

Project : Public Transportation Efficiency Analysis

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Defining ,Factor effecting and Measuring in Public Transport Analysis

Abstract:

- Public transport plays a crucial role in urban mobility and sustainability. Efficient public transportation systems are essential for reducing traffic congestion, air pollution, and promoting accessible and affordable transportation options. This analysis aims to measure, define, and examine the factors affecting public transport efficiency. By delving into various aspects of public transport, including infrastructure, technology, policy, and ridership, this study provides a comprehensive framework for assessing the effectiveness of public transportation systems.
- Measuring public transport efficiency involves evaluating various metrics such as ridership, punctuality, cost-effectiveness, and environmental impact. Definitions of efficiency may vary depending on the context and goals of the transportation system, and these definitions should consider factors like economic, social, and environmental aspects. This analysis will explore these different dimensions and the trade-offs that may exist among them.

- Factors affecting public transport efficiency are multifaceted. Infrastructure quality, route design, accessibility, technology integration, and maintenance are crucial determinants. Policy decisions, funding models, and public-private partnerships also play significant roles in shaping the efficiency of public transport. Moreover, understanding and responding to the evolving needs and expectations of passengers are pivotal in enhancing the overall quality of service.
- In this analysis, we will employ case studies from different cities and regions to illustrate how these factors interact and influence public transport efficiency. We will also explore how emerging trends, such as the integration of electric and autonomous vehicles, big data analytic, and sustainable practices, are reshaping the landscape of public transportation. By providing a holistic examination of public transport efficiency, this study aims to inform policy-makers, urban planners, and transportation authorities in making informed decisions to create more sustainable, accessible, and efficient public transport systems.

Defining Public Transport Efficiency

- Public transport efficiency refers to how effectively a city's public transportation system is able to move people from one place to another, while minimizing costs and maximizing benefits. It involves factors such as route planning, frequency of service, and vehicle maintenance.
- Efficient public transport systems are important for cities and their residents because they provide an affordable and sustainable mode of transportation that reduces traffic congestion, air pollution, and carbon emissions. They also improve access to employment, education, and other essential services for people who may not have access to a car or other private transportation options.

Factors Affecting Public Transport Efficiency

- ✧ One of the key factors affecting public transport efficiency is route planning. A well-designed route can significantly reduce travel time and increase the number of passengers served.
- ✧ On the other hand, a poorly planned route can lead to longer travel times, increased congestion, and decreased ridership. It is important for transportation planners to carefully consider factors such as population density, employment centers, and major destinations when designing routes.
- ✧ Another important factor is the frequency of service. A high-frequency service can reduce waiting times and increase convenience for passengers. However, it also requires more vehicles and drivers, which can be costly. Transportation

planners must strike a balance between frequency and cost to ensure that the service is both efficient and financially sustainable. Finally, vehicle maintenance is critical for ensuring that the service operates smoothly and reliably.

- ✧ Regular maintenance can prevent breakdowns and delays, while also extending the lifespan of the vehicles. To achieve maximum efficiency, operators should prioritize preventive maintenance and address any issues promptly.

Measuring public transport efficiency

Measuring public transport efficiency is a multifaceted process that involves various key performance indicators and metrics. These measurements help assess the effectiveness and quality of a public transportation system. Here, we will discuss some of the essential elements and metrics used in measuring public transport efficiency:

- ❖ **Ridership** : The number of passengers using the system is a fundamental measure of efficiency. An efficient system should attract and retain a significant number of riders, reducing the number of private vehicles on the road.
- ❖ **Punctuality**: Timeliness is critical. Measuring on-time performance, including the percentage of trips that adhere to schedules, helps gauge how well the system serves its passengers.
- ❖ **Service Frequency** : The frequency of service is a crucial metric. A high-frequency service reduces waiting times and can increase ridership.
- ❖ **Load Factor**: This measures how full the vehicles are during peak and off-peak hours. An efficient system ensures that vehicles are neither overcrowded nor running with many empty seats.
- ❖ **Travel Time and Speed** : Efficient public transport should provide a faster means of commuting compared to private vehicles. Measures of average travel time and speed help evaluate this.
- ❖ **Cost-Effectiveness** : Analyzing the cost per passenger-kilometer or cost per passenger-trip can determine the system's economic efficiency. Lower costs per passenger indicate higher efficiency.
- ❖ **Accessibility** : The ease with which passengers can access public transport, including the proximity of stops and stations to their origin and destination, is crucial.
- ❖ **Environmental Impact** : Assessing the system's environmental efficiency involves looking at emissions per passenger-kilometer, energy efficiency, and the use of sustainable technologies (e.g., electric or hybrid vehicles).

