A new look at planning and designing transportation systems: markets, decision-making models and the role of quantitative methods

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Outline

1 Background

2 Decision-making in transportation
   - Decision: why, who, where, what
   - Components of decision-making processes

3 Models of decision-making processes

4 Public Engagement
   - Definition and levels
   - PE and decision making

5 The role of quantitative methods in transportation decision-making
outline

1. Background

2. Decision-making in transportation
   - Decision: why, who, where, what
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3. Models of decision-making processes

4. Public Engagement
   - Definition and levels
   - PE and decision making

5. The role of quantitative methods in transportation decision-making

1. background

- Decisions related to transportation systems, made by both public and private subjects, often impacts on diverse and contrasting interests.

- Decision on transportation are time-consuming and non-efficient due to the complexity of the legal procedures and the fragmentation of the decision-makers system.

- Decision on transportation systems often capture the public eye interest.
1. TAV Turin-Lyon

Protesters derail start of longest Alp tunnel

Richard Doran
The Times | Published 02 December (2012) | European football

...by its Italian initials as TAV. The focus of their protests...Yearn the slogan: "No TAV" rang in harem...Government claims that the TAV is vital if commercial traffic...protests last year, to no avail. "Hockey..."

Italy high-speed rail protest turns violent

Police have again clashed with demonstrators in the latest days near the construction of a new high-speed line link with France

Clash over new high-speed rail tunnel in Italian Alps

1. Congestion Charge in London

Go-slow protest over road charge

Hundreds of drivers have taken part in an anti-congestion charge protest in London in a last-ditch attempt to stop the western extension of the zone.

Organised by the West London Residents Association, the go-slow began at Addison Road, in Harrow.

Protesters argue the 20p charge, being introduced from Monday, will damage businesses and cost residents hundreds of pounds a year.

But Transport for London believes congestion will be cut by 15% - and claims the number of vehicles will be reduced by 10 to 15% once the charge is introduced.

The zone will expand west from central London on Monday to include Kentington and Chiswick.

The protest convoy and march travelled along the Edgeware Road, which will be the boundary of the new zone.

One resident said: "We’re fighting [London Mayor Ken Livingstone]. At least we can show them that we care, even if they won’t listen."

Livingstone praises congestion zone extension

Matt Viso and agency

Click to see new congestion charge area

The protest convoy and march travelled along the Edgeware Road, which will be the boundary of the new zone.

One resident said: "We’re fighting [London Mayor Ken Livingstone]. At least we can show them that we care, even if they won’t listen."

"Since the introduction of the charges in 2003, traffic in the central zone by 30%, 5% reduction"
1. open skies and new (competitive) markets

1. background

TRENDS IN TRANSPORTATION DECISION-MAKING

- **Stronger awareness** of the impacts of transport-related choices and their externalities (e.g. environment, welfare, territorial inequalities, etc.) and larger opportunities to voice different opinions/interests

- **Opening of transport markets** once directly managed or strictly controlled by public authorities (infrastructure building and management, air and railway services, urban public transportation) to **private operators**
1. background

TRADITIONAL APPROACHES TO TRANSPORTATION PLANNING AND DECISION-MAKING IN TRANSPORTATION LITERATURE

- A process aimed at defining plans, actions and operations at different temporal horizons for a rational transport system (Manheim, 1979)

- Urban transportation planning is the process of: (Meyer and Miller, 2001)
  a) Establishing a vision of what a community wants to be and how the transportation system fits into this vision, and understanding the types of decisions that need to be made to achieve this vision
  b) Assessing opportunities and limitations of the future in relationship to goals and desired system performance measures
  c) Identifying the near- and long-term consequences to the community and to transportation system users of alternative choices designed
  d) Relating alternative decisions to the goals, objectives, or system performance measures established for an urban area, agency, or firm
  e) Presenting this information to decision makers in an understandable and useful form
  f) Helping decision makers establish priorities and develop an investment program

"Planning is seen mostly as a public-oriented activity, based on the simulation of alternative projects and the assessment of priorities"

...but this is often not the case
2. decision-making processes

Decisions:

Why? ... perspectives  
Who? ... decision makers  
Where? ... markets  
What? ... types of decision
2A. decisions: why, who where, what

PERSPECTIVES, main objectives (why?)

