ASSESSMENT OF WALK-TO-SCHOOL PROJECTS FOR A SUSTAINABLE TRANSPORT

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Summary

✓ Introduction

✓ Assessment methodology
  ✗ Supply representation
  ✗ Demand analysis
  ✗ Evaluation indexes

✓ Application to a real case
Introduction

Children’s health risks

Children’s statistics highlight:

✓ children’s **overweight** increase need attention

✓ **Pedestrian injuries** are one of the leading cause of unintentional injury-related death among children.

✓ **Asthma** rates have also increased in the past 15 years in children.
Introduction

Children health risks
Introduction

Walk-to-school goals

- increase daily physical activity of children
- improve pedestrian safety
- educate and empower communities to create safe routes to school
Introduction

Walk-to-school barriers

- Community Design
- Safety
- Time and Convenience
A **walking bus** is simply a group of school **children** walking to and/or from school with parents or volunteers, in an organised manner.

One parent/volunteer acts as the ‘**driver**’ who leads the way and one acts as the ‘**conductor**’ who manages the children at the rear.

They walk over a set route, stopping at designated ‘**bus stops**’ to collect pupils along the way to school and dropping them off on the journey home.
Introduction

Motivations

- Increased independence
- Increased physical activity
- Improved pedestrian skills
- More social interaction
- Reduced fear of crime
- Decreased neighborhood/school traffic
- Community design
- Less reliance on automobile

Many reasons to do a Walk to School program
This paper

... aims at evaluating the contribution of walk-to-school projects in Italian urban areas from the transportation point of view for a sustainable transport.
Methodology

Transport modelling architecture

TRANSPORT INFRASTRUCTURES AND SERVICES

SUPPLY (road and pedestrian)

Level of Service (LoS) attributes (times, costs)

DEMAND-SUPPLY INTERACTION

flows

performance functions

effect assessment

ACTIVITY SYSTEM

DEMAND (per mode)

O/D MATRICES (per mode)
Methodology

Assessment

Besides positive social and health effects for children, transportation effects can be evaluated by considering savings in the field of:

✓ environment
  *(emissions)*

✓ energy
  *(consumptions)*

✓ economy
  *(time savings)*
Assessment

Emissions

COPERT 4

✓ Estimation of pollutants
  CO, NOₓ, NMVOC, PM, CO₂, VOC, N₂O, NH₃, SO₂, CH₄, Pb, HM

✓ It considers:
  • Fuel variables: consumption, specifications (RVP, content in different species) per fuel types
  • Activity data: number of vehicles per vehicle category, distribution of the vehicle fleet into different exhaust mission legislation class, mileage per vehicle class, mileage per road class
  • Driving condition: average speed per vehicle type and per road
  • Emission factor: per type of emission (hot, cold, evaporation), per vehicle class, per road class
  • Cold mileage percentage per month, per vehicle class.
**Assessment Emissions**

- **COPERT 4**

**Fuel Variables**
- Consumption

**Activity Data**
- number of vehicles per vehicle category
- distribution of the vehicle fleet into different exhaust emission legislation classes
- mileage per vehicle class
- mileage per road class

**Driving Conditions**
- average speed per vehicle type and per road

**Other Variables**
- Climatic conditions
- Mean trip distance
- Evaporation distribution

**Emission Factors**
- per type of emission (hot, cold, evaporation)
- per vehicle class
- per road class

**Cold Mileage Percentage**
- per month
- per vehicle class

Calculation of annual emissions of all pollutants for all CORINAIR road traffic source categories at all defined territorial units and road classes

*EEA (European Environment Agency, 2007) - Methodology for the calculation of exhaust emissions - Emission Inventory Guidebook*
Assessment

Emissions (copert 4)

\[ E_j = E_{\text{hot},j} + E_{\text{cold},j} + E_{\text{vap},j} \]

\( E_{\text{hot},j} \) are the *hot emissions* of pollutant during stabilized (hot) engine operation, which can be estimated as

\[ E_{\text{hot},j} = n_j \cdot m_{j,k} \cdot e_{\text{hot},i,j,k} \]

\( n_j \) (vehicles) is the number of vehicles of class \( j \) in circulation at the reference year,

\( m_{j,k} \) (km/vehicles) is the mileage per vehicle driven on roads of type \( k \) by vehicles of class \( j \);

\( e_{\text{hot},i,j,k} \) (g/km) is the average fleet representative baseline emission factor in for the pollutant, relevant for the vehicle class \( j \), operated on roads of type \( k \), with thermally stabilized engine and exhaust after treatment system.
Assessment

Emissions (copert 4)

\[ E = E_{\text{hot}} + E_{\text{cold}} + E_{\text{vap}} \]

\( E_{\text{cold}, j} \) are the cold emissions during transient thermal engine operation (cold start)

\[ E_{\text{cold}} = \beta_{i,j} \times n_j \times m_j \times E_{\text{hot}, i, j} \times \left( \frac{e_{\text{cold}, i, j}}{e_{\text{hot}, i, j}} - 1 \right) \]

\( \beta_j \) is the fraction of mileage driven with cold engines or catalyst operated below the light-off temperature for pollutant and vehicle category \( j \);

