Innovative
Policy Modelling and Governance Tools
for Sustainable Post-Crisis Urban Development

D7.5 Comparative evaluation and assessment

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Executive Summary

The aim of task WP7.5 is to perform a comparative assessment of the suitability of different types of urban models to tackle policy issues, and evaluate their potential impact on urban planning and governance processes. Four case studies have been considered involving four cities, four different urban simulation tools and five different policy scenarios: congestion charging, teleworking, re-densification policies, Crossrail 1 construction, and Heathrow airport expansion.

The comparative assessment has been based on a two-round interview with the project's model implementers and representatives of city authorities. The interviews have followed a structured questionnaire consisting of four blocks respectively related with the background situation in each city, the technical features of the tools, the value proposition of the tool, and the contribution to policy objectives.

The policy questions addressed by the project are:

- Cordon toll. It is a measure aimed to the reduction of traffic congestion mostly in the city centres. It consists in introducing different pricing strategies through access tolls. The cordon toll policy has been simulated for three of the four cities: Madrid, Barcelona and London (in this case exploring additional cordon tolls to those already existing).
- Measures to promote teleworking, a scenario implemented for the Madrid region aimed to study its impact on traffic flows particularly at the peak hours.
- Re-densification policies, simulated for the city of Rotterdam, aimed at the reduction of urban sprawl and the regeneration of urban centres.
- The construction of Crossrail 1 in London.
- The impact on land use of a considerable increment of job offers (approximately 50,000 new jobs) in the London Heathrow airport area due to the construction of a third runway in the north west of the area between the current airport and the M4 motorway.

The main conclusions of the analysis can be divided in three main groups: general conclusions about the use of the models and their limitations, specific conclusions related to the implementation of the INSIGHT models, and conclusion about the knowledge exchange favoured by the case studies.

Conclusions on the use of models in the urban planning process:

- There is an increasing need of simulation tools in urban policy and planning due to the complexity and the long-term implications linked to policy decisions in this area. In particular, simulation tools can help to increase transparency and participatory processes.
- The use of simulation models in the public administration is growing. Currently public administrations work with different models, most of them visual models built on top of GIS, typically working in isolation. There is general perception on the convenience of integrating these models to provide more holistic advice, which suggests that interdepartmental collaboration is key for the successful implementation of integrated solutions.
- Simulation tools can help to bridge the gap between short-term policy objectives (typically derived from the four/five years' election cycle) and long-term objectives, where consensus between different constitutions and political parties is needed.

- The organisational structure of the city council regarding the implementation of simulation tools for urban policies and planning is highly relevant, with rather different models across cities. There is also an influence of local culture on how to use the different tools and their outcome in the policy-making process.
- The quality and availability of data is one of the main barriers for the use of simulation tools in the urban planning process. Fieldwork is still typically needed to complete data required for simulation tools. There is still a need to improve data gathering automation and processing within city data frameworks. Geolocated data from mobile devices are currently contributing to improve data quality and availability.
- The learning curve for the use of simulation tools in the urban planning processes is still perceived as a barrier for their usage and success, in particular in connection with calibration (the most time consuming and complex part of the usage of simulation tools), coherence and ability to interpret results.
- New professional profiles (modellers, data scientists, city scientists) are needed in the public administrations to successfully use and exploit decision support tools for urban planning. City planners perceive as a risk the shortage of these specialised profiles, remarking that this risk is bigger as a consequence of the fierce competition from the private sector.

Conclusions on the implementation of INSIGHT models:

- From a technical perspective, the hardware and software requisites are not a significant barrier. Nowadays the technical challenges lie in the storage and use of (big) data as well as its related requisites: security, privacy, availability, integrity, etc.
- The visualisation layer of urban simulation tools is deemed as a key component of such tool, sometimes not given enough relevance. Obtaining results in a comprehensible format is useful for city planners but it is also linked with the opportunity to share technical studies with citizens and increase transparency in policy making.
- Technical support to run the simulation tools is usually needed. Although documentation on the simulation tools is available, a city council or related agency as a stand-alone user is not a feasible scenario yet. The generalised use of the models implemented in the different cases by the addressed city councils or related agencies independently from external model implementers is still far from being a reality.

Conclusions on the different interactions favoured by the case studies:

- The policy-makers interviewed have a highly positive opinion of the INSIGHT project, not only because of the technical merits of the simulation tools implemented during the project but also because of the opportunities to exchange experience and overcome internal barriers for the successful implementation of evidence-based policy making.
- Sharing practices and opinions is seen as very positive initiative, since although direct experiences are not transportable between cities, previous experience about measures that have produced good results and measures that have failed is a useful input for the evaluation of options maybe not considered before.

1 Scope and objectives

The aim of task WP7.5 is to perform a comparative assessment of the suitability of different types of urban models to tackle policy issues, and evaluate their potential impact on urban planning and governance processes.

Four case studies, one in each city participating in the project, are used to this aim. In total the project has involved four cities, four different urban tools and five different policy measures (cordon toll, teleworking, re-densification, construction of Crossrail 1, construction of a third runway in Heathrow). These measures may influence a range of areas relevant for sustainable urban development: urban planning, quality of life, human resources, energy and environment, mobility and contribution to overall economy.