- Mobility planning
- Business planning
- Environmental planning
- Land-use planning
- ...

DECISION-MAKERS (who?)

- Public Administrations
  - European
  - National
  - Regional
  - Metropolitan/Urban

- Companies (private, public, mixed)
  - Construction and management of transport infrastructure (e.g. motorways, ports, airports)
  - Management of transport services (e.g. airlines, rail lines, containers lines)
2A. decisions: why, who where, what

TRANSPORT MARKETS (where?)

 Natural Monopoly

Only one subject is possible/convenient for construction and/or management of a transport system (e.g. rail network, urban road network)
- direct management by the Public Administration
- competition for the market
  - concession contracts (including PPP and PF)
  - service contracts (e.g. subsidized Public Transportation Services)

 Competitive market (competition in the market)

Several subjects compete for the same economic activity (e.g. rail services, air lines, etc.)

2A. decisions: why, who where, what

TYPES OF DECISION (what?)

 Regulations
  - Land use regulation
  - Location of activities (e.g. Public Facilities)
  - Market regulation
  - Air quality regulations, ...

 Services
  - Timetables
  - Fares, ...

 Infrastructure
  - Building
  - Upgrading, ...

 Vehicles & technologies
  - Fleet composition
  - ITS deployment, ...

TEMPORAL PERSPECTIVE
strategic

Lausanne, September 6th, 2012
2A. decisions: why, who where, what

Decisions on Transportation System or impacting on it

2A. decisions: why, who where, what

TYPES OF DECISION (what?)

A project defines physical and/or organization characteristics aimed at their implementation

Example of a road project

WHY? Mobility Planning
WHO? Public Highway Authorities
WHERE? Natural monopolies:
- Direct P.A. control/management
- Competition for the market (BOT, PF)

WHAT? Design Variables

- Geometry and Functional characteristics
  (e.g. type of road, road alignment, connectivity with the existing network, etc.)
- ITS systems
  (e.g. tolls and tolls collection, speed enforcement, ramp metering, variable speed limits, etc.)
- Environmental impacts mitigation solutions
  (e.g. noise barriers, ventilation systems, etc.)
- Building technology and phases
- Landscape insertion studies
2A. decisions: why, who where, what

**TYPES OF DECISION (what?)**

Example of a rail project

**WHY?**

Business Planning

**WHO?**

Private HSR Operator

**WHERE?**

Competition in the market (no subsidies)

**WHAT?**

- Design Variables
  - Line design and operations *(e.g. service, stations, timetables for different time periods, etc.)*
  - Vehicles and Technology *(e.g. rolling stock number, performances, etc.)*
  - On board services and travel accommodation *(e.g. classes, comfort services, etc.)*
  - Pricing policies *(e.g. fares, reductions, special offers, etc.)*

2A. decisions: why, who where, what

**TYPES OF DECISION (what?)**

Projects and plans

A transportation *plan* is a set of related *projects* and/or *project options* regarding *infrastructures, services, regulations, vehicles,* and *technologies* aimed at reaching a shared and consistent set of objectives with respect to predefined constraints.
outline

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5 The role of quantitative methods in transportation decision-making

2B. components of decision-making processes

Decision-making processes impacting on several subjects both within and outside the organization (public or private) in charge of the decision

- Decision-makers
  Those who are formally in charge of the choice

- Process coordination
  People and procedures used to plan and manage each stage of the process

- Stakeholders
  Those who hold a stake in a particular issue, even though they have not a formal role in the decision-making process

- Opportunities/problems
  They stimulate the decision-making process

- Objectives (stated/unstated)
  Targets pursued by decision makers and stakeholders

- Contextual barriers
  Anything restricting or causing the delay or cancellation of a project. They set constraints, such as institutional, legal and financial restrictions

- Consensus barriers (see later)

