TeMA

Journal of Land Use, Mobility and Environment

There are a number of different future-city visions being developed around the world at the moment: one of them is Smart Cities: ICT and big data availability may contribute to better understand and plan the city, improving efficiency, equity and quality of life. But these visions of utopia need an urgent reality check: this is one of the future challenges that Smart Cities have to face.

CITIES, ENERGY AND MOBILITY

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3 (2015)

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TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

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EDITORIAL PREFACE:

CITIES, ENERGY AND MOBILITY: STRATEGIES FOR CONSUMPTIONS' REDUCTION

ROCCO PAPA
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Transport energy consumption accounts for about one third of total energy consumption in the EU. Despite significant advances in technology, energy consumption in transport sector has increased in most EU countries in the last three decades. Long-term forecasts (up to 2030) estimate that energy consumption will further increase in all economic sectors, experiencing the most rapid growth in the transport one.

This issue of TeMA is focused on approaches, methods, techniques and tools related to urban and regional mobility with regards to energy consumption reduction and saving. In details the issues proposes articles on on strategies and practices for energy consumptions' reduction, low carbon emissions for public and individual transport modes.

The section "Focus" collects four articles. The first one, titled "A Markov Chain Model of Land Use Change" by Michael Iacono, David Levinson, Ahmed El-Geneidy, Rania Wasfi, presents an example of a modelling framework based on Markov chain approach. The model assumes that land use at any given time, which is viewed as a discrete state, can be considered a function of only its previous state. To illustrate this process, a Markov chain model is estimated for the Minneapolis-St. Paul, MN, USA (Twin Cities) metropolitan region. Using a unique set of historical land use data covering several years between 1958 and 2005, the model is tested using historical data to predict recent conditions, and is then used to forecast the future distribution of land use decades into the future.

The second article, titled "A Tool For Appraising Mobility Environment With A Percept Based Index Measure" by Abdulmajeed Olaremi Shittu and Muhammad Zaly Shah (Universiti Teknologi Malaysia) addresses the issues of complexities and data dirtiness in mobility analysis and proposes a new methodology to asses travelers' perception of "mobility environments". The proposed methodology involved a two-pronged survey of transport professionals and randomly sampled travelers. Authors propose an application to the metropolitan area of Ilorin in Nigeria. The results of the methodology's implementation reveals that a high activity mix, high road and pedestrian network density are perceived by travelers as a good mobility enhancing qualities a city should possess. However, aggregate indexing indicated that enhancing development characteristics, mode characteristics, travel and economic attributes, are the most important for the study area. The methodology laid out in this paper is targeted at facilitating the development of cost effective means of identifying urban mobility challenges by local authorities and can provide an alternate

assessments procedure aimed at simplifying mobility planning decision making, especially where the normal range of required data and information to run sophisticated mobility evaluations are lacking.

The third article, titled "A Land-Use Approach for Capturing Future Trip Generating Poles" by Iraklisis Stamos, Aifadopoulou Georgia, Evangelos Mitsakis, Maria Morfoulaki and Iasonas Tamiakis (Centre for Research and Technology, Hellas) deals with the integration of land-use and transportation planning and proposes an integrated methodology for estimating trip generating poles. The proposed methodology consists of three steps: i) the identification of trip-generating poles; ii) the development of scenarios related to the probability of these changes occurring and their potential magnitude and iii) an estimation of future trends in passenger flows. Authors apply the methodology to the Metropolitan area of Thessaloniki, Greece. Using a wide range of data obtained from different sources including development plans, national statistical services and research projects' and studies' findings, the study estimates trip-generation subsequent to land use changes within the study area. The results of the application in the case study of Thessaloniki reveals that the creation of new trip generating poles and the increase of trips' generation and distribution is correlated with the type of land use development and modifications as well as changes in provided transport services. The results of the study is assessed by local experts, representing various key-disciplines of the area's planning stakeholders, resulting in useful outcomes. The methodology laid out in this paper can be applied as a useful evaluation tool that can support planners and decision makers in the development of integrated land-use and transportation policies.

The fourth article titled "Tourism and Mobility. Best Practices and Conditions to Improve Urban Livability" presented by Rosa Anna La Rocca. This paper considers the relation between tourism and mobility and tries to highlight how tourism can act as a driving urban function in order to promote more sustainable lifestyles. Tourism and mobility are strictly connected: moving from the usual residential place for leisure or entertainment represents the essential condition of tourism. There is no tourism without physical displacements, as the WTO definition affirms, highlighting that the movement of people is connected to two different mobility forms.