The comparison has been based on a two-round interview with the project's model implementers and representatives of city authorities. The interviews have followed a questionnaire structured in four blocks respectively related with the background situation in each city, the technical features of the tools, the value proposition of the usage of the tool, and the contribution to policy objectives. The assessment criteria were based on the work done in task WP2.4 and documented in deliverable D2.4.

The document first introduces the policy measures distinguishing between common (implemented in more than one city) and specific measures. The results for each case study are then presented in detail. The document ends with some conclusions derived from the case studies, including recommendations and future avenues for research and innovation.

2 Methodology

2.1 Evaluation framework

The evaluation framework, as described in detail in deliverable D2.4, is based on three different perspectives: technical design, economic features (here renamed as value assessment), and impact on policy-making and overall benefits for society.

- The technical assessment includes the evaluation of hardware and software requirements, calibration process, data dependency, usefulness of outputs, operational characteristics, complexity, usability, flexibility and alignment with policy measures.
- The value assessment covers the value proposition and the resources required for implementing and using the tools.
- The policy assessment comprises the contribution of the urban simulation tools to governance and urban planning, including aspects related to transparency, open data, participatory decision-making and evidence-based policy-making.

Additionally, a specific section on the background situation was included to cater for the organisational structure of the city government, the political and social context, and the perceived relationship between simulation tools and policy making at the city council.

The evaluation framework also considers the results from the stakeholder consultation conducted in WP2.1 (see deliverable D2.1). From this survey it was found that while urban tools are potentially useful in practically all the stages of the political cycle, in most cases they are not currently used. City planners and modellers pointed to the connection between models and real scenarios, the availability of input data, the reliability of model results and their interpretation as the main areas of improvement to boost the use of models in the process of policy making.

The resulting questionnaires, one for city planners and another for project model implementers, are displayed in Annex I.

2.2 Structured interviews

Using the evaluation framework described above and the questionnaires in Annex I, two rounds of structured interviews were performed with both project model implementers and city planners for each of the case study cities. The first round took place before the implementation of the tool and the second round during or after the implementation.

Interviews took place mostly in person and, when this was not possible, using online tools. For confidentiality reasons the list of persons interviewed is not included in this document. The authors of this report would like to thank the open collaboration of all the project model implementers and city planners interviewed.

3 Case studies - Overview

The case studies involve:

i) four cities: Barcelona, London, Madrid, Rotterdam;
ii) one common measure (implemented in three of the four case studies): cordon toll;
iii) four specific measures: promotion of teleworking, re-densification policies, construction of Crossrail 1 and Heathrow runway expansion;
iv) four different urban simulation tools.

Table 1. Summary table of urban tools and policy measures

		London	Madrid	Barcelona	Rotterdam
Common measures	Cordon toll	X	X	X	
Specific measures	Teleworking		X		
	Re-densification				X
	Cross rail	X			
	Additional runway in Heathrow Airport	X			
Related policy priorities		↓ Congestion ↓ CO_2 ↓ Pollution ↑ Equity	↓ Congestion ↓ CO_2 ↓ Pollution ↑ Economy ↓ Sprawl	↓ Congestion ↓ CO_2 ↓ Pollution ↑ Liveability	↓ CO_2 ↓ Pollution ↓ Sprawl
Tool		SIMULACRA/QUANT	MARS	MATSim	ALBATROSS

4 Status of urban simulation tools

Within the INSIGHT project, different urban simulation tools and their implementation for the case study cities have been updated and enhanced. A summary of the improvements developed is shown in Table 2.

Table 2. Summary of urban tools features and developed extensions

Urban model	Features	INSIGHT extensions	Implemented for
SIMULACRA/ QUANT	Spatially extensive aggregate land use transportation interaction (LUTI) model built for Greater London and its outer metropolitan region.	Importing the new retail location model into SIMULACRA. SIMULACRA model is being extended from the region of London to the region of England and Wales with a web-based interface which can be accessed for any city remotely by any user. This the extension of the SIMULACRA model is now called QUANT.	London
MARS	Dynamic and aggregate LUTI model that includes two main sub-models, transport and land use. A housing location sub-model and a workplace (including retail and production) location sub-model are part of the land use sub-model. It is also a Sketch Planning Model embedded in an assessment and optimization framework.	Update of the external scenario of the MARS model with recent data including the use of non-conventional data sources like Google Maps data and data from the real estate portal Idealista. The improvements of the model include: (i) a re-calibrated housing location model, (ii) new defined performance indicators based on policy decision makers' opinion, and (iii) the general accessibility indicator, which integrates the new public service accessibility model.	Madrid
MATSim	Activity-based multi-agent micro-simulation framework used to simulate traffic flows and the congestion generated by them.	Development of an external module for the generation of activity diaries from mobile phone data, considering the socio-demographic characteristics of age and gender as well as home residence.	Barcelona
ALBATROSS	Agent-based micro-simulation model used to simulate activity-travel patterns of all adult members of a household.	Model to improve the prediction of residential location changes due to the demographic and work place changes as well as by the dwelling characteristics.	Rotterdam

5 Policy measures

5.1 Cordon toll

This is a measure aimed to the reduction of traffic congestion mostly in the city centres and it is based on introducing different pricing strategies through access tolls. Some big cities had already implemented it (such as London) and the project has simulated it in three of the four cities: Madrid, Barcelona and London (in this case exploring additional cordon tolls to those already existing). The perimeter of the cordon and the cost are the two main parameters for the simulation of the policy.