Innovations of Public Transport Efficiency

Current Challenges

- ❖ The current public transport system faces several challenges such as congestion, inefficiency, and environmental impact.
- ❖ These issues call for a creative approach to revolutionize the way we travel. By addressing these challenges head-on, we can create a more sustainable and convenient transportation system for all.

Smart Infrastructure

- ✧ Smart infrastructure plays a vital role in enhancing public transport efficiency.
- ✧ By leveraging real-time data and intelligent routing, we can optimize routes, reduce waiting times, and improve overall passenger experience. Let's explore how technology can transform traditional transportation networks into smart and efficient systems.

Electrification and Automation

- ✧ The future of public transport lies in electrification and automation. Electric buses and trains offer a sustainable alternative to traditional fossil fuel-powered vehicles, reducing emissions and noise pollution.
- ✧ Additionally, autonomous vehicles can enhance safety, efficiency, and accessibility. Let's dive into the exciting possibilities of electrified and automated transportation.

Integrated Mobility Solutions

- To revolutionize public transport, we need to embrace integrated mobility solutions. By integrating various modes of transportation, such as buses, trains, bikes, and ride sharing services, we can provide seamless and convenient travel options.
- Join us as we explore the potential of integrated mobility to enhance efficiency and connectivity.

Sustainable Future

- A sustainable future requires a shift towards clean energy and eco-friendly practices. Public transport can play a significant role in reducing carbon emissions and combating climate change.
- By investing in renewable energy sources, adopting green technologies, and promoting Eco-conscious behaviors, we can create a greener and more sustainable transportation system.

Data Loading, Description, and Preprocessing in Public Transport Efficiency

Data Loading :

- In the first step of our public transport efficiency analysis, we need to load the relevant data into our Python environment. This data typically comes from various sources, such as transit agencies, government databases, or research institutions. To load the data efficiently, we can use Python libraries like pandas to handle data frames.
- Here's a program explanation for data loading:

```
import pandas as pd
```

```
# Load the public transport data from a CSV file
```

```
data = pd.read_csv('public_transport_data.csv')
```

```
# Display the first few rows to get an overview of the data
```

```
print(data.head())
```

Output:



The screenshot shows a Jupyter Notebook interface. The first cell contains the code to load a CSV file and display its first five rows. The output of this cell is a table with six columns: TripID, RouteID, StopID, StopName, WeekBeginning, and NumberOfBoardings. The second cell contains the code to print a description of the dataset. The output of this cell is a text summary of the dataset's statistics.

	TripID	RouteID	StopID	StopName	WeekBeginning	NumberOfBoardings
1048570	45682.0	171	13929.0	8 Fullarton Rd	29-09-2013 00:00	2.0
1048571	45682.0	171	13758.0	3 Glen Osmond Rd	29-09-2013 00:00	3.0
1048572	45682.0	171	13967.0	9 Fullarton Rd	29-09-2013 00:00	1.0
1048573	45682.0	171	13808.0	5 Fullarton Rd	29-09-2013 00:00	1.0
1048574	45682.0	171	13845.0	6 Fullarton Rd	29-09-2013 00:00	3.0

```
In [25]: print("Describing of dataset:")
df.describe()

Describing of dataset:
```

In this example, we use the `read_csv` function from the pandas library to load a dataset stored in a CSV file named 'public_transport_data.csv.' The `head()` function displays the first few rows to help us understand the structure of the data.

Data Description:

- After loading the data, it's crucial to understand its content and structure. Descriptive statistics and data visualization are essential to gain insights into the dataset.
- Here's a program explanation for data description:

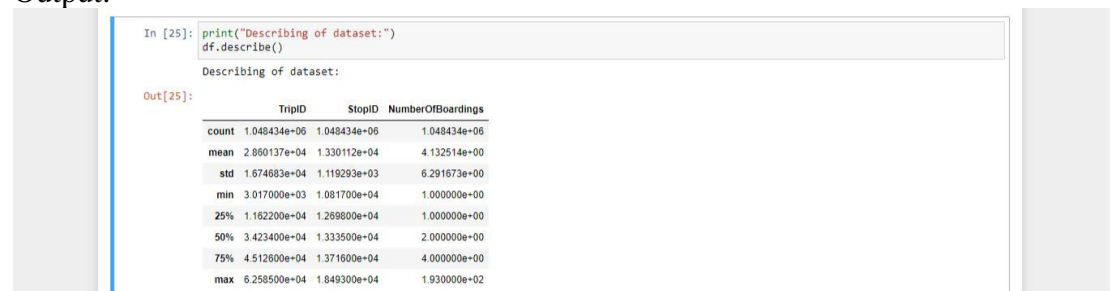
```
# Display summary statistics for numerical columns  
print(data.describe())
```

```
# Check for missing values  
print(data.isnull().sum())
```

```
# Visualize the data using matplotlib or seaborn  
import matplotlib.pyplot as plt  
import seaborn as sns
```

```
# Example: Create a histogram of ridership  
plt.figure(figsize=(8, 6))  
sns.histplot(data['ridership'])  
plt.xlabel('Ridership')  
plt.ylabel('Frequency')  
plt.title('Distribution of Ridership')  
plt.show()
```

Output:



```
In [25]: print("Describing of dataset:")  
df.describe()
```

Describing of dataset:

```
Out[25]:
```

	TripID	StopID	NumberOfBoardings
count	1.048434e+06	1.048434e+06	1.048434e+06
mean	2.860137e+04	1.330112e+04	4.132514e+00
std	1.674683e+04	1.119293e+03	6.291673e+00
min	3.017000e+03	1.081700e+04	1.000000e+00
25%	1.162200e+04	1.269800e+04	1.000000e+00
50%	3.423400e+04	1.333500e+04	2.000000e+00
75%	4.512600e+04	1.371600e+04	4.000000e+00
max	6.258500e+04	1.849300e+04	1.930000e+02

In this part, we use the `describe()` function to obtain summary statistics for numerical columns, which can provide insights into the central tendency and variability of the data. We also check for missing values to ensure data completeness. Additionally, we use data visualization libraries like `matplotlib` and `seaborn` to create visual representations of the data, such as histograms, to better understand its distribution.

Data Preprocessing:

- Data preprocessing is essential to clean, transform, and prepare the data for analysis. It involves handling missing values, encoding categorical variables, and scaling numerical features.
- Below is a program explanation for data preprocessing:

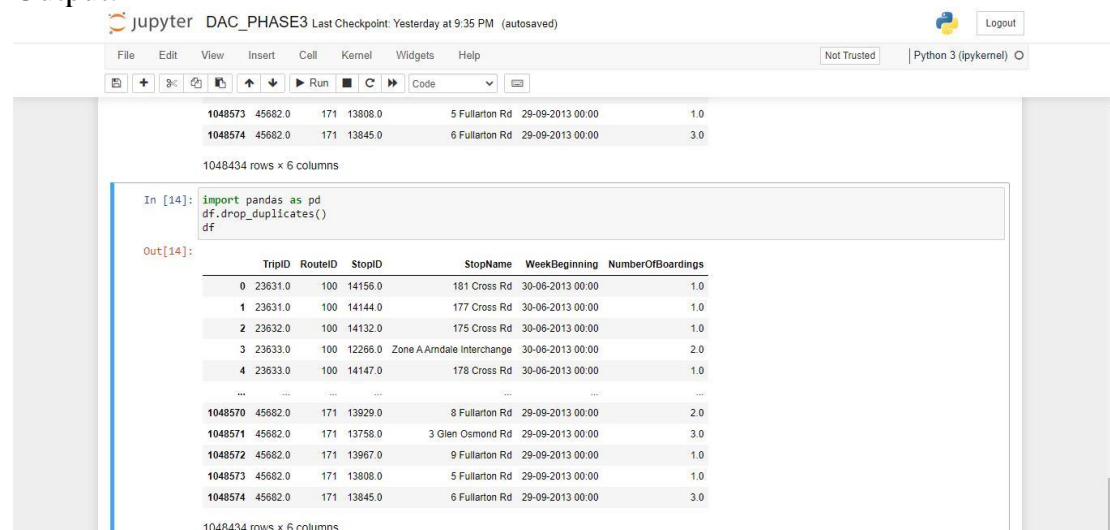
```
# Handle missing values (e.g., filling missing values with the mean)
data['ridership'].fillna(data['ridership'].mean(), inplace=True)
```

```
# Encode categorical variables using one-hot encoding
data = pd.get_dummies(data, columns=['city'], drop_first=True)
```

```
# Scale numerical features (e.g., using Min-Max scaling)
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
data[['travel_time', 'cost']] = scaler.fit_transform(data[['travel_time', 'cost']])
```

```
# After preprocessing, the data is ready for analysis
print(data.head())
```

