

# A TAXONOMY FOR SMART MOBILITY SERVICES

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**UNU-EGOV**

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Electronic Governance

# Outline

- Background
- Research Methodology
- Taxonomy
- Conclusions

# EGOV Strategy for Smart Mobility

## A TOOL FOR POLICY MAKERS AND GOVERNMENT OFFICIALS

- Guides the definition of EGOV strategies for Smart Mobility
- Provides a catalog of mobility services, applied technologies and delivery channels
- Illustrates public value that can be delivered through each type of service
- Identifies main users and beneficiaries



A taxonomy for Smart Mobility Services

# Research Methodology

## Research Questions

- What types of mobility services are being implemented in smart city initiatives?
- How such services are delivered?
- What kind of benefits are delivered through such services?

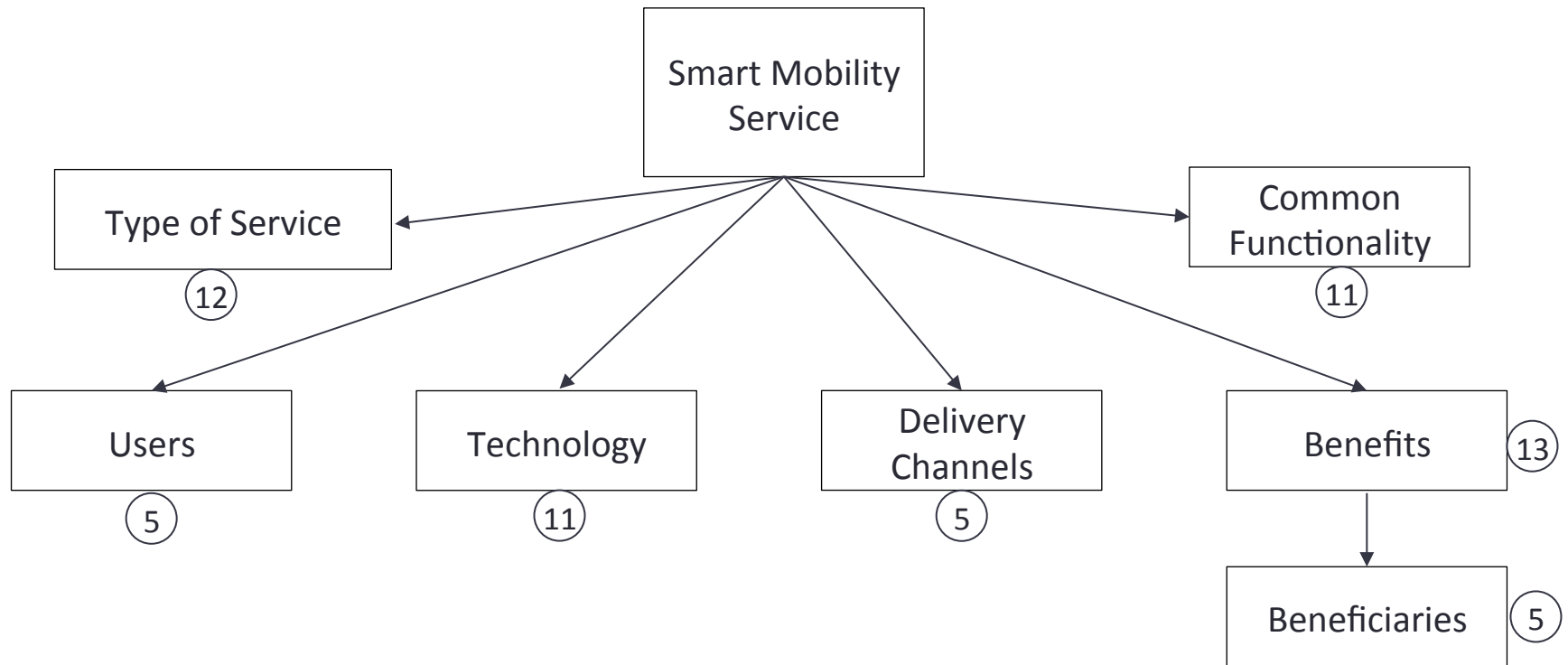
## State of Research

- assess publications on smart mobility
- 20 publications selected

## State of Practice

- assess mobility services delivered in smart city initiatives
- 9 smart cities selected:
  - Amsterdam, Netherlands
  - Seattle, USA
  - Barcelona, Spain
  - Songdo, South Korea
  - Curitiba, Brazil
  - Surrey, Canada
  - Copenhagen, Denmark
  - Vienna, Austria
  - Dubai, UAE
- 46 smart mobility initiatives

# Taxonomy



# Types of Services

Driving Guidance (regular drivers)	<ul style="list-style-type: none"><li>○ Most convenient route for moving between two places (fixed or real time)</li><li>○ Real time information of issues that can affect mobility</li><li>○ Routes can be selected based on different criteria, e.g.:<ul style="list-style-type: none"><li>• shortest</li><li>• fastest</li></ul></li></ul>
Driving Guidance (emergency vehicles)	<ul style="list-style-type: none"><li>○ Targeted to emergency vehicles – police, ambulance, and fire brigade</li><li>○ Instructions to reach a destination through the fastest route</li><li>○ Usually uses real time information</li></ul>
Improving Transport Resources	<ul style="list-style-type: none"><li>○ Replacing fuel-based vehicles by electric vehicles</li><li>○ Providing WI-FI in public buses</li><li>○ Sensors measuring number of passengers to adjust level of incoming fresh air</li></ul>