5.2 Teleworking

During the last years, the flexibility to work remotely has increased, mainly encouraged by private sector and freelance professionals and enabled by ICT. Within INSIGHT, the impact of an increase in teleworking has been explored through simulations in Madrid.

5.3 Re-densification

Re-densification measures look at the reduction of urban sprawl and the regeneration of urban centres to improve the quality of life of citizens, reduce traffic congestion and revitalise deprived areas. This is expected to have an impact on the economic performance and transport connectivity of the zone. In Rotterdam, re-densification has been simulated to evaluate its effect on congestion, number of trips and time of travel.

5.4 Crossrail 1

This study consists in evaluating the impact that the construction of Crossrail 1, running from Reading and Heathrow in the west to Shenfield and Abbey Wood in the east, will have on travel times, trip movements and the distribution of the working population.

5.5 Heathrow expansion

In this measure it is studied the addition of 50,000 jobs in the Heathrow area due to the construction of a third runway in the north west of the area between the current airport and the M4 motorway.

6 Barcelona case study

6.1 Political and social context

During the INSIGHT project execution, the political situation in the City of Barcelona has changed. After the last municipal elections in 2015, environmental and social issues have acquired a higher priority in the policy agenda of the current municipal government. An example of this is the Barcelona Climate Declaration, which proposes a 40% reduction of greenhouse gases with respect to 2005 levels.

6.2 Background for implementation

The partners that have carried out the model implementation and the policy simulation are Nommon and IFISC. The different options of policy questions to be implemented for Barcelona have been contrasted with the Barcelona City Council. Additionally, during the project there have been several interactions with Barcelona Regional, a public company providing technical assistance to the City Government for urban planning projects particularly interested in the potential of the developed solutions for the assessment of urban mobility policies.

The objectives of reduction of traffic congestion and CO_2 emissions and the increase of liveability have been identified as priority objectives for the city of Barcelona. Considering the capabilities of the MATSim simulation framework, as well as the previously mentioned priorities, it was decided to simulate the cordon toll policy measure.

6.3 Perceptions on simulation models and policy

The Barcelona City Council has several technical support departments and collaborates with a range of external agencies. The different departments of the city council (mobility, environment) and some of these related agencies, such as the Barcelona Regional agency mentioned above, use several types of urban simulation models. The perceptions on simulation models and policy making gathered through the interview process can be summarised as follows:

- Integrated models have a great potential. As an example, the “Plan Territorial” (including 164 municipalities) has been simulated in an integral approach which allowed observing, for example, connectivity improvements from new roads and new population movements, economic impact and environmental changes.
- The steep slope of the learning curve is considered the main problem for the recurrent use of these models in daily decisions, since the usefulness of the results is linked to the experience in the use of the tool.
- The quality of the input data is also crucial. In particular, the definition of the baseline scenario is one of the key elements to obtain satisfactory results. The current explosion of geolocation applications can help improve a lot the accuracy and availability of these data.
- From the hardware perspective, tools usually require high processing power but over the last 5 years the improvement in this sense has been impressive. Currently the main technical issue is the storage of data.

6.4 Technical assessment

The INSIGHT case study has been carried out using MATSim, an activity-based multiagent model that simulates traffic demand as a result of the trips that individual agents perform to conduct their daily activities. The output data of the simulation have been analysed by Nommon and IFISC to obtain indicators such as time spent traveling and modal split. Average travel time and number of people affected by the policy were reported at the level of district of residence. MATSim can only simulate one-day scenarios and hence the long-term effect of the cordon toll implementation (e.g., changes in land use) cannot be assessed with this model.

The hardware requirements of MATSim are not very different to other simulation tools and they are not a significant constraint. Regarding the required programming skills, general knowledge of Java is needed, as well as knowledge of GIS and other tools for the analysis of spatial data.

MATSim documentation can be obtained from the Internet and there is also a very active community of MATSim users' and developers. Queries, questions and comments can be posted at the web of the MATSim collaborative space[1] or sent to the MATSim mailing list. Relevant information from the MATSim community is published every month on the "MATSim Community Reports".

The calibration of the tool, even before applying any specific policy, is complex. Model parameters, such as the disutility of using different transport modes, need to be adjusted to match simulated and observed values. This is usually the most complex and time consuming part of the tool implementation.

Due to the agent-based nature of MATSim, the amount and level of detail of the required data are high. Basic data needed to run MATSim include: detailed network information, links length, lane capacity, number of lanes, nodes connecting different links, via direction, etc. If public transport is to be considered, routes, stops positions and schedule of each route are needed as well as vehicles capacity. From the agents' side a detailed diary of activities including activity type, activity location, activity duration or activity end time, and transport mode to reach each activity is needed. Agents must be representative of the total population. Activity diaries are typically obtained from surveys. In the case of the INSIGHT, activity diaries were generated by combining different data sources such as census data and mobile phone records.

MATSim has been developed to look at a specific problem/area, in this case traffic flows on a daily basis. In the specific case of the policy measure considered in the Barcelona case study, MATSim offers rich information about the effect that a cordon toll policy may have on daily traffic patterns, such as changes in modal split, route choices and travel time. It can also inform on how this policy may affect different groups according to their mobility needs and other socio-economic characteristics.

