LAND USE MODELS AND SUSTAINABLE URBAN MOBILITY PLANS: AN INTEGRATIVE APPROACH FOR STRATEGIC PLANNING

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ABSTRACT

The notion of integrative and multidisciplinary approach in developing and implementing sustainable urban mobility plans (SUMPs) has been prevalent in the transportation planning agenda for several years now. The benefits of such approach include preparing better and public legitimate plans and promoting cooperative planning culture. In this context, European Commission (EC) currently promotes the concept of the SUMP, which can be defined as a strategic planning framework for the urban multimodal transport system combining multi-disciplinarity, policy analysis and decision making, while its objectives concise with the main pillars of sustainable urban mobility. Furthermore application guidelines for SUMP propose a combination of appropriate techniques and tools, for successful conduction of the activities and fulfilment of the requirements of the planning process. In this context, this paper argues that the use of Land Use Transport Interaction (LUTI) models could enhance the prospect of successful implementation of such plans. Therefore, it explores the possibility of integrating LUTI models in the various phases of a SUMP cycle. To do so, it starts with an investigation and recording of the different types of land use models and their functionality. It then specifies the criteria that someone should use in order to choose the appropriate LUTI model and it proposes a framework for the integration of LUTI models into a SUMP cycle. Finally, it discusses the expected benefits and drawbacks from such integration. The paper concludes that integration of LUTI models into the SUMP cycle, could enhance the strategic and communicative aspects of SUMPs, mainly due to the fact that LUTI models can be used as testing and evaluating tools of alternative 'mobility futures', and as tools to communicate and ensure mutual understanding amongst involved stakeholders and individuals.

Keywords: integrated strategic planning, land use transport interaction models, mobility plans, sustainable development, sustainable urban mobility.

1 INTRODUCTION

The evolution of the transport system is directly related to the mobility needs of a region in each time period, in order to obtain access to specific socio-economic activities. More specifically, transport system aims at overcoming the spatial and time separation between inter-related activities. An example from the daily travel on urban scale is the separation between place-of-work and place-of-residence. At the same time, new transport infrastructure or service may lead to an opportunity to access an activity, which was previously not accessible, thus affecting the relation between socio-economic activities [1].

The location and organisation of socio-economic activities within the boundaries of a spatial entity is described by the land use system. The land use system can be assessed by the following land use features [2, 3]: (a) type, location and spatial features, (b) characteristics and distribution of demand for socio-economic activity and (c) differentiation between the demand and supply of land uses.

Main urban land uses comprise employment, education, commerce, services and recreation. An example frequently encountered in the international literature concerning the interaction between urban transport and land use system, refers to the concentration of main

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land uses in an area with access from main public transport stations and the corresponding effect on land prices [4, 5].

Apart from the effect of the operation of the transport system to the accessibility conditions, transport infrastructure itself is a land use, which influences the land use system by occupying part of the available surface. This issue is significant mainly within urban areas due to the limited available space and fragmentation and segregation effects that may derive from the structure of transport infrastructure developments per se [6, 7].

There are several approaches in dealing with the analysis of the interaction between the transportation system and the land use system, one of them being the sustainable urban mobility planning approach. In opposition to conventional planning, where the increasing demand in mobility is coped with the constant increase of infrastructure, sustainable urban mobility planning is a holistic approach that aims at the maximisation of the efficiency of the transportation system while minimising transport externalities, i.e. the negative effects on the urban development, the natural environment, the economic competitiveness and the quality of life. Thus, the analysis of the interaction between the transportation system and the land use system is established as a main part of contemporary mobility planning because it integrates essential features of urban development [8].

Another significant feature of the sustainable urban mobility planning approach is that it strongly promotes the collaboration and consensus building among involved stakeholders into the various stages of the planning process. Achieving consensus among different forms of knowledge and different stakeholders from science and policy is quite a challenging task [A0]. Towards this purpose several methodologies have been developed. Some of them rely on qualitative approaches while other on quantitative methods where assessment of several planning goals for each stakeholder is performed [9–11]. Usually these methods establish a framework, which solves mobility decision-making problems in a systematic way and help in selecting the optimal policies to achieve sustainable mobility. The final decision in regard to the desired urban mobility scenario should integrate simultaneously all relevant stakeholders with different interests, some of them opposed to each other and with different criteria, which have to be consensuated [9]. Regardless the method used, consensus building seems to be a necessary procedure in order to overcome implementation challenges that most of the time cofound the execution of even strong policies and planning structures [11].