- Coalitions: Groups of actors whose objectives converge to one solution

- Implementation: Development of the project or part of it
2B. components of decision-making processes

STAKEHOLDERS

<table>
<thead>
<tr>
<th>Institutions and Authorities</th>
<th>Users</th>
<th>Transport operators</th>
<th>Business and Unions</th>
<th>Local communities</th>
<th>Media</th>
<th>Financial institutions</th>
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<tr>
<td>European Union</td>
<td>Direct users (passengers)</td>
<td>Transport operators</td>
<td>National and local</td>
<td>Transport users</td>
<td>TV station</td>
<td>Banks</td>
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<td>industry associations</td>
<td>associations</td>
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<td>National government and authorities</td>
<td>Direct users (freight)</td>
<td>Transport operator associations</td>
<td>National and local</td>
<td>Local interest</td>
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<td>Funds</td>
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<td>trade unions</td>
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<td>borough associations</td>
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<tr>
<td>National parliament</td>
<td>Indirect users (passengers)</td>
<td>Consultants</td>
<td>National and local</td>
<td>Environmental</td>
<td>Newspapers</td>
<td>Insurances</td>
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<td>Regional governments and Authorities</td>
<td>Indirect users (freight)</td>
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<td>Retailers associations</td>
<td>Citizens</td>
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<td>Regional transport authority</td>
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<td>Industry in public</td>
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<td>Local authorities (Provinces and</td>
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<td>Industry in vehicles</td>
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<td>Municipalities)</td>
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<td>Political parties and single members</td>
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<td>Industry in technology</td>
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2B. components of decision-making processes

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<table>
<thead>
<tr>
<th>INTEREST/POWER MATRIX</th>
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<tbody>
<tr>
<td><strong>POWER</strong></td>
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<tr>
<td><strong>HIGH</strong></td>
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<td>Keep satisfied</td>
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<tr>
<td>Key players</td>
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<tr>
<td><strong>LOW</strong></td>
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<tr>
<td>Minimal effort</td>
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<tr>
<td>Keep informed</td>
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<tr>
<td><strong>LOW</strong></td>
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<tr>
<td><strong>HIGH</strong></td>
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<tr>
<td><strong>DYNAMISM/POWER MATRIX</strong></td>
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<tr>
<td><strong>POWER</strong></td>
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<tr>
<td><strong>HIGH</strong></td>
</tr>
<tr>
<td>Powerful but predictable</td>
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<tr>
<td>Greatest danger or opportunities</td>
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<tr>
<td><strong>LOW</strong></td>
</tr>
<tr>
<td>Fewer problems</td>
</tr>
<tr>
<td>Unpredictable but manageable</td>
</tr>
<tr>
<td><strong>LOW</strong></td>
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<tr>
<td><strong>HIGH</strong></td>
</tr>
<tr>
<td><strong>DYNAMISM</strong></td>
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- Consensus barriers

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  Groups of actors whose objectives converge to one solution

- Implementation:
  Development of the project or part of it

MULTIPLE, CONFLICTING, OBJECTIVES

**Stated**
- To improve accessibility (Activity participation)
- To reduce production costs (Efficiency)
- To reduce users generalized costs (Quality)
- To improve public health (i.e. harmful pollutants, road safety, ...)
- To reduce environmental impacts (i.e. gas emissions, visual intrusion in the surrounding landscape, ...)
- To reduce territorial inequalities and group disparities (Equity)
- To foster territorial development (redevelopment areas, new districts, ...)
- To boost economic growth
- To enlarge public consensus upon decisions
- To maximize company profit

**Unstated**
- To enlarge political consensus
- To legitimate public role
- To maximize personal profit
- To expand markets and/or shares
- To weaken competing companies
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**CONSENSUS BARRIERS**

Consensus: problems associated with achieving acceptance by stakeholders

Not only related to new infrastructures and plants but also to new traffic schemes (e.g. road pricing), new lines etc.