[1] https://matsim.atlassian.net/wiki/display/MATPUB

7 London case study

7.1 Political and social context

According to representatives of Future Cities Catapult, a network of world-leading organizations established by Innovate UK, the UK Government's innovation agency, some of the main policy priorities for London in the next five years are the development of the smart city involving the use of ICTs for dashboards, public participation and open data, and big infrastructure projects such as Crossrail and Heathrow expansion.

During the INSIGHT project, the most relevant political change has taken place at country level, with the referendum held in June 2016 about the permanency of UK in the European Union. This has not affected the project as such, although the new context is influencing the policy agenda.

7.2 Background for implementation

The partner in charge of the London case study is CASA-UCL. The work developed through QUANT and the results of the simulations have been shared with the Future Cities Catapult.

The objectives that have been identified as priorities for London are environmental (specifically focused on the reduction of traffic congestion and CO_2 emissions) and oriented to increasing equity and economic growth and reducing sprawl. In this context, the policy scenarios that have been tested are the extension of the cordon toll, the impact of Crossrail1 and the impact of Heathrow Airport expansion.

7.3 Perceptions on simulation models and policy

The perceptions on simulation models and policy making gathered through the interview process can be summarised as follows:

- The main areas of improvement for urban simulation tools are considered to be a better characterisation of the housing sector and housing markets and a better handling of trip making.
- In terms of usability by non-technical users, it is essential to make model outputs visual and simple. Linking models to the planning process would help to reduce the problems arising from the trade-offs between political cycles and the long-term impact of adopted measures.
- Tolls like SIMULACRA and QUANT can help to make policy assessment processes more transparent.

7.4 Technical assessment

SIMULACRA/QUANT is a series of fast, visually accessible, cross-sectional equilibrium models, hence static urban models for large metropolitan areas that allow the evaluation of many different scenarios pertaining to both short-term and long-term urban futures.

The outputs from the simulation have been aggregated and processed by CASA, obtaining indicators such as travel distance, flows per link, modal shifts and measures of density.

Regarding the technical requirements to use it, an intermediate level of familiarity with the underlying modelling concepts is required, but model operation is through a straightforward visual interface.

Hardware and software requirements are not high; the model can easily run on a basic machine, and it is possible to run it from smart phones and tablets as well.

The theoretical background needed to use the tool comprises knowledge of the model underlying principles, its functions and its possible predictions. There is a detailed help facility for a user with no experience of the system, including a very detailed manual.

The calibration of QUANT model is relatively simple. A standard maximum likelihood method is used. All the results are obtained from data available and free for academic use.

The implementation of different policies to explore combined effects is easily implementable.

The interface designed for the model is friendly and web based. It can be launched and used from anywhere with a network connection.

8 Madrid case study

8.1 Political and social context

During the INSIGHT project, in Madrid there have been new municipal and regional elections and a new comprehensive (urban and mobility) regional plan has been promoted. According to the Regional Government of Madrid, the main objectives are to start a re-densification process (density rebalance) and to improve the mobility system in collaboration with the Regional Transport Consortium.

Urban regeneration is one of the main axes of the plan, promoting renting in the city centre instead of new construction. Fostering of renting schemes is aligned with the purpose of reducing travel time because as far as it is flexible, citizens can change their residences to be closer to new labour locations.

8.2 Background for implementation

The partner in charge of the technical implementation of the policy measures in the urban simulation tool MARS has been TRANSyT-UPM. The definition of the main objectives and the policy measures to be explored for Madrid was conducted in collaboration with the Regional Government of Madrid[2] (Comunidad de Madrid), through the Environment, Local Administration and Urban Planning Department.

The priority objectives identified for Madrid are the reduction of traffic congestion and CO_2 emissions, the economic growth and reduction of sprawl. In this context, the policy measures selected to be analysed were the implementation of a cordon toll system in the city core and the impact of teleworking.

8.3 Perceptions on simulation models and policy

The perceptions on simulation models and policy making gathered through the interview process can be summarised as follows:

- According to the Regional Government of Madrid, the main objectives regarding urban planning in Madrid are the reduction of urban sprawl and the renovation of depopulated areas. These objectives are necessarily long-term while the political decision windows are typically four years with expectations of results in the short term. In this sense urban simulation models can play a relevant role providing relevant information on possible implications of different measures at different temporal scales and providing a scientific basis for policy assessment, facilitating decisions shared by different political parties.
- Simulation models could help to offer estimates of relevant indicators to support the consideration of controversial measures and reach the necessary political consensus. The implementation of a cordon toll is a good example, as in general terms it is perceived by policymakers like an unfriendly and hardly implementable measure although the positive effects in traffic congestion and emissions are known.

[2] Consejería de Medio Ambiente, Administración Local y Ordenación del Territorio

8.4 Technical assessment

MARS is a system dynamics model constructed using the simulation software known as VENSIM. There are various versions of VENSIM, but only the professional one can run the MARS model. A special licence is required to install the software though a basic version is free to download[3].

Long-term simulations are possible with MARS. The range of variables contained in the model is rich, and the cause/effect relation is logical and clear. The indicators that can be directly obtained as output of the model include time spent travelling (total time per person, average travel time per mode, average time per zone), modal share (number of trips per mode), the distribution of residents in the different zones (number of residents per zone), the distribution of workplaces in the different zones (number of workplaces per zone) and with an indirect calculation but also as an direct output of the model, the total CO_2 emissions and CO2 emissions per mode. However, as an aggregate model, it is not able to offer the detailed changes at the micro level, e.g., traffic flows in the road network.