The section "Land Use, Mobility and Environment" contains the article "Council tax policies and territorial governance: analysis and outlook of a difficult relationship" by Simone Rusci from University of Pisa in Italy. The article examines the connections between fiscal policies and urban planning, focusing on different types of taxes and discussing the aspects that have come to influence planning practice. In particular, the article analyzes from an urban planning viewpoint the consequences of new fiscal instruments on planning, paying special attention not only to problems, but also to unexpressed potential in management tools: urban equalization above all, transfer of development rights, and land consumption mitigation measures.

The section "Review Pages" defines the general framework of the issue's theme, with an updated focus on websites, publications, laws, urban practices and news and events on the subject of energy reduction consumption in the transport sector. In particular, the Web section by Raffaella Niglio describes three web resources: i) the Transport Research and Innovation Portal; ii) the Bump mobility website and iii) the Eltis portal. The Books section by Gerardo Carpentieri briefly reviews three relevant books related to the Issues' theme: i) "50 BIG IDEAS - Shaping the Future of Electric Mobility"; ii) "Urban Mobility in the Smart City Age" and iii) "Smart and Sustainable Logistics for a Competitive Europe". The Law section by Laura Russo keeps readers up to date with recent European directives on sustainable mobility. The Urban Practices section by Gennaro Angiello presents two relevant case studies of sustainable city logistic solutions: i) The Cityporto of Padova in Italy and ii) the Elcidis Urban Consolidation Center of La Rochelle in France. Finally, the News and Event section by Andrea Tulisi reports on five conferences related to the Issue's theme that will be held in 2016.

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A MARKOV CHAIN MODEL OF LAND USE CHANGE IN THE TWIN CITIES, 1958-2005

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ABSTRACT

The set of models available to predict land use change in urban regions has become increasingly complex in recent years. Despite their complexity, the predictive power of these models remains relatively weak. This paper presents an example of an alternative modeling framework based on the concept of a Markov chain. The model assumes that land use at any given time, which is viewed as a discrete state, can be considered a function of only its previous state. The probability of transition between each pair of states is recorded as an element of a transition probability matrix. Assuming that this matrix is stationary over time, it can be used to predict future land use distributions from current data. To illustrate this process, a Markov chain model is estimated for the Minneapolis-St. Paul, MN, USA (Twin Cities) metropolitan region. Using a unique set of historical land use data covering several years between 1958 and 2005, the model is tested using historical data to predict recent conditions, and is then used to forecast the future distribution of land use decades into the future. We also use the cell-level data set to estimate the fraction of regional land use devoted to transportation facilities, including major highways, airports, and railways. The paper concludes with some comments on the strengths and weaknesses of Markov chains as a land on the strengths and weaknesses of Markov chains as a land use modeling framework, and suggests some possible extensions of the model.

KEYWORDS:
land use, twin cities, statistical models, Markov chain, state dependence

TeMA

有关土地使用、交通和环境的杂志

ABSTRACT

用来预测城市地区土地利用变化的一套模型在近些年变得越发复杂。虽然很复杂，但这些模型的预测能力仍然相对较弱。文将介绍一个基于马尔可夫链概念的备选模型框架的例子。这个模型假设，任意给定时间的土地利用（被视为离散状态）可被理解成其前个状态的函数。每对状态之间的转换概率被记为转换概率矩阵的一个元素。假设这个矩阵随着时间变化是静止的，它可被用来根据当前数据预测未来的土地利用分布。为了演示这个过程，特用一个马尔可夫链模型来为美国明尼苏达州明尼阿波里斯圣保罗市做预测。通过使用涵盖1958年到2005年之间一些年份的一套独特的土地利用历史数据，可用历史数据对模型进行测试，然后再用来预测未来几十年的土地利用分布。我们还用元级数据集来估计被用于交通设施（包括主要的高速公路、机场和铁路）的区域土地的比例。本文得出结论，提出了关于将马尔可夫链用作土地利用模型框架优缺点的一些评论，并建议对该模型进行一些可能的扩展。

土地利用变化的马尔可夫链模型

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KEYWORDS:
土地利用, 子城, 统计模型, 马尔可夫链, 状态依赖