“There is no opinion, however absurd, which men will not readily embrace as soon as they can be brought to the conviction that it is generally adopted”

- Schopenhauer
2B. components of the process

TYPICAL CONSENSUS BARRIERS
NIMBY and other syndromes

- **NIMBY** Not In My Back Yard
- **NIABY** Not In Anyone's Back Yard
- **NAMBI** Not Against My Business or Industry
- **BANANA** Build Absolutely Nothing Anywhere Near Anything (or Anyone)
- **NIMTO** Not in My Term of Office

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3. models of decision-making processes

TRANSPORT-RELATED DECISION-MAKING PROCESS

A sequence of activities performed by several actors (including decision-makers and possibly stakeholders) in order to decide on options including projects, plans, and not deciding (delaying)

CLASSIFICATION

- RATIONAL models
- A-RATIONAL models
3. models of decision-making processes

RATIONAL MODELS

Rationality: Acting in the best possible way considering the aim (Elster, 1986)

Minimal Requirements of Rational decisions: (Cascetta and Carteni, 2012)

- **consistent**
  - internally w. r. t. the objectives and externally with other decisions (plans, projects)

- **comparative**
  - considering one or more alternatives (e.g. not deciding, one of the available options, searching for other possibilities)

- **aware**
  - sufficient information about the options (features), the context (physical and decisional) and other related choices (internal, horizontal and vertical coherence)
  - sufficient information about the effects of the options (costs, benefits, risks and opportunities)

- **flexible**
  - amenable to changes due to
    - new information on the alternative options and their effects
    - context changes (economic, physical, institutional)
    - Decision “opportunity costs” (postpone unnecessary decisions)

For technical, economic and administrative feasibility

3. models of decision-making processes

RATIONAL MODELS

- **STRONG RATIONALITY**
  Homo oeconomicus is a utility maximezer relative to his/her choices

- **COGNITIVE OR BOUNDED RATIONALITY**
  Decision-makers have limited time, capacity and resources and therefore choose an alternative which is satisfying, learning from previous choices
3. models of decision-making processes

RATIONAL MODELS

The strongly rational approach

1. Problem complexity, that is impossibility of evaluating all the alternatives and the related impacts
2. Different and often contrasting objectives among decision-makers and stakeholders
3. Each option brings a series of favourable or unfavourable consequences difficult to compare
4. Cognitive limits to the capacity of the decision makers of considering all the feasible options, and in the uncertainty of the results
5. Limited times and resources to assess and compare alternatives
6. Presence of stakeholders with a veto right
3. models of decision-making processes

RATIONAL MODELS
Application areas of the strongly rational approach

- **Simple objectives** (e.g. to minimize total travel time, production costs, with constraints expressed by quantitative variables)
- **Possibility to automatically generate alternative options** (Supply and Demand problems)
- **Limited or no impact on stakeholders**
- **Limited number of decision-makers**

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The cognitive or bounded rational approach

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Lausanne, September 6th, 2012
3. models of decision-making processes

RATIONAL MODELS
Cognitive/Bounded Rational approach

It is loosely consistent with:

▪ Bounded Rationality Choice Theory (Simon 1957; Rubinstein, 1999; Kahneman, 2003) (Economics)

▪ Learning Theory in Dynamic Decision-Making Models (Brehemer, 1992; Gonzalez et al., 2003) (Management science/Psychology)

▪ Cognitive Processes in Decision-Making (Wang et al. 2003, 2007) (Cognitive sciences)

3. models of decision-making processes

RATIONAL MODELS
Application areas of the cognitive/bounded rationality approach

✓ Multiple (and possibly ill-posed) objectives, also related to non-quantitative variables

✓ Not exhaustive knowledge of the context variables/available solutions

✓ Impacts on multiple stakeholders

✓ Several decision-makers

✓ Significant uncertainty in the simulated impacts
3. models of decision-making processes

A-RATIONAL MODELS

The garbage can model (Cohen et al., 1972; Daft, 2001; Lipson, 2007)

Originally proposed for describing organizational decision-making processes in companies

The variables

- Actors/participants (A)
- Problems (P)
- Solutions (S)
- Decision Opportunities (O)