It takes less than 10 minutes to install the software in the computer, although there seem to be some problems to run it in the OS system of MAC. No specific software requirements are needed.

In order to use MARS for a city simulation, users need to have knowledge on transport and land use modelling. The learning curve to manage the model is high. The main references for new users are the academic publications of Paul Pfaffenbichler, the initial developer of the model. A user manual is available online but there is no technical support to implement the tool.

The calibration of the MARS model is complex and it depends on the modeller's knowledge and skills. In the case of Madrid, not all the required data are easily available.

The outputs of the model can be easily saved in .XSL format and can be processed simply by other software.

[3] The website to download the software is http://vensim.com/download/

9 Rotterdam case study

9.1 Political and social context

During the INSIGHT project execution, the political situation in the City of Rotterdam has changed. The last municipal elections took place in 2014. The current 7-member Municipal Executive Committee (2014-2018) is a majority coalition composed by Leefbaar Rotterdam, D66 and CDA. The Municipal Executive Committee and the City Council jointly govern the city and make up the City Government. The City Council is the legislative body (sets out general policy and passes bills), while the City Executive is the executive body (submits bills, implements policy and makes day-to-day decisions).

The political agenda defines as a priority the reduction of sprawl, focused on the inclusion of the called Rotterdam-South area, one of the most deprived areas in the Netherlands, with lower average education levels, higher unemployment rates, poorer housing quality and lower residential satisfaction. Historically, this has been a settlement place for (immigrant) dock-workers and currently its population consists of low-skilled workers and ethnic minorities. The progressive automation of pier works has impacted severely the unemployment rate and the relocation of these work profiles is a priority. The program focuses on three themes: education, work, and housing.

The other main priority is the improvement of the quality of life in the city centre, reducing road traffic and favouring the use of public space. Among the main measures considered to achieve this are:

- Better infrastructures to improve the city connection with the periphery.
- Reducing the road traffic spaces and encouraging the bicycle use.
- Launching a set of policies focused on retaining the talent in the city.

9.2 Background for implementation

The partner in charge of the model implementation has been the Technical University of Eindhoven. The identification of the main objectives for the City of Rotterdam and the selection of redensification policies as the policy measures to be tested in the case study have been done in collaboration with the Urbanism Department of the City Council.

9.3 Perceptions on simulation models and policy

In general, urban tools are frequently used for decision making, especially regarding mobility aspects. The perceptions on simulation models and policy making gathered through the interview process can be summarised as follows:

- The main challenge is to link the models to the political needs. In the case of Rotterdam, the relationship between the reduction of road traffic in the city centre and the improvement of the living conditions and the ability to attract more citizens is well captured by ALBATROSS.
- Interdepartmental collaboration, specially between the Urban Departments and the Mobility Areas, is key to explore integrated solutions.

9.4 Technical assessment

Albatross is an agent based modelling tool that simulates activity-travel patterns of all adult members of a household. To improve the integration of different models, in INSIGHT the Albatross model system was systematically linked with a residential choice model and a dynamic population synthesiser.

The outputs from the simulation have been aggregated and processed by TU/e, obtaining the following indicators: time spent travelling (total time per person, average travel time per mode, average time per zone) and modal share (%). CO_2 emissions could be just estimated due to lack of detailed information. The temporal window of simulations is one day, and therefore Albatross does not allow long-term impact calculations.

In terms of hardware, Albatross requirements are not a barrier since it runs on a simple laptop although it is time consuming.

Regarding the skills required to use it, specific training is needed to work with the model and use it in the right way. Users need to be aware of decision heuristics, probabilistic decision tables, computational process models, etc. As of today, Albatross is only used in planning and consulting projects by the model developers.

The calibration of the tool is as complex as other similar travel demand models. Basic data needed to run Albatross include detailed network information and agents' detailed diary of activities. For the project, some data were purchased from external sources, in particular employment and land use data.

Compared to competing activity-based models, Albatross has a richer set of concepts and hence can be used to a wider set of policies, subject to data availability: it has constraints, it simulates task and resource allocation, it has a more comprehensive synthesiser, it is not using patterns as input, it separates between process and outcomes, parameters do not simply reflect the spatial distribution of land use such as power functions, etc.

Regarding simulations, Albatross captures various secondary and tertiary effects. Policies are often based on simple, even highly simplistic views like higher density leads to less travel and to mixed land use too. Albatross provides richer information, while many models do not go beyond primary relationships. A relevant limitation is the simulation of a single day.

10 Value proposition assessment

Most of the stakeholders interviewed pointed out the positive impact that simulation tools and models can have in urban planning. The features identified as most important are:

- Compatibility with other inputs currently used to evaluate policy decisions such as surveys, citizens experience, etc.
- Ability to support evidence-based decision-making and share policy proposals and their potential impacts with different agents, easing the collaboration in multi-stakeholder processes and promoting transparency.
- Models shall help identify unintended consequences of a policy measure.
- The visualisation layer is key to provide a friendly interface which allows results to be shared with non-technical users, including citizens and other relevant stakeholders in the policy making process.

Concerning the required resources, the majority of the public stakeholders have remarked that urban simulation models are in general very demanding in terms of new skills and profiles, such as big data experts. In this sense, some of the cities evaluate as a risk the shortage of these specialised profiles, highlighting that this risk is bigger as a consequence of the fierce rivalry for these specialised profiles with private sector.