1   INTRODUCTION

Modelling the dynamics of land use change in urban regions is an inherently difficult task. Despite improvements to the theoretical and empirical frameworks within which the problem of land use change has been cast, few researchers have been able to produce operational models with the ability to predict land use change accurately. Those who have experienced modest successes have largely done so at the expense of tractability and ease of interpretation. Meanwhile, there has been an emerging consensus that models attempting to predict land use change ought to incorporate probabilistic elements in order to make them more realistic and to represent the significant uncertainty that surrounds land development decisions. This paper describes the application of one type of probabilistic land use change model based on the notion of a Markov process. Within this process, the study area (in this case the Minneapolis-St. Paul, MN metropolitan area) is divided into a regular lattice of cells, each of which may take on one of 10 discrete land use states at any given time. At the heart of the Markov process formulation is the notion that the state of a cell at any time is a function only of its previous state. Transitions between states are governed by a matrix of transition probabilities, which are estimated based on actual land use data. Where the assumptions of the Markov process hold, the transitions of cells between states through time can be modelled and predicted as Markov chains. Markov chain models have a relatively simple and intuitive logic that makes them attractive alternatives to more complex formulations of stochastic land use models, at least for sketch planning purposes. Of interest is their ability to fore- cast over medium to long-term time horizons. In this study we use land use data for the Minneapolis-St. Paul (Twin Cities) region covering various years between 1958 and 2005 to calibrate a Markov chain model of land use change. The data represent a fine scale of spatial resolution, with the dimensions of each cell measuring 75 meters by 75 meters. This data set is applied to both "backcast" changes from the past to the present and to predict the distribution of land use decades into the future. The paper is organized as follows. The next section describes the properties of Markov chains and cites several of their applications to questions of urban land use. The third section formally introduces the structure of the model and the assumptions required for its application. The fourth section describes the cell- level data set constructed for this study, and uses it to develop an estimate of the amount of land use in the region devoted to transportation. The fifth section describes the results of the application of the Markov chain model to the regional land use data, generating historical predictions based on earlier periods of data and using more recent data to forecast several periods into the future. The sixth, and concluding, section comments on the strengths and limitations of the model while also suggesting some directions in which it might be generalized in order to increase its usefulness as a planning tool.

2   MARKOV CHAINS AND LAND USE MODELING

2.1 PROPERTIES OF MARKOV CHAINS

Markov chain models are essentially projection models that describe the probabilistic movements an individual in a system comprised of discrete states. When applied to land use and many other applications, Markov chains often specify both time and a finite set of states as discrete values. Transitions between the states of the system are recorded in the form of a transition matrix that records the probability of moving from one state to another. The definition of a system as a finite Markov Chain requires a certain set of properties to hold (Stokey and Zeckhauser, 1978). These include:

- a finite number of well-defined states that mutually exclusive and collectively exhaustive (meaning that the rows of the probability matrix must sum to one);
- the probabilities of the transition matrix must be the same for any two periods;
- probabilities have no memory, that is, the state tomorrow depends only on the state today (the Markov condition);

─   time periods must be uniform in length or duration.

In practice, one or more of these conditions may not be met. This is especially true in the case of land use applications, where the uneven temporal availability of data often requires relaxation of the last assumption. Moreover, the assumption regarding constant transition probabilities (or stationarity of the system) is often rejected when tested as a statistical hypothesis, yet is still included in forecasting applications. Turner (Turner, 1987) argues that, in fact, land use change is not a strictly Markovian process, though it does have some such elements. For example, the transition of a land use cell between states may be influenced by state of neighbouring cells as well, sometimes referred to as the "spatial neighbourhood effect". Additionally, transition rates are often not constant through time, especially over longer periods. Thus, an important question may concern the optimal length of transition periods in Markov chains. Unfortunately, the transition probabilities estimated in most empirical applications are a function of data availability and take the length of transition periods as given.

2.2   PREVIOUS APPLICATIONS

Markov chains as a modeling tool evolved out of social and economic science research dating to the late 1950s. Empirical applications of Markov chains in urban and regional analysis began appearing in the 1960s. One such early application was Clark's use of Markov chains to model the movement of rental housing in U.S. cities (Clark, 1965). Using census tract data on mean contract rents, Clark described the movement of census tracts between 10 different rent classes in four different cities (Detroit, Pittsburg, Indianapolis and St. Louis) over the period from 1940 to 1960. Another application by Lever sought to describe the decentralization of manufacturing in the Clydeside region of Glasgow, Scotland, UK (Lever, 1972). Using postal directory data on 419 manufacturing firms for the years 1959, 1964 and 1969, Lever modeled the movement of manufacturing firms between four zones of the city as both a closed and an open system, with the latter formulation allowing for firm birth, death and inter-regional migration. Applications of Markov chains to urban land use dynamics began to appear in the 1970s as an alternative to the use of large-scale urban simulations models for land use forecasting. Bourne cited the ability to incorporate elements of inertia in land use succession processes as a key advantage of Markov chain models (Bourne et al., 2000). In particular, the matrix of transition probabilities could be seen as embodying important aspects of urban land use such as the durability of housing and other building stock. This was critical, since stock adjustment processes were largely absent from previous models of land use change. Bourne illustrated these principles by estimating transition matrices with data on central city land use from the municipality of Toronto over the period from 1952 to 1962. Key findings of this study indicated that land use in developed parts of urban areas tends to stay in the same state (land use class) despite the occurrence of rebuilding or structural modification. Changes in land use that did occur tended toward more intensive uses (e.g. residential to commercial), with scattered, vacant parcels among the most likely candidates for conversion. While Bourne's study relied on parcel-level data with recorded changes to the building stock, Bell exemplified the use of remotely-sensed data and the cell-based representation of land use that is common in most contemporary studies of land use change (Bell, 1974). Bell studied land use change on San Juan Island, WA from 1949 to 1971 by breaking the study area into 100 meter-by-100 meter (1 hectare) grid cells, using the remotely-sensed land use imagery. This data was used to test for independence of current and preceding land uses for the given years. Results indicated that land uses for the later year were not independent of the preceding land use, lending support for the Markov chain formulation. Additional empirical findings on tests of stationarity of the transition matrix and a continuous time formulation of the Markov chain model, where transition probabilities are replaced by rates of change, are reported in Bell and Hinojosa (Bell and Hinojosa, 1977). More recent studies using Markov chains for land use prediction have sought to broaden the scope of application of these models and probe new kinds of questions. Turner compared the results of a Markov