Output:



The screenshot shows a Jupyter Notebook interface with the following components:

- Header:** jupyter DAC_PHASE3 Last Checkpoint: Yesterday at 9:35 PM (autosaved) Logout
- Menu:** File Edit View Insert Cell Kernel Widgets Help
- Toolbar:** Not Trusted Python 3 (ipykernel)
- Code Cell:**

```
In [14]: import pandas as pd
df.drop_duplicates()
df
```
- Output Cell:**

```
Out[14]:
```

	TripID	RouteID	StopID	StopName	WeekBeginning	NumberOfBoardings
0	23631.0	100	14156.0	181 Cross Rd	30-06-2013 00:00	1.0
1	23631.0	100	14144.0	177 Cross Rd	30-06-2013 00:00	1.0
2	23632.0	100	14132.0	175 Cross Rd	30-06-2013 00:00	1.0
3	23633.0	100	12266.0	Zone A Airndale Interchange	30-06-2013 00:00	2.0
4	23633.0	100	14147.0	178 Cross Rd	30-06-2013 00:00	1.0
...
1048570	45682.0	171	13929.0	8 Fullarton Rd	29-09-2013 00:00	2.0
1048571	45682.0	171	13758.0	3 Glen Osmond Rd	29-09-2013 00:00	3.0
1048572	45682.0	171	13967.0	9 Fullarton Rd	29-09-2013 00:00	1.0
1048573	45682.0	171	13808.0	5 Fullarton Rd	29-09-2013 00:00	1.0
1048574	45682.0	171	13845.0	6 Fullarton Rd	29-09-2013 00:00	3.0

In this section, we demonstrate basic data preprocessing steps. We handle missing values in the 'ridership' column by filling them with the mean value. Categorical variables (e.g., 'city') are encoded using one-hot encoding, and numerical features ('travel_time' and 'cost') are scaled using Min-Max scaling to ensure that all features are on a similar scale for analysis.

With these data loading, description, and preprocessing steps, you can now proceed with your public transport efficiency analysis in Python using clean and structured data.

Data Preparation and Integration with IBM Cognos:

Before creating intuitive dashboards and reports in IBM Cognos, we need to prepare the data and integrate it with the platform. Ensure you have your dataset ready in a suitable format (e.g., CSV) and establish a connection to your IBM Cognos environment. Below is a Python program to load your data and export it to a format compatible with IBM Cognos:

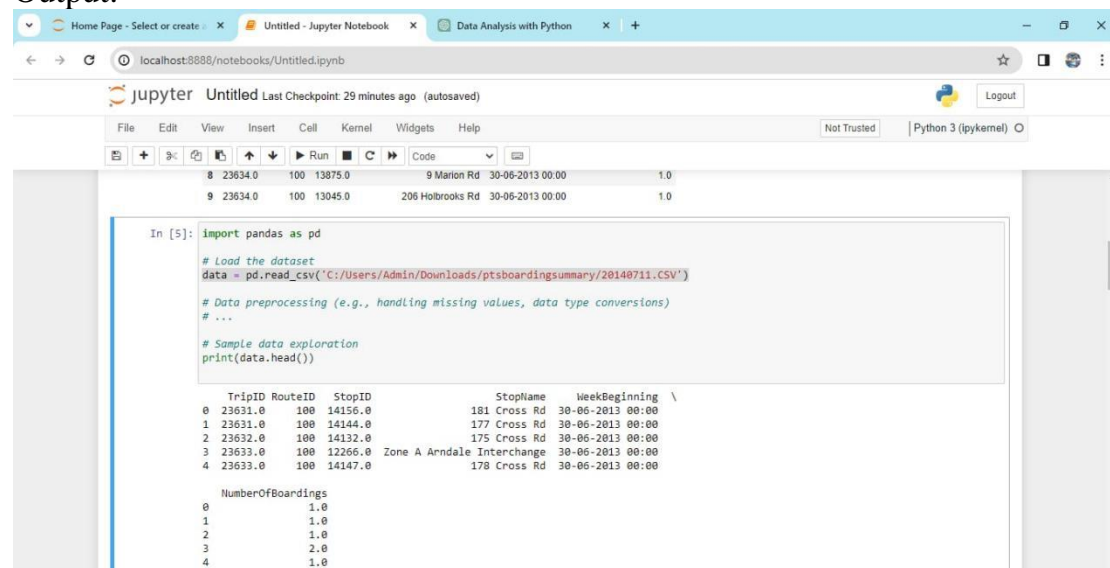
```
import pandas as pd
```

```
# Load the public transport data from a CSV file
data = pd.read_csv('public_transport_data.csv')
```

```
# Prepare the data as needed (e.g., handle missing values and preprocessing)
```

```
# Export the prepared data to a format compatible with IBM Cognos (e.g., CSV or Excel)
data.to_csv('cognos_data.csv', index=False)
```