In this context, European Commission (EC) currently promotes the sustainable strategic planning approach for urban mobility in the framework of Sustainable Urban Mobility Plans (SUMPs) [12]. A SUMP is a strategic plan for the urban multimodal transport system that combines inter-disciplinary planning and policy analysis with decision making. Its objectives coincide with the components of sustainable mobility, i.e. accessibility for all, efficient and affordable mobility services, enhancement of safety and security, decrease of emissions and improvement of energy efficiency and upgrade of the urban environment. More specifically, it covers the whole planning process from the preparatory and goal setting stages to the elaboration and implementation/evaluation stages through a series of elements that consist of a set of activities and correspond to the specific objectives of the plan. The plan unravels in a circular pattern concluding in the setting of the basis for the conduction of the next SUMP. A combination of the appropriate techniques, such as quality management and benchmarking, and tools, such as indicators and models, are used in the context of a SUMP in order to successfully conduct the corresponding activities and achieve the goals of each element. One of the tools proposed by the SUMP guidelines is the Land Use and Transport Interaction (LUTI) models, which can be used during the preparatory stage in order to analyse the strategic scenarios regarding the impact of the transportation system on locational choices [13].

The scope of this paper is to investigate the potential contribution of the implementation of a LUTI model in the context of a SUMP's objectives and activities. Based on previous work, the paper argues that the contribution of a LUTI model into the SUMP cycle may exceed the use during only the preparatory stage, and proposes a framework, which fully integrates a LUTI model into the SUMP cycle [14]. The first part of the paper provides a presentation of the definition of a typical land use model, the classification of land use models, as well as the role and contribution of these models to strategic transport planning. The next part refers to the description of the framework for the full integration of a typical LUTI model into the SUMP cycle. The paper concludes with an outline of the possible emerging problems and implementation issues and the overall added value from the full integration of a LUTI model to the SUMP cycle.

2 LAND USE MODELS: DEFINITION AND ROLE IN STRATEGIC TRANSPORTATION PLANNING

A LUTI model is a tool for the support of strategic planning through the estimation of trends in locational choices and the forecast of land use patterns by combining the features of mobility, the socio-demographic characteristics, the features of the industry, the geomorphological and wider environmental factors, the availability of urban networks and the institutional and policy frameworks [15]. According to Fig. 1, the available infrastructure and the physical characteristics of the wider urban space and the way these features are taken into account by

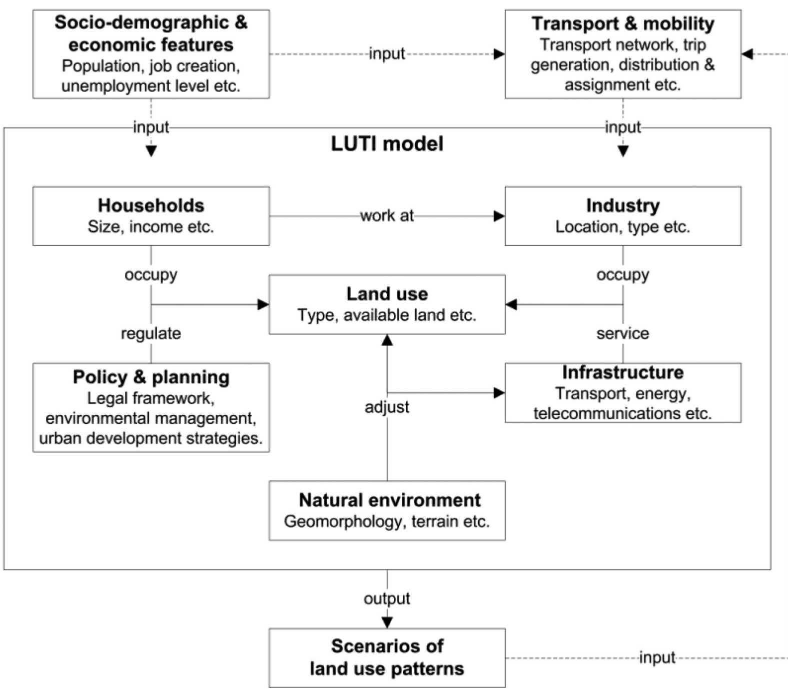

Figure 1: Form of a typical LUTI model.

the planning and policy framework create the conditions which determine the locational choices of the industry. These choices affect the locational choices of households that work in the industry according to the demographic and socio-economic features as well as to the demand and supply of the transportation system. In this way, the model is able to produce forecasts for the prediction of future land use patterns.