chain model with two other types of spatial simulation models to forecast long-term changes in landscape cover in the Piedmont region of northern Georgia (Turner, 1987). Muller and Middleton provide an application to the Niagara region of Ontario, Canada, where land use data from five different points in time between 1935 and 1981 are used to estimate a three-state Markov chain to predict the consequences of urban growth (Muller and Middleton, 1994). McMillen and McDonald demonstrated the coupling of Markov chains with regression models (McMillen and McDonald, 1991). In order to estimate the influences of land values on zoning changes they estimated a price function to predict land values, which then serve as explanatory variables for the transition probabilities of a three-by-three matrix of land use zoning change. Weng integrated the use of geographic information systems capabilities and remote sensing with a Markov chain model to predict the possible land use consequences of rapid urbanization and industrialization in the Zhujiang Delta of China (Weng, 2002). Finally, Levinson and Chen provide a Markov chain model of land use change in the Twin Cities region using historical data (Levinson and Chen, 2005). The states of the model include both a land use class and an indicator of the presence and type of highway within each cell. The model is used to demonstrate the mutually interconnected evolution of transportation networks and land use patterns.

3   THE MODEL

The basic premise of the Markov chain model is that land use at some point in the future $(t+1)$ can be determined as a function of current land use (t), or mathematically,

$$X_{t+1} = f(X_t) \tag{1}$$

where $X_{(t)}+1$ represents the land use at time $t+1$ and X_t represents land use at time t. The structure of the Markov chain model as applied to land use change involves a vector $\boldsymbol{n_t}$ with dimension $m\,\mathrm{x}\,1$ (where m represents the number of states, in this case land use classes) describing the distribution of land use among current states and an $m\,\mathrm{x}\,m$ matrix of transition probabilities $(\boldsymbol{P})$ that governs the probability of transition between each pair of land uses, i and j. The model can then be written as a difference equation in matrix form Baker (Baker, 1989)

$$\boldsymbol{n_{t+1}} = \boldsymbol{Pn_t} \tag{2}$$

where $\boldsymbol{n_{t+1}}$ is another $m\,\mathrm{x}\,1$ column vector describing the distribution of land use at time $t+1$. Since the transitions are probabilities, it follows that:

$$\sum_{j=1}^{m} p_{ij} = 1 \quad i = 1,2,\dots m \tag{3}$$

meaning simply that the rows of the transition matrix must sum to 1. Maximum likelihood estimates of the transition probabilities can be obtained as (Anderson and Goodman, 1957):

$$\hat{p}_{ij} = n_{ij}/\sum_{j=1}^{n} n_{ij} \tag{4}$$

where p_{ij} is the probability of transition between i and j and n_{ij} denotes the number of transitions from i to j. These values can all be obtained empirically. To test the validity of the Markov chain model, a useful first step is to test the null hypothesis that land use at one point in time, $t+1$, is statistically independent of land use at the preceding time period, t. This test can be conducted using standard contingency table techniques for cross-classified categorical data. The expected values for each cell indicating the number of transitions between i and j can be compared with the actual number of transitions to compute the test statistic, Pearson's chi-square, which is distributed χ^2 with $(M-1)^2$ degrees of freedom, where M indicates the

number of land use classes (in this case 10). Under the hypothesis of independence, the expected number of transitions in each cell of the transition matrix $\widehat{m}_{ij}$ can be calculated by:

$$\widehat{m}_{ij} = n_{i+}n_{+j} \tag{5}$$

where n_{i+} denotes the marginal total of transitions for the ith row of the transition matrix and n_{+j} denotes the marginal total for the jth column of the transition matrix. Using these expected values, the test statistic (K^2) then takes the form:

$$K^2 = \sum_{i=1}^{I}\sum_{j}^{J}\frac{(n_{ij}+\widehat{m}_{ij})^2}{\widehat{m}_{ij}} \tag{6}$$