On the other hand, none of the public stakeholders considers hardware and software requirements as a relevant barrier. All of them estimate that their current technical facilities are enough to run and implement urban models, and in general city councils can afford the supply of new equipment when needed. Most of the city planners consider that cities will be able to afford the required investments to adopt these types of tools provided that a solid use case for evidence-based policy making is developed.

11 Policy assessment

11.1 Governance

The urban modelling tools are considered to have a great potential to support decision-making processes, especially in participatory schemes with multiple stakeholders. Providing scientific evidence of the implications of a policy measure is of great value for presenting the benefits and costs of the policies on a more objective basis.

According to the interviews with the city planners and collaborators, projects like INSIGHT are very useful to bridge the gap between scientific knowledge and decision making. As a recommendation, it is suggested to continue working in the alignment between scientific and political language.

The link between the technical and the political approach is clearly a challenge: internal coordination is essential to match the potential of simulation tools and the political needs.

One of the main handicaps to develop long-term urban policies is the gap between the political window (usually 4 years) and the impact of the measures (10-15 years). The possibility of obtaining objective reasons and results with simulations can encourage the adoption of structural measures with a long term vision. A combination of tools looking at policy impacts at different temporal scales is still required.

The visualisation interface of the simulation tools is extremely relevant to understand and share results. INSGHIT has put considerable effort in this area, with good results. The general usability of state-of-the-art urban models is perceived to be restricted to very technical profiles, and visualisation tools can help share the modelling results both internally and with stakeholders.

11.2 Quality of life

The models used within INSIGHT are focused on quantitative outputs (number of trips, modal share...) that need additional interpretation if policy stakeholders require some qualitative impacts. The possible impact of teleworking on work-life balance and the impact of transport policies on “social cohesion” are examples raised by some of the policy stakeholders interviewed of questions that cannot be fully modelled by the simulation tools and need to be accompanied by more qualitative considerations.

11.3 Energy and environment

The urban simulation tools used in the project (MARS, MATSim, QUANT and ALBATROSS) are clearly focused on transport patterns and land use. This is aligned with most integrated urban plans, but these are usually complemented with general energy policies and it would be very useful to consider their impact jointly. For example, most cities have included in the agenda a transition from traditional energy sources to renewables, with the main objective of reducing CO_2 emissions from industry. It would be very interesting to have models that jointly take into account energy consumption and CO_2 emissions from transport and buildings.

11.4 Mobility

All the tools used in the project allow simulating transport policies. This is one of the key points in most political agendas at urban level, with particular focus on the reduction of the use of private car and the transition to public transport, walking and cycling.

11.5 Overall impact

The INSIGHT project has been highly valued by policy stakeholders, in particular the possibility to share experiences about successes and failures and the understanding gained from model construction and policy simulation. The coordination between the project team and the policy makers has also been positively valued.

12 Conclusions and some recommendations

12.1 Conclusions

Conclusions on the use of models in the urban planning process:

- There is an increasing need of simulation tools in urban policy and planning due to the complexity and the long-term implications linked to policy decisions in this area. In particular, simulation tools can help to increase transparency and participatory processes.
- The use of simulation models in the public administration is growing. Currently public administrations work with different models, most of them visual models built on top of GIS, typically working in isolation. There is general perception on the convenience of integrating these models to provide more holistic advice, which suggests that interdepartmental collaboration is key for the successful implementation of integrated solutions.
- Simulation tools can help to bridge the gap between short-term policy objectives (typically derived from the four/five years' election cycle) and long-term objectives, where consensus between different constitutions and political parties is needed.
- The organizational structure of the city council regarding the implementation of simulation tools for urban policies and planning is highly relevant, with rather different models across cities. There is also an influence of local culture on how to use the different tools and their outcome in the policy-making process.
- The quality and availability of data is one of the main barriers for the use of simulation tools in the urban planning process. Fieldwork is still typically needed to complete data required for simulation tools. There is still a need to improve data gathering automation and processing within city data frameworks. Geolocated data from mobile devices are currently contributing to improve data quality and availability.
- The learning curve for the use of simulation tools in the urban planning processes is still perceived as a barrier for their usage and success, in particular in connection with calibration (the most time consuming and complex part of the usage of simulation tools), coherence and ability to interpret results.
- New professional profiles (modellers, data scientists, city scientists) are needed in the public administrations to successfully use and exploit decision support tools for urban planning. City planners perceive as a risk the shortage of these specialised profiles, remarking that this risk is bigger as a consequence of the fierce competition from the private sector.

Conclusions on the implementation of INSIGHT models:

- From a technical perspective, the hardware and software requisites are not a significant barrier. Nowadays the technical challenges lie in the storage and use of (big) data as well as its related requisites: security, privacy, availability, integrity, etc.

- The visualisation layer of urban simulation tools is deemed as a key component of such tool, sometimes not given enough relevance. Obtaining results in a comprehensible format is useful for city planners but it is also linked with the opportunity to share technical studies with citizens and increase transparency in policy making.

- Technical support to run the simulation tools is usually needed. Although documentation on the simulation tools is available, a city council or related agency as a stand-alone user is not a feasible scenario yet. The generalised use of the models implemented in the different cases by the addressed city councils or related agencies independently from external model implementers is still far from being a reality.