Various LUTI models with different approaches were developed during the late 1970s and 1980s. Indicative examples are the works of Lowry, Putman, Echenique, Anas and others [16–18]. However, many of the earlier models accepted criticism regarding mainly the high cost of implementation due to the high requirements for data collection and management in relation to their ability to produce valid and case-specific results [19]. Later factors like the evolution of computers and new technologies, the ability to produce and manage geo-spatial data through Geographic Information Systems (GIS) and the emergence of innovative concepts, such as sustainable planning, lead to the enhancement of existing and the development of new types of land use models. In this context microsimulation, discrete choice and cellular-automata (CA) based models have been the mainstream approach in the last 10–15 years. In comparison to the early approaches of LUTI models these models tend to be more disaggregate and temporally dynamic in focus, while they are designed to be more user friendly [20]. Indicative examples of new generation models are Urbansim, SLEUTH, TIGRISXL and UPLAN.

2.1 Classification and types of urban models

Using the appropriate LUTI model is essential for its successful integration in the strategic transportation planning process. Therefore, it is imperative to understand the different types of LUTI models that could correspond to different planning needs. Following is a short description of the classification criteria and the basic characteristics of each class.

There are several methodologies for classifying urban models, associated mainly to the criteria used to formulate the classes. Such criteria can be the reference scale, simulation mode, time horizon, etc. [21–25] Moreover, in most cases the proposed classification is the outcome of a comparative analysis of specific urban models and therefore the criteria used serve only the classification of specific models under study. Therefore in this paper a more general classification is presented that refers to the full range of urban models combining three criteria that substantially define the character of a model: time, scale and representation of spatial correlations. The three main classes formed are: the spatial interaction models, the dynamic aggregated urban models and finally the models incorporating the 'bottom-up' approach and operate in small spatial units.

Spatial Interaction Models: Spatial interaction models are the most applied category in urban planning practice, and the first generation of these models were static synthetic economic and spatial interaction models. Their theoretical background is identified in the science of regional economics, location theories, and urban economics. They embody the principle of suitability of land as a result of the interaction between various production factors. This category is represented by various kinds of models, which can be divided into four subcategories the entropy models, the macroeconomic and general equilibrium models, the activity based models and the microsimulation models.

Dynamic Urban Models: A key element of this class of models is the interpretation of the process of urban development under the notion that both development and changes in space and time occur in a nonlinear way, thus creating discontinuities and random disturbances in space [22]. Allen, in 1978, borrowed the concept of 'order through fluctuation' from the physical and biological sciences to interpret the development of urban systems [25]. Today, very few dynamic urban models have been developed and even less have put into planning practice.

Cellular Automata models: Cellular automata models are probably the most common type of urban models. Their special characteristic is the way they depict geographic space, from which they have taken their name, were space is considered to have the form of a grid or matrix of cells (cells). The basic principle they incorporate is that changes in land use can be explained by the present state of a cell and changes to that of neighbouring cells. Therefore, as regards land use correlation principles, they incorporate the principle of historical continuity and land use neighbouring interactions. For instance, the construction of a transport axis in a peri-urban zone will increase the accessibility of this zone, which in turn will trigger the process of mutation of land use from agricultural to residential or commercial.

Conclusively the classification presented here, highlights the fact that there is a great variety of land use models that could be used in strategic spatial planning. Each category presents certain advantages and disadvantages that make them appropriate or not, depending on the urban/transportation planning goals. Therefore, the next section presents how land use models can be integrated into the strategic transportation planning process.

2.2 The role of LUTI models in strategic transportation planning

Land use models can play a significant role in setting the framework and substance of a strategic transport plan. Relevant bibliography emphasizes the importance of treating cities as complex and evolving systems and adopting a holistic approach in order to achieve the goals of sustainable urban mobility [12].

As such, LUTI models have received a renewed attention as tools and methodologies that enable city governments and citizens to design sustainable mobility policies. LUTI models can help in various stages and in various ways in the process of a strategic transport plan. First, they can help achieve an understanding of the interaction and interrelationship between the transportation and land use system. This explanatory ability of the cause-effect relation represented in LUTI models, could determine decisions about sole planning investments or even the core of the proposed strategic approach.

Second, they can be used as tools for visual experimentation during the planning process. One of the main qualities of LUTI models is their predictive abilities that are built in the system. As such, they can visualize and communicate to the user the impact of new infrastructure, policies etc., enabling the creation of alternative future scenarios.

Finally, LUTI models could be very powerful communicative tools and play a significant role in a participatory planning process. More specifically in a process where different planning stakeholders are coming together to negotiate upon different interests, LUTI models could play a significant role in communicating the mutual interdependence among various perceptives, forming in that way new perceptions and values that will eventually set the ground for a collaborative decision making process.