The test statistic is typically given the notation K^2 instead of X^2 to differentiate it from its distribution, which is chi-square. The null hypothesis of independence is almost universally rejected, indicating some level of dependency between successive land use states. Another important property of Markov chains, as identified in an earlier section, is the property of stationarity, particularly as it applies to the transition probability matrix. This property is critical for applications in which a Markov chain model is to be used for forecasting. The transition probability matrix (P) is assumed to remain constant in successive periods, meaning that at any future period $t+k$, the matrix of cell transitions can be obtained by multiplying the vector of current land uses, n_t nt by the transition probability matrix P, raised to the kth power (P^k). In most forecasting applications, the transition probability matrix is assumed to remain constant through successive time periods, and is seldom tested empirically. This study follows the work of Bourne (1971), who compared transition matrices for successive periods using simple correlations between cells of the matrix. By expressing the elements of one matrix ($P_{t+1,t+2}$) as a function of another ($P_{t,t+1}$), one can provide a rough check for stationarity by determining whether the correlation between matrix elements is significantly different from a value of one. In order to use the Markov chain model for prediction, an additional stochastic element is added. Since the transition probabilities represent estimates of the likelihood of conversion from one land use state at time t to one of 10 other states at time $t+1$, a mechanism is added to introduce randomness to the model and its predictions of future states. Since each row of the transition probability matrix sums to one, predictions of future land use states are obtained by drawing a pseudorandom number between zero and one, rounded to four digits. If the number falls within the probability space allocated to a particular land use state according to the transition matrix, then that state is chosen for conversion. This process is repeated for each land use cell in the data set. Predicted land uses can then be compared to actual observed land uses to summarize the accuracy of the model's predictions..

3   DATA

The land use data employed in this study build from a previous set of land use data used by Levinson and Chen (Levinson and Chen, 2005) in an earlier study of the Twin Cities. The expanded data set comprises a time series with observations for the years 1958, 1968, 1978, 1984, 1990, 1997, 2000 and 2005. Land use data for years prior to 1984 were manually digitized from paper copies of land use maps stored at the John R. Borchert Map Library at the University of Minnesota. Data for selected years from 1984 to 2005 were obtained from the Metropolitan Council, the Twin Cities' regional planning agency and designated metropolitan planning organization (MPO), which maintains a parcel-level land use inventory for the region that is updated every few years. The parcel-level land use data was converted to a raster format and rectified to reduce geometric distortion. Some error remains due to the manual digitization process and the lower level of accuracy associated with earlier mapmaking processes. Differences in classification schemes

for land use across years were addressed by adopting a common set of 10 generalized land use classes. These land use classes, along with their adopted abbreviations, include: Airports (AIRPOR); Commercial (COMM); Highway (HWY); Industrial (INDUST); Parks (PARKS); Public (PUBLIC); Railroads (RAILWA); Residential (RES); Vacant (VAC); Water (WATER).