# Types of Services

## Improving Transport Infrastructure

- Enhanced functionality for parking places, roads, traffic lights, etc., e.g.:
  - devices to automatically open barriers in parking places
  - devices to detect empty parking places
  - dynamic led signs in the asphalt to indicate which kind of transport has priority
  - dynamic message signs in roads

## Journey Planners

- Instructions for moving inside the city using one or multiple types of transport, e.g.:
  - types of transport available
  - travel and arrival times for each part of the journey
  - guidance for commuting between the different types of transport

# Types of Services

Locating Objects	<ul style="list-style-type: none"><li>○ Cars</li><li>○ Public bicycles</li><li>○ Public transport</li><li>○ Bus stops, train stations, subway stations</li></ul>
Monitoring Traffic	<ul style="list-style-type: none"><li>○ Monitor, analyze, and get insights about, traffic, including pedestrians – e.g.:<ul style="list-style-type: none"><li>• monitoring traffic at intersections for detecting congestions</li><li>• monitoring corridors and cars for estimating traveling times</li><li>• monitoring intersections for detecting cars' illegal behavior</li></ul></li><li>○ Provide evidence of incidents to police or other authorities through recorded data</li><li>○ Monitor simulated traffic data to evaluate impact of various events on traffic flow:<ul style="list-style-type: none"><li>• closure of roads</li><li>• adjustments in traffic lights patterns</li><li>• weather</li></ul></li></ul>



# Types of Services

## Monitoring Transport

- Insights about events on board of the vehicles
- Performance based on current traveling times an expected times
- Number of passengers
- Time spent at bus stops
- Increasing demand

## Parking

- Searching for unoccupied parking facility
- Pre-booking a parking place
- Negotiating parking fee
- Managing parking facilities
- Announcing offered parking places
- Facilitating interactions with interested users requiring the place

# Types of Services

## Payment

- Seamless payment of transport-related services:
  - tickets for single or multi-modal journeys
  - parking places
  - energy for an electric vehicles
  - road tolls
  - use of public bicycles.