O are the cans in which A throw P and S. The decision depends on the random coupling of P and S

Applications to public decision-making in transportation can be found in Cascetta and Carteni (2012)
3. models of decision-making processes

A-RATIONAL MODELS
The garbage can model

It deals with “organized anarchies”, i.e. organizations where there are three properties:

1) Choices are made on the basis of ill-posed and inconsistent ideas

2) A solution/an idea could be proposed even if there is not a problem or it could contribute to define it. On the contrary, a problem could exist without being able to find a solution

3) Participation changes: different actors are involved over time

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3. models of decision-making processes

A-RATIONAL MODELS
The garbage can model

Decisions based on an a-rational approach have some limitations:

- **Non-efficiency**: the “organized anarchy” often brings to projects that do not solve the problems or might solve them only partially

- **Instability**: decisions depend crucially on the actors (decision-makers and stakeholders) contributing to it, and are not retraceable if they change

- **Lack of legitimization**: the organization is able to survive without making its processes understandable by the members of the organization itself
3. models of decision-making processes

A-RATIONAL MODELS
Application areas of the garbage can model

✓ No regulations requiring formal assessment of projects, proposals, plans
✓ Strong interests for a specific solution rather than for solving the problem
✓ Limited public debate (see later)

“Real-life decision-making process could be approximated by different models at different stages”
4A. definition and levels

- Public Engagement (PE) is the process of identifying and incorporating stakeholders’ concerns, needs and values in the transport decision-making process.

- It is a two-way communication process that provides a mechanism for exchanging information and promoting stakeholder interaction with the formal decision-makers and the transport project team.

- The overall goal of engagement is to achieve a more transparent decision-making process with greater input from stakeholders and their support of the decisions (larger coalitions)

- Stakeholders management is also studied in organization and management sciences (Clarkson, 1999)
4A. definition and levels

THE FIVE LEVELS OF PE

1. **Stakeholders identification**: e.g. authorities, local communities, etc.
2. **Listening**: systematic analysis of the current social, cultural and economic conditions with a direct impact on stakeholders
3. **Information giving**: information relative to the project provided by the stakeholders
4. **Consultation**: decision-makers listen to the different points of view and interact with the stakeholders
5. **Participation**: extension of the consultation level where the groups, directly interested, become joint partners of the project and in the project implementation. They take part in making the final choice

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4A. definition and levels

SOME EXPERIENCES OF PUBLIC ENGAGEMENT REGULATIONS

In the United States:

- Title VI of the Civil Rights Act (1964)
- The Intermodal Surface Transportation Efficiency Act (1991)
- Office of Public Engagement (since 2009)

In France:

The National Public Debate Commission was established in 1995 with the Barnier law, related to the protection of the environment. Public debates to be organized between the various actors during the implementation phase of the large-scale public projects promoted by the State.

In UK:

- Code Of Practice On Consultation (2000): how consultation exercises are best run and what people can expect from the Government when it has decided to run a formal consultation exercise
4A. definition and levels

THE ARCH-ENEMY OF PE: THE DAD (DECIDE, ANNOUNCE, DEFEND) SYNDROME
(e.g. Susskind et al., 1983; Walker, 2009)

Administration makes a DECISION (the best project/plan), it ANNOUNCES the project to the population and other stakeholders that have not been involved previously. This produces many oppositions and the Administration is obligated to DEFEND the decision against criticism, accusations and controversy without having the opportunity to improve the project (if only marginally)

Limits of the DAD
- It fosters barriers
- It increase costs
- It increases times

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4B. PE and decision-making

- Public Engagement and rational decision-making do not necessarily imply each others (e.g. DAD syndrome and PE based on “pure” negotiation)
- PE and the cognitive/bounded rational approach have a strong interaction potential

THE BOUNDED RATIONALITY TRANSPORT PLANNING PROCESS AND THE ROLE OF PUBLIC ENGAGEMENT
4. the role of quantitative methods in transportation decision-making