Conclusions on the different interactions favoured by the case studies:

- The policy-makers interviewed have a highly positive opinion of the INSIGHT project, not only because of the technical merits of the simulation tools implemented during the project but also because of the opportunities to exchange experience and overcome internal barriers for the successful implementation of evidence-based policy making.

- Sharing practices and opinions is seen as very positive initiative, since although direct experiences are not transportable between cities, previous experience about measures that have produced good results and measures that have failed is a useful input for the evaluation of options maybe not considered before.

12.2 Recommendations

From the conclusions above it is possible to derive the following recommendations:

1. It would be beneficial to share with city representatives more cases of application and best practices, and in general increase awareness on the advantages of urban simulation.

2. The relationship between the different stages of the policy cycle and the opportunities derived from simulation tools to support evidence-based policy making should be further researched. Further research is required regarding the different organisational models, cultures and priorities related with strategic urban planning and the opportunities based on simulation tools.

3. More empirical research is needed to increase the confidence in the models as well as point to the required improvements, and in that sense new sources of big data constitute an interesting opportunity. In this respect, the development of pilot projects allowing the real impact of measures to be observed would be very helpful.

4. Open data strategies at city level are building and linking common databases and developing structured processes for data gathering. The implementation of urban simulation tools should take advantage of the new opportunities opened by such strategies.

5. Cooperation between different departments within the city council as well as higher coordination between technicians and policy-makers should be encouraged.

6. New professional profiles and new skills related with urban analytics and urban modelling are needed. In particular, there seems to be an opportunity for new profiles with techno-political background (modellers, data analysts...) that can understand policy objectives, translate them into model parameters and treat the results for policy assessment purposes.

7. The learning curve for the use of simulation tools needs to be tackled. Enhancements of the visualisation layer can be particularly useful to facilitate involvement of relevant stakeholders.

Annex I. Questionnaires

1. Questionnaire for city planners/staff – First round

A. Background questions

A.1- Position of interviewed / Organizational structure / Available resources

1. Which is your position within / relationship with the City Council?
2. In which department/area?
3. How long have you been in this position/area?
4. How many people do you have under your supervision?
5. Approximately, what is the budget related with models /tools?

A.2- Perception on the relevance of the measures to be evaluated and link with modelling / simulation tool

6. From 1 to 10 (10 is the highest grade), how much do you think the tool can help to support the decision making process? Explain your valuation
7. Particularly about the (particular measures implemented):
    a. From 0 to 10 (10 is the most important), grade (the particular measures) as a good way to achieve the objectives of your city? Explain your valuation
    b. From 0 to 10, do you think the simulation of (particular measures) is a good starting point to value the real implementation of this policy? Explain your valuation

A.3- Political, economic, social, technical context

8. When did last municipal elections take place?
9. How is the composition of the current municipal government (same party, coalition…)?
10. Is there any change in the composition compared to the previous municipal government?
11. From 0 to 10, what is the relevance of the objectives (↓reducing congestion/ ↓CO2&pollution/↑ Economy/↓ Sprawl/↑ liveability & security) in the political agenda of this Council? Explain your valuation

12. Particularly about the (measures implemented), From 0 to 10, what is the probability to take this measure into reality? Do you think the results of the simulations could be determinant to implement it? Which other factor do you think could affect to the decision? Explain your valuation

B. Technical assessment

B.1- Need of theoretical background, availability of support

13. Do you work with urban modelling tools? (If yes, with which ones and continue this part. If not, jump to C)
14. Do you think that urban modelling tools require very specific technical requirements to use them?
15. Regarding the hardware requirements (PC, connection, specific items...) to implement and use urban modelling tools, how do you qualify them from 1 to 10 (being 10 the hardest and most specific requirements)? Explain your valuation
16. Regarding the software requirements to implement and use urban modelling tools, how do you qualify them from 1 to 10 (being 10 the hardest and most specific requirements)? Explain your valuation
17. From 1 to 10 (being 10 the most), how do you consider is the theoretical background needed to use urban modelling tools? Explain your valuation
18. Is specific previous background required to use these tools?
19. How would you describe the availability of technical support related to the implementation and use of urban modelling tools (in terms of answer time, accuracy of the answers, etc.)?

B.2- Calibration, data dependency, output usefulness, operational characteristics, robustness, compatibility, complexity

20. How would you describe the calibration process of urban modelling tools (easy, complex...)?
21. From 1 to 10 (being 10 the maximum dependence level), how would you describe the urban modelling tools dependency on data? Are all required data available for the city?
22. Do you like the output/report of the urban modelling tools? (if there are differences between the different measures analysed, please point at them)
23. Would you say urban modelling tools output/data are compatible to later use and process? Why?
24. From 1 to 10 (being 10 the maximum grade of complexity), how do you grade the complexity of using urban modelling tools? Why?

B.3- Usability, flexibility, alignment with policy measure, validation with existing evidence

25. From 1 to 10, how do you grade urban modelling tools in terms of usability? Explain your valuation

26. How many people are working with urban modelling tools in the Council? Was specific training required? In this case, how many training hours were needed?
27. How do you describe urban modelling tools in terms of flexibility of use?
28. Do you consider that urban simulations are aligned with other sources of information?

C. Value/Economic assessment

C.1- Value proposition

29. How would you describe urban modelling tools in terms of value added with respect to the previous state of your area (the council) in this field?
30. Assuming you have enough economic resources, would you recommend the use of urban modelling tools considering the value added?
31. Which would be your recommendations for future improvements of the tools?

