Background and Objectives

INTRODUCTION

Although most multiclass traffic assignment models can capture the interaction between trucks and passenger cars, they assume that the Passenger Car Equivalent (PCE) value of truck is only flow-independent. However, a large body of studies and the Highway Capacity Manual show that PCE values for trucks are a function of geometric parameters and truck flow.

OBJECTIVES

• Develop fitting functions for flow-dependent PCEs of trucks based on the latest Highway Capacity Manual (HCM) 6th edition
• Formulate a multiclass traffic assignment model to describe the flow distribution of trucks and passenger cars across a general network
• Explore the properties of the proposed traffic assignment model

Fitting Functions for Truck PCEs

RELATIONSHIP BETWEEN PCEs AND PERCENT OF TRUCKS

It was found that the Power Function is able to describe the relationship between the percent of trucks and the PCE well, as reflected by the R² coefficients of determination pretty close to 1.

![Figure 1. PCE of trucks for 0.875 mi grades in multilane segments](image)

**EXAMPLE DELAY FUNCTION, LEVEL TERRAIN**

- \( y = 1.3225x \) (R² = 0.9950)
- \( y = 1.595x \) (R² = 0.8975)
- \( y = 1.2872x \) (R² = 0.8744)
- \( y = 1.3225x \) (R² = 0.7850)
- \( y = 1.095x \) (R² = 0.6842)

![Figure 2. Modified BPR Function](image)

**Fitting Functions for Truck PCEs**

- \( f(x) = \frac{x^2}{v_0^2 + x^2} \)
- \( f(x) = 1 + 0.35 \frac{x^2}{x_0^2 + x^2} \)

![Figure 3. A Toy Network](image)

**The cost increases when truck flow disperses**

![Figure 4. Social costs for different equilibrium patterns](image)

**Numerical Example and Discussion**

- **76 LINKS, 24 NODES**
  - Grades set to 3.5%
  - PCEs from 2.2-3.4

**VARIANCE OF LINK FLOW DISTRIBUTION**

- **COMPARISON**
  - Constant PCEs
  - Variable PCEs

**Discrepancies as large as 12.8%**

![Figure 5. Sioux Falls network](image)

**Figure 6. Variance of aggregate flows in PCE**

**Conclusions and Recommendations**

- We proposed the use of power functions fitted to the discrete PCE values presented in the latest HCM (6th edition).
- The equilibrium link flow distribution for the VI formulation was proved to exist but may not be unique, impacting the social cost.
- Taking the congestion pricing design problem as an example, several approaches were provided to deal with such impact.
- We recommend that the additional impact of truck flow on link and signalized intersection capacity proposed by the HCM 6th edition.

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