## Reporting Mobility

- Information about events that affect mobility:
  - planned events (constructions, concerts, closure of roads, etc.)
  - congestions
  - current traveling times

# Types of Services

Sharing transport	<ul style="list-style-type: none"><li>○ Sharing vehicles and journeys (personal or taxis):<ul style="list-style-type: none"><li>• announcing vehicles or taxi journeys</li><li>• booking and paying for shared journeys</li><li>• finding shared journeys based on different criteria</li><li>• assessing the experience</li></ul></li></ul>
Traffic Light Optimization (regular vehicles)	<ul style="list-style-type: none"><li>○ Adjusting traffic lights based on different factors to attend changing demands:<ul style="list-style-type: none"><li>• Current traffic flow</li><li>• Historical and simulated data</li></ul></li></ul>
Traffic Light Optimization (special vehicles)	<ul style="list-style-type: none"><li>○ Adjusting traffic lights to prioritize the moving of special vehicles:<ul style="list-style-type: none"><li>• emergency vehicles (ambulances, police, fire brigade)</li><li>• public buses</li></ul></li></ul>

# Analyzing Types of Services

Type of services	Driving Guidance	<ol style="list-style-type: none"> <li>1. Is there any category that you believe should be removed or merged with other?</li> <li>2. Is there any category that should be added?</li> <li>3. Is there any category name you would like to change?</li> </ol>
	Improving transport resources	
	Improving transport Infrastructure	
	Journey planners	
	Locating objects	
	Monitoring traffic	
	Monitoring transport	
	Parking	
	Payment	
	Reporting mobility	
	Sharing transport	
	Traffic light optimization	

# Users

Transport Authority	<ul style="list-style-type: none"><li>○ Agencies licensing public and commercial vehicles</li><li>○ Agencies for designing, building and maintaining transport resources and infrastructures</li><li>○ Agencies for regulating and monitoring land transport in a given territory.</li></ul>
Driver	<ul style="list-style-type: none"><li>○ Motor-Vehicle Driver</li><li>○ Bicycle Driver</li></ul>
Passenger	<ul style="list-style-type: none"><li>○ Public transport passenger</li><li>○ Taxi passenger</li><li>○ Non-public transport passenger</li></ul>
Resource Owner	<ul style="list-style-type: none"><li>○ Owners of vehicles, public or private parking place, etc. willing to share or rent it</li></ul>
Pedestrian	<ul style="list-style-type: none"><li>○ A person who walks through the city and interacts with traffic lights, journey planners, etc.</li></ul>

# Analyzing Users

Transport Authority	
Driver	1. Is there any category that you believe should be removed or merged with other?
Passenger	2. Is there any category that should be added? 3. Is there any category name you would like to change?
Resource Owner	
Pedestrian	

# Technology

11 identified applied technologies classified into ICT tools and computational techniques



# Technology

ICT Tools	Internet Access	Journey planners, traffic conditions
	3G Mobile Internet	Parking services, driving guidance
	Wi-Fi Access Points	Geo-locate mobile devices
	Near Field Communication (NFC)	Pay transport services
	Closed Circuit Television (CCTV)	Detect congestions or incidents
	Global Positioning System (GPS)	Locate near-by parking and public transport
	Radio Frequency Identification (RFID)	Detect congestions, green light for buses
	Smart Sensors	Detect free parking
	Inductive Loop Traffic Detector	Counting vehicles



# Technology

## Computational Techniques

Simulation Algorithms

Traffic simulation models for traffic light optimization

Video Recognition Techniques

Algorithms for identifying license plates, estimating travel times

# Analyzing Technology

ICT Tools	Internet Access 3G Mobile Internet
	Wi-Fi Access Points
	Near Field Communication (NFC)
	Closed Circuit Television (CCTV)
	Global Positioning System (GPS)
	Radio Frequency Identification (RFID)
	Smart Sensors Inductive Loop Traffic Detector
Computational Techniques	Simulation Algorithms
	Video Recognition Techniques

1. Is there any category that you believe should be removed or merged with other?
2. Is there any category that should be added?
3. Is there any category name you would like to change?