C.2- Resources

32. From 0 to 10 (being 10 the highest), how do you grade the affordability of the resources needed to implement and use urban modelling tools? Explain your valuation
33. How do you describe the consumption of human resources to install and use urban modelling tools (learning curve by the city staff, training requirements, etc.)?

C.3- Supplier evaluation

34. How do you describe the relation with the supplier of urban modelling solutions?

C.4- Cost structure and valuation

35. Do you think the implementation of the tools is expensive compared to the benefits obtained?

D. Policy assessment

D.1- Contribution to governance (transparency, open data, participatory decision-making, evidence-based policy-making…)

36. Economic issues aside, do you consider that urban modelling tools help (particular city) to make the governance process more transparent?
37. From 1 to 10 (being 10 the highest level), how do you grade the contribution of using urban modelling tools to the (particular city) open data strategy?
38. Do you think urban modelling tools could be useful to increase (particular city) participatory decision-making process? Why / How?

39. From 1 to 10 (being 10 the highest level), how do you grade the contribution of urban tools evidences to the decision making process?

D.2- Contribution to quality of life of citizenship (healthier, safer, cultural, social cohesion...)

40. Would you say that the implementation of (particular measures) can improve the quality of life of people in (particular city)? In which sense?

D.3- Contribution to improve human resources (inclusivity, creativity, innovation...)

41. How do you think the implementation of (particular measures) could improve human life in terms of inclusion?

42. Would do you say that the use of the tool in the Council improves the processes in terms of innovation and creativity?

43. Do you think that the publication of the results could have positive effects in terms of innovation or entrepreneurship in the citizens?

D.4- Contribution to improve environment (renewables, pollution…)

44. From 1 to 10 (being 10 the highest contribution), how would you evaluate the contribution of implementing (particular measures) to improve (particular city) environment?

D.5- Contribution to improve mobility

45. Would you say that the implementation of (particular measures) can improve mobility in (particular city)? How?

D.6- Contribution to overall economy (innovations, entrepreneurship, connectivity…)

46. Would do you say that adopting (particular measures) could improve (particular city) economy in general terms? In which sense?

E. Relation to entrepreneurship / innovation

47. From your point of view, could these models / tools be useful to stimulate entrepreneurship in your city? How?

48. Do you think it could be useful to publish the results to improve innovation in the city?

2. Questionnaire for city planners/staff – Second round

A. Perception on the relevance of the policy measures evaluated and link with modelling / simulation tool

1. What is your valuation of the improvements that have been developed in the tool for your specific city?
2. Do you think the results of the simulations could be determinant to implement the policy measures under study? Which other factors do you think could affect to the decision? Please, explain your valuation

B. Value proposition

3. How do you describe the model developed in your city in terms of value added with respect to the previous state of the council in this field?
4. What would be your recommendations for future improvements of the tools?

C. Supplier evaluation

5. How would you describe the relation with the supplier of urban modelling solutions?
6. What would be your recommendations for future technical-policy coordination?

D. Contribution to governance (transparency, open data, participatory decision-making, evidence-based policy-making…)

7. Do you consider that the urban simulations that have been developed would help the city to make the governance process more transparent?
8. Could these simulations improve your open data strategy and participatory decision-making processes?
9. How do you value the visualization layer that has been added?

E. General valuation of INSIGHT

10. How do you value the INSIGHT project in terms of relevance of research?
11. What would be your recommendations for future projects?

3. Questionnaire for project model implementers

A. Technical assessment

Specific Tool (MATSim, SIMULACRA/QUANT, MARS, ALBATROSS): _____

A.1- Hw / Sw requirements, need of theoretical background, availability of support

1. Do you think that the tool has very specific technical requirements to use it?
2. Regarding hardware requirements (PC, connexion, specific items...) to implement and use [Simulation Tool], how would you grade them from 1 to 10 (being 10 the hardest and most specific requirements)? Please, explain your valuation.
3. Regarding software requirements to implement and use [Simulation Tool], how do you qualify them from 1 to 10 (being 10 the harder and most specific requirements)? Please, explain your valuation
4. From 1 to 10, how advanced is the theoretical background needed to use this tool? Please, explain your valuation
5. Is specific background needed?
6. How would you describe the availability of technical support related to the implementation and use this tool (in terms of available documentation, answer time, accuracy of the answers, etc.)?

A.2- Calibration, data dependency, output usefulness, operational characteristics, robustness, compatibility, complexity

For each of the measures implemented:

7. How would you describe the calibration process of this tool (easy, complex...)?
8. From 1 to 10 (being 10 the maximum dependence level), how would you describe this tool dependency on data? Please, explain your valuation
9. Are all required data available for the city? Please, explain your valuation
10. Would you say the output/data of this tool is compatible with later use and processing? Why?
11. Do you think it is easy to explore the effects of different combinations of policies?

A.3- Usability, flexibility, alignment with policy measures, validation with existing evidence

12. From 1 to 10, how would you grade this tool in terms of usability? Please, explain your valuation
13. How would you describe this tool in terms of flexibility of use? Please, explain your valuation
14. Do you consider this tool is able to offer results aligned with the policy objectives identified in this project? (Please explain the limitations).
15. Which are the indicators obtained as outputs from the simulation of each of the measures under study?