The data set covers a large portion of the core seven counties of the Twin Cities region. Some portions of the region could not be covered due to a need to limit the analysis to the part of the region for which common land use data sets could be acquired for each year. The portions left out of the study area are comprised mostly of low-density residential and non-urban uses, which would likely be classified as vacant under the present scheme. The resulting study area covers approximately 3,426 square kilometers (1,322 square miles). The study area is partitioned into a grid of 75-meter by 75-meter cells, a spatial resolution much finer than the 188-meter square cells used in Levinson and Chen's study, leading to a roughly tenfold increase in the number of land use cells in the study area. This produces a data set containing over 610,000 cells. Each cell is assigned a land use class according to its predominant land use. Figure 1 shows the land use patterns in the region in 1958 and 2005, respectively, while Figure 2 presents a summary of trends among the land use classes from 1958 to 2005.
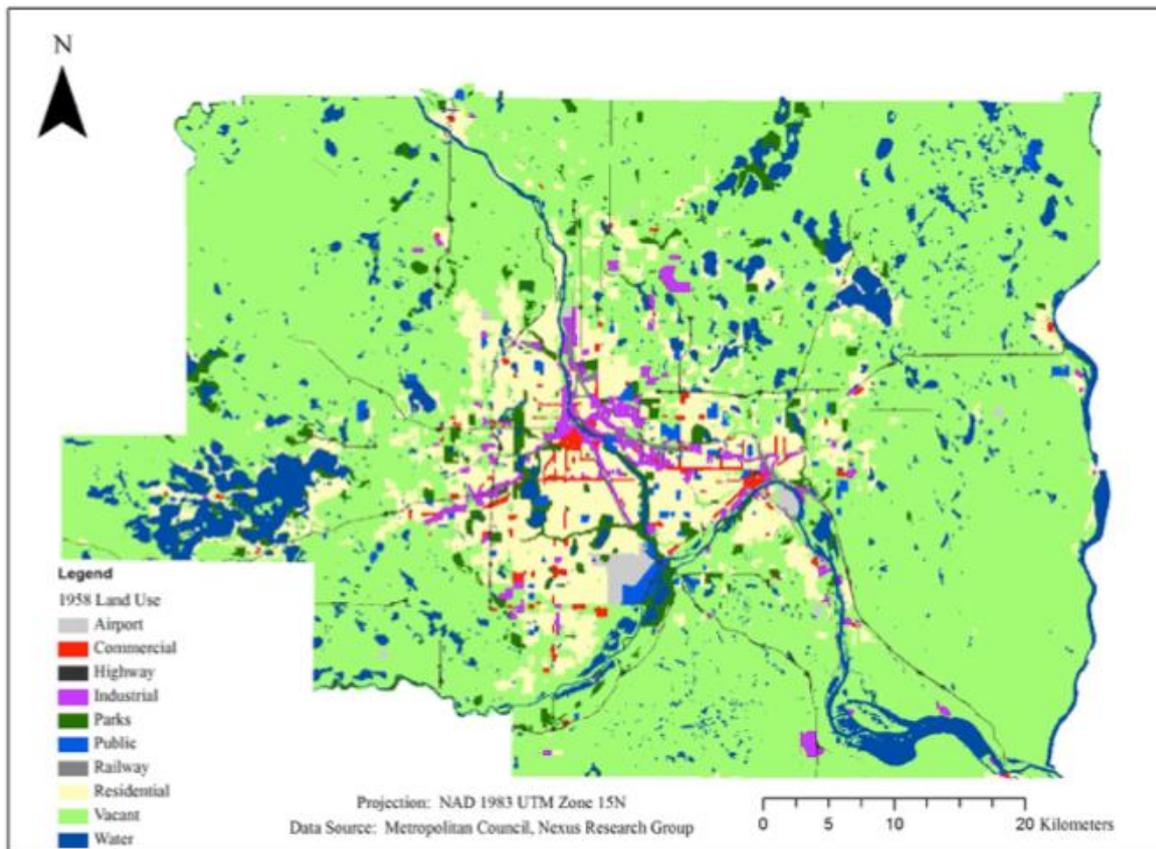