In order to ensure high quality results and useful conclusions that support strategic planning, it is essential for the planning authority to choose the appropriate LUTI model, which corresponds to the study and the available infrastructure and resources (Fig. 2).

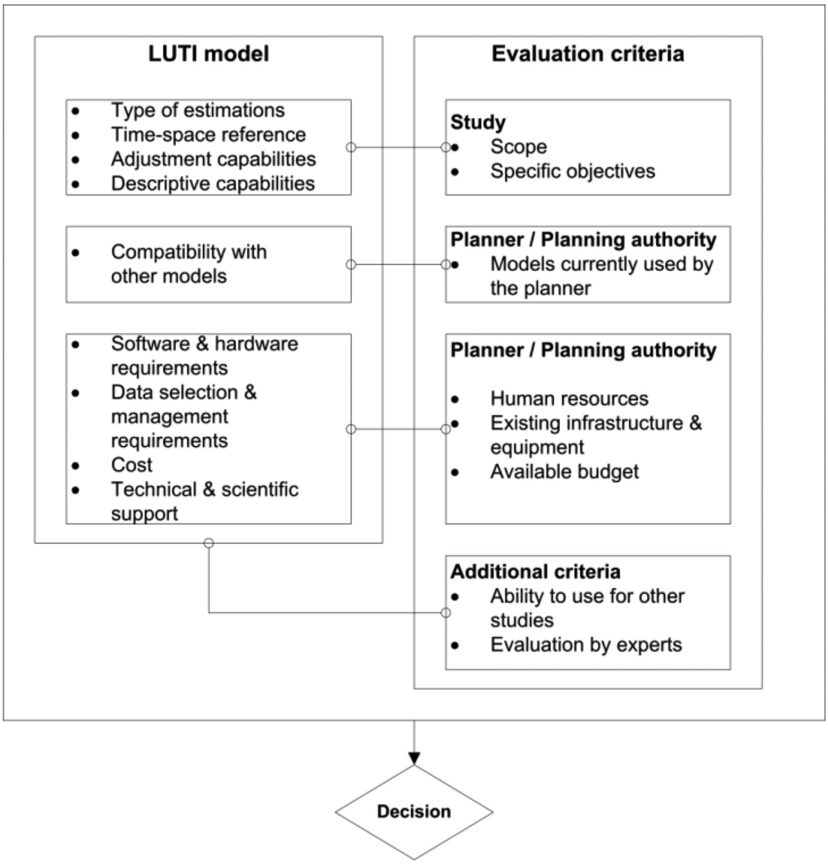

Figure 2: Criteria for the selection of the appropriate LUTI model.

In specific, the first criterion refers to which model should be selected according to the conceptual basis of the model, the level of spatial reference and the time dependency. It is obvious that these criteria correspond to the criteria used for the classification of urban models presented in previous section of this paper that ended up to three main categories (spatial interaction, dynamic, cellular automata models), which includes several subcategories. It is very likely that the selection of a model would depend on its flexibility and adjustability to the scope and specific objectives of the study or alternatively a series of models would be selected in order to serve the various needs (in scale, time and purpose) in every stage of the strategic planning process.

Furthermore the compatibility of the model with other models, such as econometric or traffic models, which are currently used by the authority, is another significant criterion. In addition, the existing infrastructure of the planning organization and human resources, especially employees with appropriate expertise, and the available budget for acquiring new infrastructure and expertise, should be taken into account in relation to the model's requirements concerning cost, infrastructure data and the technical and scientific/technical support provided by the model provider. Additionally, a noticeable added value of the model is the ability to build upon the data and results of the study and to be used in other similar studies in the future. Finally, one should take into consideration the use of the model by other planning authorities and institutions and the conduction of an evaluation with the participation of experts. Several studies for the evaluation of LUTI models by experts were conducted by planning and administrative authorities in the United States of America (USA) [26].

3 INTEGRATION OF A LUTI MODEL TO THE SUMP CYCLE

3.1 Brief presentation of the SUMP cycle

The SUMP cycle includes the four basic stages (a) Preparing well, (b) Rational and transparent goal setting, (c) Elaborating the plan and (d) Implementing the plan, covering the process of strategic planning from the preparation to the implementation and final evaluation and identifying the corresponding milestones, i.e.: (a) Analysis of problems and opportunities concluded, (b) Measures identified, (c) SUMP document adopted and (d) Final impact assessment concluded. Each stage comprises a set of elements that include a number of activities, which are essential in order to overcome the corresponding milestone (Table 1). In this way, the SUMP is concluded with the update and review of the implementation results and the identification of the key-features that will lead to the conduction of another SUMP cycle.