# Delivery Channels

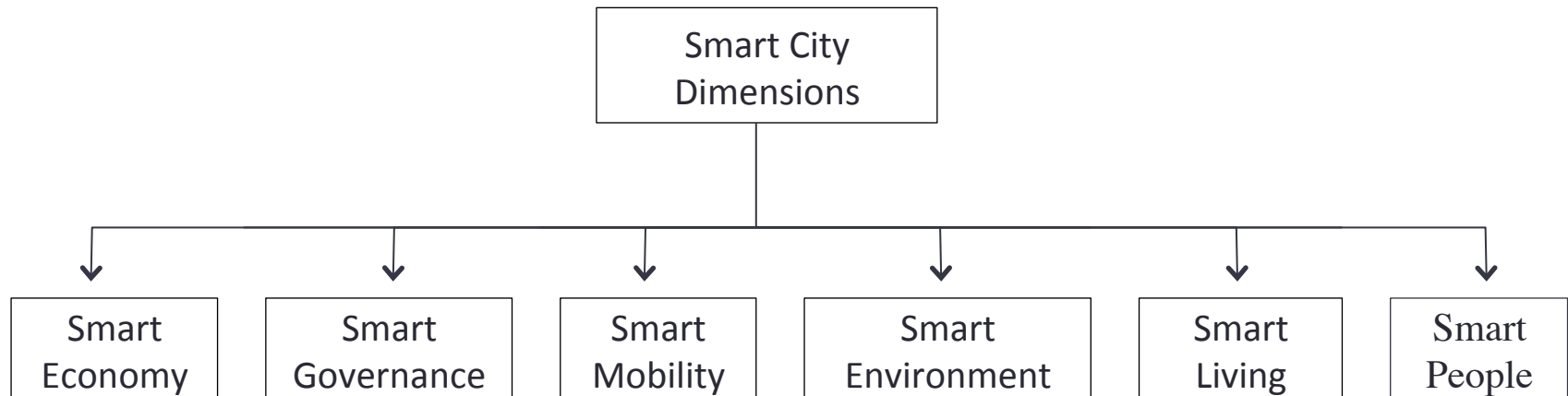
Dynamic Message Sign	Current traffic information, parking nearby
Mobile Devices	Driving guidance, journey planners, parking services
Smart Card	Payment of public transport and parking
Short Message Service (SMS)	Information about public bicycles, payment of transport tickets
Website	Journey planners, parking services, traffic information

# Analyzing Delivery Channels

Dynamic Message Sign	<ol style="list-style-type: none"><li>1. Is there any category that you believe should be removed or merged with other?</li><li>2. Is there any category that should be added?</li><li>3. Is there any category name you would like to change?</li></ol>
Mobile Device	
Smart Card	
Short Message Service (SMS)	
Website	

# Benefits

13 identified benefits classified across 6 smart city dimensions



# Benefits

Smart Economy	Generating new sources of income	Car and parking sharing
	Generating personal savings	Parking guidance (fuel), seamless payment (transport)
Smart Governance	Resolving conflicts	Identify traffic incidents for faster response
	Detecting illegal behavior	Vehicles passing red light

# Benefits

Smart Mobility	Facilitating journeys	Multimodal journey planners, real time information of public transport
	Reducing commuting time	Driving and parking guidance, faster green lights for public transport
	Contributing to reducing traffic congestions	Traffic light optimization, driving guidance (alternative routes)
	Facilitating seamless payment of services	Seamless payment for transport and parking places

# Benefits

Smart Environment	Reducing CO2 emissions	Parking and driving guidance, carpooling
	Contributing to becoming a paperless society	Transport payment through mobile applications and text messages
	Encouraging use of environmentally-friendly means of transport	Faster green lights for buses, journey planners
Smart Living	Improving Safety	Real time information about traffic conditions, monitoring traffic and transport



# Benefits

Smart People

Developing e-skills

Driving and parking guidance, journey planners

Developing social values

Car sharing, carpooling (sharing and trust)