Fig. 1a Land use patterns in the Twin Cities region 1958
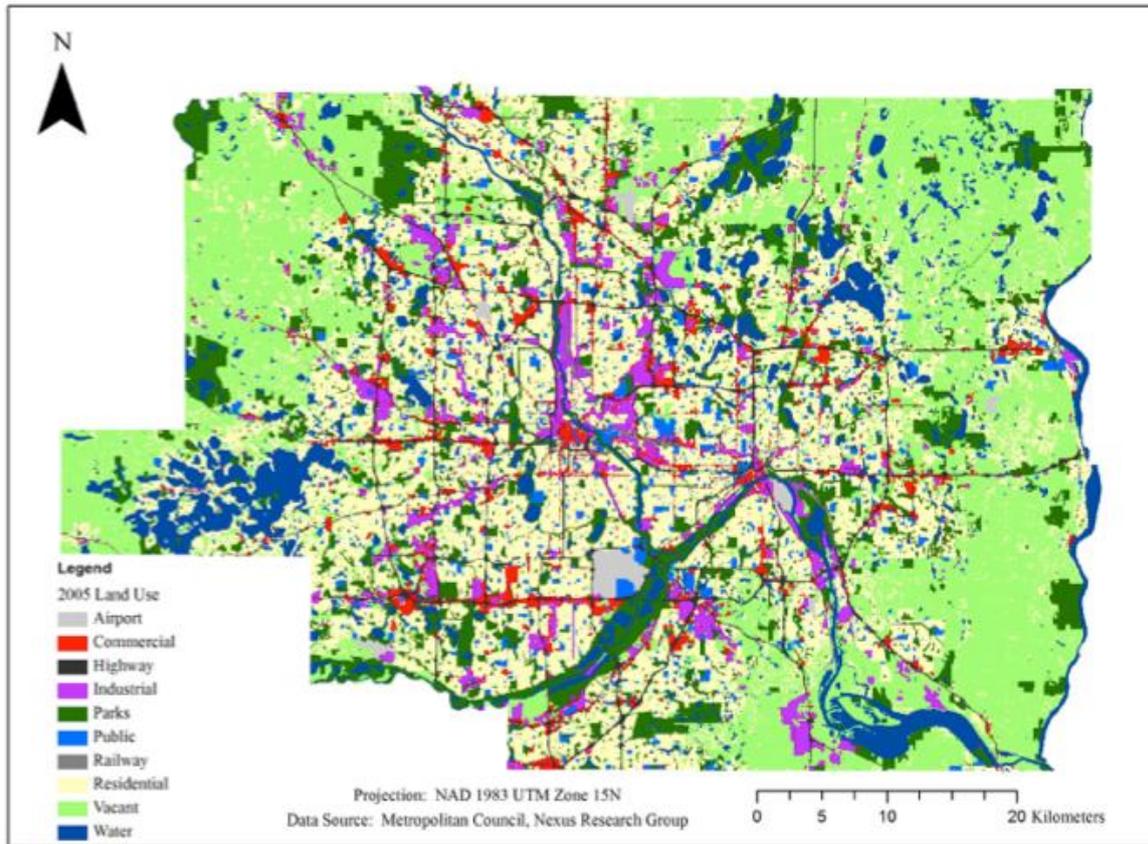
Fig. 1b Land use patterns in the Twin Cities region 2005
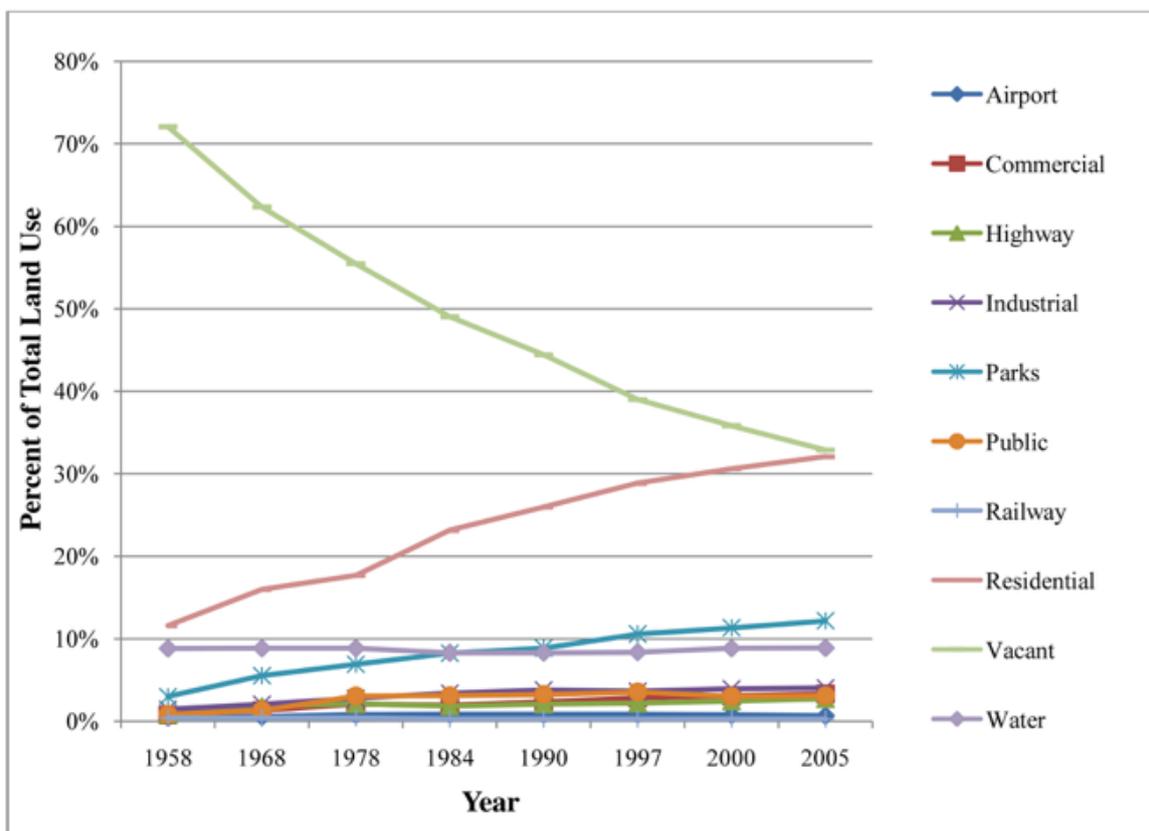
Fig. 2 Land use patterns in the Twin Cities region 2005

Virtually all land use classes have increased over this period, with the greatest increase in land use registered by the residential category. This growth has largely come at the expense of vacant land, as the region has been able to accommodate growth over the years via outward expansion. The data set contains three classes of land use related to transportation infrastructure: airports, railroads, and major highways. We can use the intermittent observations of land use to develop rough estimates of the amount of land that is consumed by transportation facilities and how it has changed over time as the region has developed. In the earliest year for which data are available (1958), transportation land uses covered 9,907 of the cells in the data set, the equivalent of about 1.6 percent of the total area in our sample or 55.7 km2 (21.5 mi2). Highways accounted for about one-half of all transportation-related land use. By 2005, these same three land uses covered a total of 22,187 cells, or 3.6 percent of the total area. Much of this growth came in the form of new highways, with highway land use increasing more than threefold. By comparison, the population of the 7-county core of the region, from which the land use data were drawn, increased by about 87 percent, from 1.5 million to 2.8 million. We interpret this estimate of transportation-related land use as a lower-bound estimate and, most likely, an underestimate. The land use data have no category for local roads which tend to be a denser network than regional highways, and treat parking as part of the respective land uses they serve. Other recent published estimates of parking coverage suggest that in urban settings, parking may account for 4 to 6 percent of total land use, while suburban settings tend to have lower amounts of coverage (mostly below 2 percent) (Davis et al., 2010a, Davis et al., 2010b). Were these two components to be added in to the total of transportation-related land use, the total coverage for the region would probably be somewhere in the range of 5 to 10 percent of all urban land use.

