Big Data Analysis Application Experience to Traction Power Demand for HSR

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Introduction

- Profile of THSRC- HSR Route Plan
  - The total length 349 km
  - 12 Stations constructed
  - 5 Depots
    - Lioujia Depot
    - Wurih Depot
    - Taibao Depot
    - Main Workshop
    - Zuoying Depot
  - Operation times from 06:15 to 24:00 every day (July 1, 2016)
## Overview of Train Service

### Service Level and Patterns (July 1, 2016)

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<tr>
<th>Direction</th>
<th>Mon</th>
<th>Tue~Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Trains per week</th>
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<td>Southbound</td>
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<th>TAY</th>
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<th>TAC</th>
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Overview of Traction Power

- **7 Bulk Supply Substations, BSS**
- Service Range of BSS along MainLine
  - BSS1 (Nangang, Taipei, and Banqiao, 45.5km)
  - BSS2 (Taoyuan, and Hsinchu Stations, 47.5km)
  - BSS3 (Miaoli Station, 51.8km)
  - BSS4 (Taichung Station, 55.7km)
  - BSS5 (Changhua, and Yunlin Stations, 56.0km)
  - BSS6 (Chiayi Station, 53.0km)
  - BSS7 (Tainan, and Zuoying Stations, 44.5km)

![Map of Taiwan with BSS locations](image)
Demand and Contract Capacity

• **What is the “Demand”?**
  It is based on maximum kilowatts consumed (averaged over 15 min) during each Time of Unit (TOU) period.

• **What is the “Demand Contract Capacity”?**
  It is an agreement between customer and Utility for the Demand which is applicable to pay contract capacity charge and subjected to specified minimum.
Why Big Data?

- Predictive Analytics
- Data Science
- Large/Raw data
- Complex data
- Correlation
- More Accurate

- Relational
- Non-Relational
- Real Time Intelligence
- Data Discovery

Factors of Demand Fluctuation:

- Weather/Earthquake/Topography
- Headway/Temporary extra train
- Equipment malfunction/Train fault
- Train driver's operation habit
- Set a Temporary Speed Restriction due to abnormal
- Travel time for a BSS

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Demand Fluctuation affected by Topography

Average Traction Power = 67.81 kWh/min

- BSS7
- BSS6
- BSS5
- BSS4
- BSS3
- BSS2
- BSS1

- Northbound

Average Traction Power = 62.97 kWh/min

- BSS1
- BSS2
- BSS3
- BSS4
- BSS5
- BSS6
- BSS7

- Southbound

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What are we looking at?

Optimal Contract Capacity
- Best time frame for additional service trains
- Intelligent management
- APP module of exceeded demand capacity warning
Lower cost in the longer term, through better capacity planning approach, thus as Big data technology introducing.

Accurate assessment of Contract Capacity must be made by good utilization.
Optimal Contract Capacity

Time Series Data

Multi Factor Line Regression method

ARIMA, Autoregressive Integrated Moving Average

Demand

Time Table vs. Traveling time

Historical Data

Relational Non-Relational

Forecasting Optimal Contract Capacity for a BSS
What are we looking at?

- Optimal Demand Contract Capacity
- Best time frame for additional service trains
- Intelligent management APP module of exceeded demand capacity warning
Best time frame for additional service Trains

- **Considering** on both passenger services principle and power demand variation due to additional train service, Based on the Big Data technology to estimate the optimum power demand, search out best time slot for inserting of the additional train service and avoid the possibility of exceeding the contract demand capacity, to reduce unnecessary cost.

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**Pax Service Principle First**
- Additional service train
  - Peak demand for Pax
  - Time Table Tunning
  - Stop patterns

**Best Time Frame survey**
- Time Slot evaluation
  - Under Contract capacity
  - Traction Demand of train
  - Demand Homogenization

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Time frame for additional service trains

Suitable for adding extra train

Not suitable for adding extra train

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What are we looking at?

- Optimal Demand Contract Capacity
- Best time frame for additional service trains
- Intelligent management APP Tool
Demand Monitor and Smart Driving

Based on the time table and power demand characteristic to develop the APP which could be used by train driver and train controllers. Combined with the existing train driver “Smart Driving” activities, which feedback on demand trend and characteristic, to achieve the goal of economic operation.
Demand Monitoring System

Operation Control Center

Back office

Data Highway

BSS1  BSS2  BSS3  BSS4  BSS4-1  BSS5  BSS6  BSS7  BSS7-1

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Next Steps
Step forward to Demand Big Data Survey

- **Optimal Demand** solution through Big Data exploring
- **Good Demand utilization** lie in best time frame of adding trains.
- **An Intelligent management APP module** development is applicable to real-time and on-site operators, which make added value for economical operation.