Table 1: SUMP stages, steps and activities.

Stages	Steps	Activities
A. Preparing well	1. Determine your potential for a successful SUMP	1.1 Commit to overall sustainable mobility principles
		1.2 Assess impact of regional/national framework
		1.3 Conduct self-assessment
		1.4 Review availability of resources
		1.5 Define basic timeline
		1.6 Identify key actors and stakeholders
	2. Define the development process and scope of plan	2.1 Look beyond your own boundaries and responsibilities
		2.2 Strive for policy coordination and an integrated planning approach
		2.3 Plan stakeholder and citizen involvement
		2.4 Agree on workplan and management arrangements
	3. Analyse the mobility situation and develop scenarios	3.1 Prepare an analysis of problems and opportunities
		3.2 Develop scenarios

(*Continued*)

Table 1: (*Continued*)

Stages	Steps	Activities
B. Rational and transparent goal setting	4. Develop a common vision	4.1 Develop a common vision of mobility and beyond
		4.2 Actively inform the public
	5. Set priorities and measurable targets	5.1 Identify the priorities for mobility
		5.2 Develop SMART targets
	6. Develop effective packages of measures	6.1 Identify the most effective measures
		6.2 Learn from others' experience
		6.3 Consider best value for money
		6.4 Use synergies and create integrated packages of measures
C. Elaborating the plan	7. Agree on clear responsibilities and allocate budgets	7.1 Assign responsibilities and resources
		7.2 Prepare an action and budget plan
	8. Build monitoring and assessment into the plan	8.1 Arrange for monitoring and evaluation
	9. Adopt Sustainable Urban Mobility Plan	9.1 Check the quality of the plan
		9.2 Adopt the plan
		9.3 Create ownership of the plan
D. Implementing the plan	10. Ensure proper management And communication	10.1 Manage plan implementation
		10.2 Inform and engage the citizens
		10.3 Check progress towards achieving the objectives
	11. Learn the lessons	11.1 Update current plan regularly
		11.2 Review achievements - understand success and failure
		11.3 Identify new challenges for next SUMP generation

Source: Bührmann *et al.* [13]

3.2 Description of the LUTI model integration framework

The proposed framework for the integration of a LUTI model to the SUMP cycle is based on the scope of maximising the potential contribution of the model to the successful

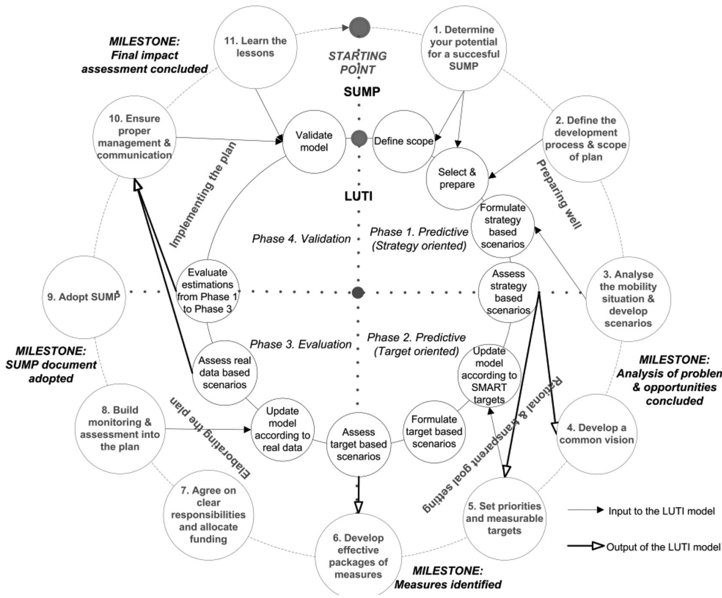

Figure 3: Framework of a typical LUTI model integration to the SUMP cycle.

conduction of the aforementioned activities. The overview of the framework is presented in Fig. 3.

There are four (4) phases, which formulate the proposed LUTI integration framework corresponding to the four (4) stages of the SUMP cycle and eleven (11) actions which are connected to the appropriate activities of the eleven (11) SUMP elements. More specifically, either the outcome of an Activity of the SUMP cycle (from here after referred to as SUMP Activity) can be used as input for the corresponding action for the integration of the LUTI model (from here after referred to as LUTI Action) or a LUTI Action can provide outputs for the support of a SUMP Activity, as described in the following sub-sections.

