

21. Route Optimization:

Develop algorithms to minimize travel time and reduce congestion.

22. Schedule Adjustment:

Optimize bus and train schedules to enhance system efficiency.

23. Vehicle Fleet Management:

Determine the appropriate number and type of vehicles for routes.

24. Cost Analysis:

Calculate operating costs and potential savings from optimization efforts.

25. Simulation:

Use simulation tools to test proposed changes before implementing them in the real system.

Effective loading and preprocessing of data for public transport optimization is essential for improving system efficiency, reducing costs, and enhancing the passenger experience.

Continue building the public transport optimization model by features engineering,model training,and evalution.

Certainly, here are additional points to continue building a public transport optimization model with a focus on feature engineering, model training, and evaluation:

Feature Engineering:

1. Weather Data Integration:

Incorporate historical and real-time weather data to predict how weather conditions affect public transport operations.

2. Holiday Schedules:

Create features that capture variations in transport schedules on holidays and weekends.

3. Social Events:

Include data on major events (concerts, conferences) that could lead to increased or decreased transport demand.

4. Safety Features:

Integrate features related to safety, such as accident data or crime rates along routes.

5. Vehicle Health Monitoring:

Implement features for monitoring the health of public transport vehicles, including maintenance schedules and mechanical data.

6. Public Health Data:

If relevant, include data related to public health events, such as pandemics, which can impact transport usage.

7. Traffic Signal Data:

Capture information about traffic signal timings and their impact on route optimization.

8. Environmental Data:

Features that consider environmental factors like air quality and noise pollution.

9. Customer Feedback:

Include sentiment analysis of customer feedback and ratings to gauge user satisfaction.

10. Infrastructure Data:

Features that represent the state of transportation infrastructure (e.g., road conditions, bus stop conditions).

Model Training:

11. Simulations:

Use simulation models to test and train the model in a controlled virtual environment before deploying it in the real world.

12. Custom Loss Functions:

Create custom loss functions that address specific objectives like minimizing delays or costs.

13. Transfer Learning:

Leverage pre-trained models or knowledge from similar domains to improve model training.

14. Sparse Data Handling:

Implement techniques for handling sparse data, which is common in public transport datasets.

15. Data Augmentation:

Augment training data to account for variations and data scarcity.

16. Model Ensemble:

Combine multiple models for improved accuracy and robustness.

17. Online Learning:

Explore online learning methods to continuously update the model as new data becomes available

18. Multimodal Integration:

If dealing with multiple modes of transport (e.g., buses and trains), model the interaction between them.

19. Customer Segmentation:

Segment passengers based on behavior and preferences, then tailor transport services accordingly.

20. Dynamic Route Adjustments:

Train models that adapt routes in real-time based on changing conditions like traffic and passenger demand.

Model Evaluation:

21. A/B Testing:

Implement A/B testing to compare the performance of the new model with existing systems in a controlled manner.

22. Sensitivity Analysis:

Assess how the model's performance changes with variations in input data or parameters.

23. Predictive Accuracy:

Measure the model's predictive accuracy for different time horizons (short-term vs. long-term forecasting).

24. Optimization Objectives:

Evaluate the model's performance against specific optimization objectives, such as cost reduction or environmental impact reduction.

25. Performance Dashboards:

Develop dashboards for real-time monitoring of key metrics and model outputs.

26. Route Efficiency Metrics:

Create metrics for assessing the efficiency of specific routes, including passenger wait times and travel times.

27. Resource Allocation:

Evaluate how well the model optimizes resource allocation, such as vehicle utilization and crew scheduling.

28. User Behavior Analysis:

Analyze changes in passenger behavior and satisfaction after implementing the model.

29. Operational KPIs:

Monitor key performance indicators for operations, such as vehicle breakdowns and driver scheduling.

30. Predictive Maintenance:

Evaluate the model's ability to predict maintenance needs and reduce downtime.

Building a public transport optimization model is an ongoing process that requires continuous monitoring, feedback, and adaptation to ensure it meets the dynamic demands of public transport systems.