\( m_j \) is the total mileage per vehicle in vehicle class \( j \),

\( \frac{e_{\text{cold}, i, j}}{e_{\text{hot}, i, j}} \) is the cold over hot ratio for pollutant, relevant to vehicles of class \( j \).
Assessment

Emissions (copert 4)

\[ E = E_{\text{hot}} + E_{\text{cold}} + E_{\text{vap}} \]

\( E_{\text{vap},j} \) is the evaporative emissions given by evaporative NMVOC emission from gasoline

\[ E_{\text{hot}} = 365 \times n_j \times (e_d \times S_c \times S_{fi}) + R \]

\( n_j \) (vehicles) is the number of vehicles of class \( j \);
\( e_d \) is the factor emissions associated with the ambient diurnal temperature variation;
\( S_c \) is the factor of hot and cold emissions for vehicles equipped with carburetor;
\( S_{fi} \) is the factor of hot and cold emissions for vehicles equipped with electronic injection
\( R \) are the losses during running
Assessment

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\( R \) are the losses during running
Assessment
Consumptions and VTTS

✓ FC (fuel consumptions)

\[ C = C_R + \frac{800}{V_M(V_M + 8)} \quad \text{per } V_M < 15 \text{ km/h} \]

\[ C = 7.0 + \frac{99}{V_M} \quad \text{per } 10 \leq V_M \leq 60 \text{ km/h} \]

✓ VTTS (value of Travel Time Saving)

\[ VTTS = \sum_j VOT_j \cdot (TT_{D,j} - TT_{A,j}) \]

\( VOT_j \) (vehicles) is the value of time of the parent of user \( j \)

\( TT_{Y,j} \) is the travel time spent by the parent of user \( j \) with the ped-bus scenario

\( TT_{N,j} \) is the travel time spent by the parent of user \( j \) without the ped-bus system
Assessment

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The authors wish to thank the municipality of Grottaferrata for the data made available for the development of this application.
The case study (Grottaferrata, Rome)

Road network

severe congestion
(7.30-8.30am)
Grottaferrata walk-to-school project

Coverage area

Main characteristics

✓ 3 schools
✓ 4 lines
✓ 62 users
Supply Lines

<table>
<thead>
<tr>
<th>line</th>
<th>length (m)</th>
<th>number of stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (yellow)</td>
<td>750</td>
<td>4</td>
</tr>
<tr>
<td>2 (white)</td>
<td>1000</td>
<td>4</td>
</tr>
<tr>
<td>3 (red)</td>
<td>710</td>
<td>4</td>
</tr>
<tr>
<td>4 (blue)</td>
<td>620</td>
<td>4</td>
</tr>
</tbody>
</table>

Crisalli et al. – Assessment of walk-to-school projects for a sustainable transport
Supply Lines

path labels

stops

timetable
GROTTFERRATA WALK-TO-SCHOOL PROJECT

Demand analysis

User locations
Demand analysis

User characteristics

user distribution by school

user distribution by age
Demand analysis
Demand analysis
Access to stop per mode

user access per mode

32%
68%

by car
on foot

severe congestion
(7.30-8.30am)
Demand analysis

Access to stop per mode
(Line 1)
Demand analysis
Child to school by car

user travel distance to school by car

- 29% <= 0.5 km
- 35% 0.5 - 1 km
- 14% 1 - 1.5 km
- 10% 1.5 - 2 km
- 5% 2 - 2.5 km
- 3% 2.5 - 3 km
- 2% >= 3 km
Assessment

Road network
### Assessment Results

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Units</th>
<th>Savings</th>
<th>€/Unit</th>
<th>€/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>kg/year</td>
<td>5.9</td>
<td>3.4</td>
<td>20</td>
</tr>
<tr>
<td>PM10</td>
<td>kg/year</td>
<td>0.5</td>
<td>255.6</td>
<td>132</td>
</tr>
<tr>
<td>PM2.5</td>
<td>kg/year</td>
<td>0.4</td>
<td>393.2</td>
<td>153</td>
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<tr>
<td>HC</td>
<td>kg/year</td>
<td>4.5</td>
<td>1.7</td>
<td>8</td>
</tr>
<tr>
<td>CO2</td>
<td>kg/year</td>
<td>1 060.0</td>
<td>0.1</td>
<td>106</td>
</tr>
<tr>
<td>FC</td>
<td>lt/year</td>
<td>1 005.6</td>
<td>1.5</td>
<td>1 508</td>
</tr>
<tr>
<td>VTTS</td>
<td>h/year</td>
<td>4 910.1</td>
<td>15.0</td>
<td>73 651</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>75 578</strong></td>
</tr>
</tbody>
</table>

€/year-user 1 219
Conclusions & Future developments

This paper applies transportation modelling for the assessment of walk-to-school services. The application to a real case demonstrates limited benefits from the external cost point of view:

😊 social and health benefits
😊 carbon footprint reduction
😊 travel time savings

Future developments mainly regard:

✔ mode choice models for ex-ante assessment
✔ optimal walk-to-school path generation methods
✔ optimal fare definition