3.2.1 Phase 1. Predictive (Strategy oriented)

The first phase of the proposed integration framework aims at the selection and preparation (adjustment) of the appropriate LUTI model and the development of the strategic scenarios. The results from the deployment of strategic scenarios are expected to support the analysis of problems and opportunities, according to the SUMP's first Milestone. The first LUTI Action is the definition of the model's scope in relation to the needs of the specific study. This action depends on the following SUMP Activities: (a) 1.1, aiming at the understanding of which sustainable mobility principles will be adopted by the plan and how, (b) 1.2, involving among others the analysis of the transportation and land use policy priorities which should be taken into account by the model and (c) 1.6, aiming at the definition of the network of stakeholders from different transport-related sectors. The next action refers to the selection of the most suitable model and its adjustment to the plan's purpose. The action depends on the aforementioned scope as well as on the SUMP Activity 1.5, i.e. the setting of the plan's timeline, which will define the time dynamic characteristics of the model and the desired time reference of the short-term and long-term forecasts. After the selection of the most suitable model, the formulation of strategy based scenarios, i.e. a series of scenarios based on the strategic approach of the plan as suggested in SUMP Activity 3.2, takes place [12]. However, in order to formulate resilient and realistic scenarios, one should take into close consideration the analysis of problems and opportunities, conducted during SUMP Activity 3.1. The final action of this phase is the assessment of the strategy-based scenarios, which are expected to lead to generic forecasts of the urban development patterns according to the examined urban mobility strategies. These forecasts can be exploited in the context of the SUMP Activities 4.1 and 5.1, which aim respectively at the identification of the strategic directions and the setting of specific priorities for sustainable urban mobility planning. Moreover, the demonstrative capabilities of the model can create a space for discussion among the stakeholders and the public (SUMP Activity 4.2).

3.2.2 Phase 2. Predictive (Target oriented)

During the second phase, the LUTI model can be updated according to the quantified targets set by the second stage of the SUMP in order to provide more-detailed forecasts of the way that the selected measures for the enhancement of urban mobility are expected to affect the land use system. In this way the model can contribute to the SUMP's second milestone, i.e. the identification of the suitable measures. The SUMP Activity 5.2 has the objective of developing a series of Specific, Measurable, Achievable, Realistic and Time-bound (SMART) targets through the selection and formulation of a set of indicators. The corresponding LUTI Action aims at the model's update according to these targets so as to be able to produce estimations of indicator values (especially the ones related to the impact of transport on land use) in different time projections. After the formulation of scenarios based on the appropriate combinations of transport-related measures and interventions, the target based model can be used to estimate the impact of these measures on the land use system and support the decision making of SUMP Activity 6.1 for the identification of the most effective measures.

3.2.3 Phase 3. Evaluation

The specific phase aims at the update of the LUTI model according to the real data that derive from the regular monitoring of indicators during the stage of the SUMP's elaboration and the provision of accurate estimations that can be used to check the progress during the stage of the SUMP's implementation and the milestone of the adoption of the plan's document. The SUMP Activity 8.1 refers to regular monitoring of a core set of measurable indicators for the evaluation of the plan's elaboration. These measurements can be used as input in the LUTI Action for the update of the model. Then, the updated model can be used for the reassessment of the target-based scenarios according to real data. The estimations from the reassessment can provide useful conclusions on the progress of the plan's implementation and the achievement of its objectives concerning mainly the goals related to urban development. Moreover, the review of the model's assessment results during the strategic-, target- and real data based scenarios should be made in order to evaluate the progress of the plan towards the achievement of land use related objectives.

3.2.4 Phase 4. Validation

The objective of the phase is the overall validation of the LUTI model in order to contribute to the SUMP's last milestone, i.e. the conclusion of the final impact assessment, and to make the necessary changes and adjustments for its implementation in the next SUMP. Towards this purpose, the results and conclusions from the SUMP Activities: (a) 10.3 Check progress towards achieving the objectives and (b) 11.1 Update current plan regularly, should be