SOME SUGGESTIONS

1. Understanding and modeling mobility and transport related phenomena
2. To assist in the design, assessment and evaluation of transport-related decisions:
   - What If
   - What To
3. To contribute towards reaching larger consensus through Public Engagement (e.g. information-based PE)
4. To provide inputs for economic/financial plans of operators
5. To analyze new transport markets and their possible regulations
4. the role of quantitative methods in transportation decision-making

SOME INDICATIONS FROM THE NEW PERSPECTIVE

- To model the **impacts relevant to stakeholders** and decision-makers
- To increase the design (and modeling) effort for the **preliminary stages**
- To adopt assessment methods allowing the evaluation of both **quantitative and qualitative impacts** for **different actors**
- To represent **results** in ways that can be understood by **non-experts**
- To highlight the (neglected) relevance of **ex-post studies**
- To improve the capability to capture users’ **willingness to pay** for transport services
- To quantify the **uncertainty** entailed in the simulation results and in the assessment methodology

Model the impacts relevant to stakeholders and decision-makers
4. the role of quantitative methods in transportation decision-making

Model the impacts relevant to stakeholders and decision-makers

**Users' Impacts Perceived by the Users**
- Being informed
- Traveling quality/experience
- Aesthetic Quality
- Contributing to sustainable mobility
- Reliability of travel times
- Possibility of multitasking
- Time spent waiting/queuing

**Social System**

Social and Economic Cohesion
- Winners and losers by area
- Impacts for socio-economic groups (e.g. children and elderly people, no-auto licensed, ethnic minorities)
- ...

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4. the role of quantitative methods in transportation decision-making

Increase the design (and modeling) effort for the preliminary stages

![Graph showing the relationship between project costs and added value.](image)

Total value of the project brought by each design stage
Total Cost of each design stage

Stages: Feasibility, Preliminary, Final, Executable, Working Plan

4. the role of quantitative methods in transportation decision-making

Adopt assessment methods allowing the evaluation of both quantitative and qualitative impacts for different actors (Cost-Benefit analysis is not enough!)

Multiple Agent Multi-Criteria Decision Making (MAMCDM)

1. Identify competing alternatives
2. Define objectives
3. Establish performance criteria for each objective
4. Establish relative importance of performance criteria
5. Rank of alternatives
6. Determine the most shared alternative

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4. the role of quantitative methods in transportation decision-making

Creative ways to represent results that can be understood by non-experts

Establishing the role of quantitative methods in PE decision-making processes

- Make use of appropriate communication language
- Adoption of “self-explanatory” graphics for the presentation of results
- Analogies for quantitative variables
- Make reference to comparable case-studies
- Flexible aggregation levels

4. the role of quantitative methods in transportation decision-making

Highlight the (neglected) relevance of ex-post studies

- To give feedbacks to stakeholders and decision-makers for further stages of the process
- To increase credibility and limits of quantitative methods
- To fine tune models
- To enrich the stock of “stories” to be told for similar projects
4. the role of quantitative methods in transportation decision-making

Improve the capability to capture users’ willingness to pay for transport services
More reliable simulation of transport services revenues

- Traditionally, quantitative tools mainly focus on physical measures (e.g. flows, speeds, travel times, etc.)
- Increasing need to capture willingness to pay for different users’ segments of transportation services (e.g. yield management)

![Graph showing measured AADT vs. estimated AADT with average flow over-estimation of 23% and improved modeling of users' willingness to pay for new services/infrastructures.]

\[
\text{Measured AADT} / \text{Estimated AADT}
\]
4. the role of quantitative methods in transportation decision-making

Quantify the uncertainty entailed in the simulation results and in the assessment methodology, for risk assessment
Uncertainty Propagation and Global Sensitivity Analysis frameworks

basic references (1/2)

Decision-Making in Transportation and Models – RATIONAL MODELS

Decision-Making in Transportation and Models – A-RATIONAL MODELS

Decision-Making in Transportation and Models – PUBLIC ENGAGEMENT
The role of quantitative methods in transportation decision-making


Thank you for your attention!