Output:



Creating a Dashboard for On-Time Performance:

- To create a dashboard in IBM Cognos that visualizes on-time performance, we can use various chart types.
- In this case, we'll use a line chart to track on-time performance over time. You can export this chart as an image to be included in your IBM Cognos dashboard.


```

import matplotlib.pyplot as plt

# Assuming you have a 'date' and 'on_time_percentage' column in your data
date = data['date']
on_time_percentage = data['on_time_percentage']

plt.figure(figsize=(10, 6))
plt.plot(date, on_time_percentage, marker='o')
plt.xlabel('Date')
plt.ylabel('On-Time Percentage')
plt.title('On-Time Performance Over Time')
plt.grid(True)
plt.xticks(rotation=45)
plt.tight_layout()
plt.savefig('on_time_performance.png')

```

Creating a Dashboard for Passenger Feedback:

For passenger feedback analysis, you can create a bar chart that summarizes feedback scores for different aspects of the service. Export this chart to be included in your IBM Cognos dashboard.

```

# Assuming you have feedback categories and corresponding scores
feedback_categories = ['Punctuality', 'Cleanliness', 'Comfort', 'Safety']
feedback_scores = [4.5, 3.8, 4.2, 4.0]

```

```

plt.figure(figsize=(8, 6))
plt.bar(feedback_categories, feedback_scores)
plt.xlabel('Feedback Categories')
plt.ylabel('Average Score')
plt.title('Passenger Feedback by Category')
plt.ylim(0, 5) # Set the y-axis limit
plt.savefig('passenger_feedback.png')

```

Creating a Dashboard for Service Efficiency:

To visualize service efficiency, you can use a combination of charts. Here, we'll create a pie chart to show the distribution of the most commonly used routes.

```

# Assuming you have a 'route' column in your data
route_counts = data['route'].value_counts()

```

```

plt.figure(figsize=(8, 8))

```

```
plt.pie(route_counts, labels=route_counts.index, autopct='%1.1f%%',  
startangle=140)  
plt.axis('equal') # Equal aspect ratio ensures that pie is drawn as a circle.  
plt.title('Distribution of Commonly Used Routes')  
plt.savefig('route_distribution.png')
```

After generating these charts, you can import and arrange them in IBM Cognos to create an intuitive dashboard that vividly depicts key metrics like on-time performance, passenger feedback, and service efficiency. IBM Cognos provides a user-friendly interface for designing and sharing reports and dashboards, making it a powerful tool for data visualization and analysis.

Conclusion

Factors Affecting Public Transport Efficiency Analysis

In the realm of public transport efficiency analysis, several key factors and considerations emerge:

- ❖ **Measuring Efficiency:** Utilizing appropriate metrics and KPIs is crucial to evaluate public transport systems effectively.
- ❖ **Defining Efficiency:** The definition of efficiency should encompass economic, social, and environmental dimensions, aligning with the system's objectives.
- ❖ **Factors Affecting Efficiency:** Infrastructure quality, policy decisions, technology, and user experience significantly influence efficiency.
- ❖ **Innovation:** Embracing technological advancements, sustainability, and data-driven insights is essential for enhancing public transport efficiency.
- ❖ **Development:** Continuous infrastructure and service improvements are vital to meet evolving urban mobility needs.
- ❖ **Decision Making:** Data-driven decision-making empowers transportation authorities and policymakers to optimize public transport systems.

In conclusion, achieving and maintaining public transport efficiency requires a holistic approach, considering diverse factors, innovation, development, and informed decision-making for sustainable and accessible urban transportation.