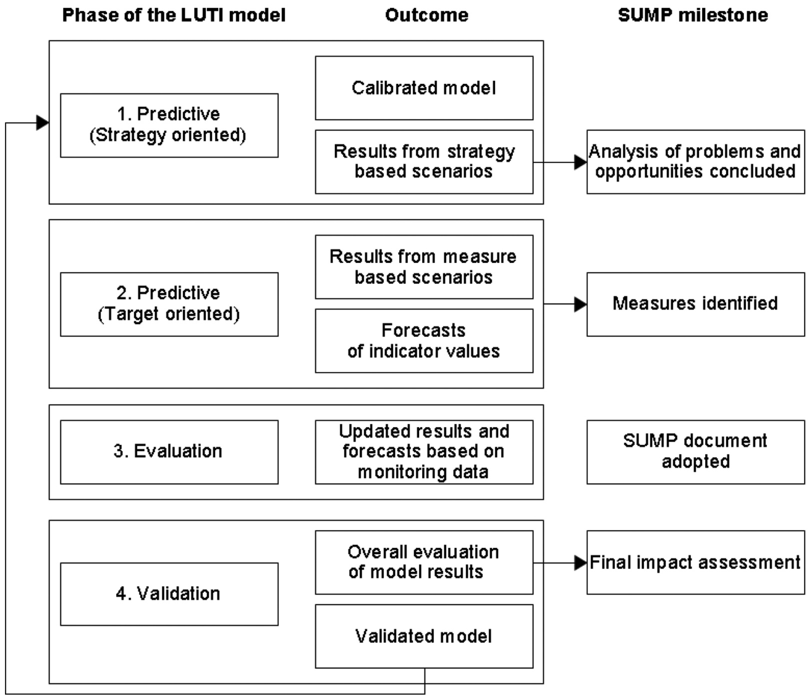

Figure 4: Schematic representation of the outcomes from the LUTI model integration in relation to the SUMP's milestones.

embedded in the LUTI Action for the model's validation. This process will ensure that the model will keep up with the whole SUMP cycle and be prepared for future use.

In order to better understand how the integration process works, the following diagram depicts the relation between the main outcomes of every LUTI phase and the corresponding milestones for each SUMP stage (Fig. 4).

4 THE CASE STUDY OF THESSALONIKI

4.1 Spatial and transport characteristics of the study area

Thessaloniki is the second largest metropolitan area in Greece after Athens and one of the largest cities in the wider Balkan region. The regional unit of Thessaloniki has a population of approximately 880,103 inhabitants [27]. The city's centre, which is bounded by mountainous terrain from the north and the gulf of Thermaikos from the south accommodates a mix of land uses with the main commercial stores and services sharing the same space with dense residential uses. Nowadays, development of residential areas and commercial centres are being observed mainly at the eastern suburbs and some urban areas of the northwest, which were relatively underdeveloped until recently, while the industrial zone of the city resides at the western edge.

The majority of city's movements are made by private car as the only available public transport mode within the city is the public bus. Moreover, approximately 25% of the 2.3·106 daily trips in the city have their origin or destination in the centre leading frequently to congestion [28]. There is an active discussion over the last years between the city's authorities, the stakeholders and the planners on possible solutions that can decrease private car dependency in the city. Recently, a bicycle network and a public bicycle sharing system were developed while a metro system and a seaborne transport system are under development. In the meantime, there are several urban regeneration schemes, which are being gradually implemented mainly within the city centre, which include traffic calming measures and the pedestrianisation of roadway segments. Moreover, other alternatives are being examined at the level of strategic planning, such as the expansion of the orbital road network and the development of surface railway systems.

4.2 Outline of Thessaloniki's SUMP

Thessaloniki's SUMP was initiated in 2010 by the city's Public Transport Authority (ThePTA) in the context of the project: 'ATTAC' of the European Union's SEE Transnational Cooperation Programme [29]. The participating stakeholders comprise the public transport organisations, municipalities, institutes, technical chambers and citizens' associations of the wider metropolitan area. The SUMP is mainly focused on the enhancement of the city's public transport system and the counter-measures against private car dependency. The main components of the plan are the following: (a) Mobility forum with the participation of the stakeholders, (b) Internal evaluation procedures, (c) Public information and dissemination, (d) Measures for the upgrade of public and active transport and road traffic management, (e) Allocation of resources for the plan's financing requirements, (f) Monitoring methods and indicators and (g) Establishment of a dedicated SUMP Unit.

The main measures included in Thessaloniki's SUMP comprise:

- Smart and integrated ticketing and payment.
- Bus rapid transit and priority at intersections. Bus feeder lines to the metro system, which is currently under construction.
- Promotion of a tramway system complementary to the metro system.
- Pedestrianization and public space regeneration. Improvement of the bicycle network and the bicycle sharing system.
- Operation of the seaborne transport system.
- Flexible road transit including innovative taxi services.
- Congestion charging, access control and integrated parking management policy as instruments against private car dependency.
- Public awareness campaigns for sustainable mobility.