# Analyzing Benefits

Smart Economy	<ul style="list-style-type: none"> <li>○ Generating new sources of income</li> <li>○ Generating personal savings</li> </ul>
Smart Governance	<ul style="list-style-type: none"> <li>○ Resolving conflicts</li> <li>○ Detecting illegal behavior</li> </ul>
Smart Mobility	<ul style="list-style-type: none"> <li>○ Facilitating journeys</li> <li>○ Reducing commuting time</li> <li>○ Contributing to reducing traffic congestions</li> <li>○ Facilitating seamless payment of services</li> </ul>
Smart Environment	<ul style="list-style-type: none"> <li>○ Reducing CO2 emissions</li> <li>○ Contributing to becoming a paperless society</li> <li>○ Encouraging use of environmentally-friendly means of transport</li> </ul>
Smart Living	<ul style="list-style-type: none"> <li>○ Improving safety</li> </ul>
Smart People	<ul style="list-style-type: none"> <li>○ Developing e-skills</li> <li>○ Developing social values</li> </ul>

1. Is there any category that you believe should be removed or merged with other?
2. Is there any category that should be added?
3. Is there any category name you would like to change?

# Beneficiaries

	Transport Authority	Drivers	Passengers	Resource Owners	Society
Generating new sources of income		X		X	
Generating personal savings		X	X	X	
Resolving conflicts		X	X		
Detecting illegal behavior	X				
Facilitating journeys			X		
Reducing commuting time		X	X		
Contributing to reducing traffic congestions		X	X		
Facilitating seamless payment of services		X	X		
Reducing CO2 emissions					X
Contributing to becoming a paperless society					X
Encouraging use of environmentally-friendly means of transport					X
Improving safety		X	X		X
Developing e-skills	X	X	X	X	X
Developing social values				X	X

# Analyzing Beneficiaries

	Transport Authority	Drivers	Passengers	Resource Owners	Society
Generating new sources of income		X		X	
Generating personal savings		X	X	X	
Resolving conflicts		X	X		
Detecting illegal behavior	X				
Facilitating journeys			X		
Reducing commuting time		X	X		
Contributing to reducing traffic congestions		X	X		
Facilitating seamless payment of services		X	X		
Reducing CO2 emissions					X
Contributing to becoming a paperless society					X
Encouraging use of environmentally-friendly means of transport					X
Improving safety		X	X		X
Developing e-skills	X	X	X	X	X
Developing social values				X	X

1. Are the benefits identified for each beneficiary correct?
2. Is there any beneficiary missing for a given benefit?
3. Is there any beneficiary you would like to change?

# Common Functionality

Requesting near resources	Buses, taxis, parking, carpooling, car sharing
Requesting available near resources	Parking, public bicycles, car sharing
Requesting guidance to move to a location	Driving, using public transportation (fixed or real time)
Calculating arrival time	Driving, taxis, public transport
Calculating cost of a service or resource	Multimodal journeys, taxi, parking
Sharing a resource	Car, parking, taxi, car ride
Booking a resource	Car, parking, transport tickets
Paying a service	Car, parking, transport, public bicycles,
Requesting locking/unlocking access to a resource	Cars for car-sharing, parking
Requesting records of mobility services used	Monthly expenses for public transport, parking
Locating a resource	Parking places, public bicycles, bus stops

# Analyzing Common Functionality

Requesting near resources	<ol style="list-style-type: none"><li>1. Is there any category that you believe should be removed or merged with other?</li><li>2. Is there any category that should be added?</li><li>3. Is there any category name you would like to change?</li></ol>
Requesting available near resources	
Requesting guidance to move to a location	
Calculating arrival time	
Calculating cost of a service or resource	
Sharing a resource	
Booking a resource	
Paying a service	
Requesting locking/unlocking access to a resource	
Requesting records of mobility services used	
Locating a resource	

# Conclusions

## TAXONOMY

- Types of services
- Users
- Technology
- Delivery Channelss

- Benefits
- Beneficiaries

- Common Functionality

- **Policy Makers**
- **Government Officials**

A tool for strategy processes for improving mobility

Concrete public value to justify business cases

- **Software Engineers and Developers**

A tool for building smart mobility services

# Conclusions

## Extensions to the taxonomy

- Quantitative benefits
- Government actions and policies to promote the use of the services
- Government plans to train people to learn to use the services
- Government efforts to disseminate the availability of the services



# THANK YOU

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