4.3 Prospects for the integration of a LUTI model to Thessaloniki's SUMP

The implementation stage of Thessaloniki's SUMP is expected to introduce a number of measures with significant effect on the city's mobility conditions. Moreover, these measures are also due to generate an impact on the land use patterns. International literature provides us with many examples of such measures and their implicationssuch as [30, 31]: (a) An intermodal public transport system is expected to affect locational choices and land rents which are expected to increase within the areas of public transport stations, (b) Promotion of active transport is expected to increase the interaction of travellers with the adjacent land uses along their trip while drivers usually interact with the land uses located at the beginning and end of each trip, and (c) Restrictive measures for private car use combined with regeneration schemes within the city centre and other congested areas aims also at the upgrade of the urban environment.

The determination of the aforementioned impacts on the city's land use system secures a holistic approach of strategic planning that becomes essential due to the proposed measures and interventions for the improvement of urban mobility. The use of a LUTI model is an effective tool for the estimation and assessment of the appropriate features that can support such an analysis.

In terms of the integration of a LUTI model into a SUMP, there are no functional or structural problems. Problems might occur due to reasons that are related to the functionality of the LUTI model itself. In the case of Thessaloniki's SUMP there were some issues that are briefly presented:

(a) Data acquisition issues: LUTI modelling is a quite data intensive task. Application of such a model includes calibration and validation procedures that heavily rely on data quality and availability. Despite the significant progress in data acquisition processes there is still a lot of effort to be done in order to obtain appropriate urban mobility statistics and land use data. More specifically in the case of the city of Thessaloniki two data acquisition issues arose:
   (i) The issue of spatial analysis unit: Most of data needed for LUTI models (i.e. socio-economic data) is available in census tract level, provided by the Hellenic Census Bureau. On the other hand transportation data is available on different spatial analysis unit, this of Transportation Analysis Zones (TAZ's). As such a process of 'spatial matching' of these two spatial units should be applied in order to achieve full spatial data compatibility.
   (ii) The issue of in time reference: Despite the fact that most of the data needed to run a LUTI model is available there are serious issues when it comes to its temporal reference. In the case of Thessaloniki, a transportation study was conducted in 1997 and is the only available source for detailed and appropriate transport data. As such it is predetermined that any analysis would start with data that depicts the 1997 situation of the city, when meanwhile employment, household and market 'reality' has radically changed over the last four years, due to the economic crisis. Furthermore, the effects of economic crisis are in many ways related to the calibration of the model. Therefore, if the model has to be calibrated with 1997 data, due to data availability, it will be implicitly assumed that past urban development trends will continue to occur.

(b) Usability issues: Despite that LUTI models are quite common in academia, their use in policy making and planning is scarce. This is due to the fact that potential users might not have the skills to use such models [32]. Recently there has been several efforts to develop more user driven LUTI models that account for the requirements of policy makers and are integrated in the collaborative decision making process.

5 CONCLUSIVE REMARKS

In this paper there was an effort to demonstrate that integration of LUTI models into SUMPs could bring substantial benefits to the contemporary strategic planning approach. In this context it proposes a framework for the full integration of such models into a SUMP cycle. It is obvious that such integration enhances the strategic and communicative aspects of SUMPs, mainly due to the fact that LUTI models can be used as testing and evaluating tools, and as tools to communicate and ensure mutual understanding amongst involved stakeholders.

Successful integration of LUTI models into a SUMP cycle is not unconditional. More specifically, it seems that there are no functional or structural integration problems per se, but problems might occur due to reasons that are related to the functionality of the LUTI model itself. These problems are mostly related to the data needed in order to run LUTI models' calibration and validation procedures, which heavily rely on data quality and availability.

Other concerns in regard to appropriate data have to do with compatibility issues, meaning that data for LUTI models must be consistent (spatially and temporal wise) with data used for transportation models within SUMP. Nevertheless, it is expected that all the above data-related problems will not be much of an issue, since in the last decade there is significant progress in data acquisition practices.

Finally it one of major pitfalls of LUTI models is their usability issues. Despite that these models are quite common in academia, their use in policy making and planning practice is scarce. This is due to the fact that potential users might not have the skills to use such models. Recently there has been an effort to develop more user driven LUTI models that account for the requirements of policy makers and are integrated in the collaborative decision making process.

Summarizing, this paper advocates that integrating LUTI models in a SUMP process could significantly improve its strategic and communicative aspects. The necessary conditions for this to happen are related to certain applicability aspects of LUTI models. These include (a) data availability with certain spatial and temporal specifications (b) understanding the communicative role that a LUTI model can play and finally (c) the presence of an expert (i.e. planner) that has the 'know how' to facilitate the different aspects of LUTI models into the planning process.

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