	AIRPOR	COMM	HWY	INDUST	PARKS	PUBLIC	RAILW	RES	VAC	WATER	TOTALS
AIRPOR	2874	12	2	148	9	90		59	160		3354
COMM	9	3709	59	588	238	508	1	2257	635	2	8006
HWY		15	10989	14	3	13		27	57		11118
INDUST	4	825	138	7641	343	496	21	1114	1886	4	12472
PARKS	383	364	137	378	18440	1191	4	3096	9622	76	33691
PUBLIC	62	226	5	95	354	4984	1	1688	644	3	8062
RAILW		3		9	3	4	2162	10	18		2209
RES	138	4597	261	1865	5579	5646	14	72155	7089	74	97418
VAC	1375	2976	1304	6198	17038	5676	35	27410	318548	174	380734
WATER		1	2	10	103	3		65	104	53636	53924
TOTALS	4845	12728	12897	16946	42110	18611	2238	107881	338763	53969	610988

Tab.1 Observed cell frequencies, 1968-1978

The K^2 statistic can be compared to a χ^2 distribution with $(10-2)^2 = 81$ degrees of freedom. With a critical region of $\alpha = 0.05$, values of the test statistic less than approximately 100 would indicate that land uses in 1978 were independent of those in 1968.

	AIRPOR	COMM	HWY	INDUST	PARKS	PUBLIC	RAILW	RES	VAC	WATER	TOTALS
AIRPOR	27	70	71	93	231	102	12	592	1860	296	3354
COMM	63	167	169	222	552	244	29	1414	4439	707	8006
HWY	88	232	235	308	766	339	41	1963	6164	982	11118
INDUST	99	260	263	346	860	380	46	2202	6915	1102	12472
PARKS	267	702	711	934	2322	1026	123	5949	18680	2976	33691
PUBLIC	64	168	170	224	556	246	30	1423	4470	712	8062

RAILW	18	46	47	61	152	67	8	390	1225	195	2209
RES	773	2029	2056	2702	6714	2967	357	17201	54014	8605	97418
VAC	3019	7931	8037	10560	26241	11597	1395	67225	211098	33631	380734
WATER	428	1123	1138	1496	3717	1643	198	9521	29898	4763	53924
TOTALS	4845	12728	12897	16946	42110	18611	2238	107881	338763	53969	610988

Tab.2 Expected cell frequencies, 1968-1978

With a computed K^2 of roughly 2.75×10^6, this is clearly not the case. Again, it should be noted that in the case of Markov chain models of land use, the hypothesis of independence is nearly always rejected. Historical dependence in land use is a strong force, as is indicated by the primacy of the diagonal elements of the observed transition matrix. Another way to examine the validity of the Markov chain framework is to test the stability or stationarity of the transition matrix. As described in an earlier section, one way to do so is to observe the correlation between the elements of matrices describing the transition probabilities. By regressing the matrix elements of a subsequent time period on a base period, it is possible to determine whether (and how far) the correlations between the two matrices deviate. The matrix of transition probabilities for the period from 1958 to 1968 will serve as a base period, since this is the earliest transition period for which data is available. Table 3 shows the results of three successive transition probability matrices being regressed on the original 1958 to 1968 matrix. The X and Y variables denote the response and predictor variables in the regression. The fit of the equation is summarized with the adjusted R^2 value.

				95% C.I.	
Y	X	ADJ. R^2	β	LOWER	UPPER
1968-78	1958-68	0.977	0.98	0.95	1.01
1978-90	1958-68	0.943	0.948	0.902	0.995
1990-2000	1958-68	0.962	1.029	0.988	1.07
1968-78	1958-68	0.977	0.98	0.95	1.01
1978-90	1958-68	0.943	0.948	0.902	0.995

Tab.3 Summary of transition probability regressions

The value of the slope coefficient (β) is indicated, along with the lower and upper bounds of a 95% confidence interval for the mean value. In two of the three cases the 95% confidence interval includes the value of one, and in the third case the upper bound falls just short of one. While these results do not provide entirely conclusive evidence on whether the transition matrix is stationary, they offer some confidence that dramatic changes in transition probabilities are not occurring over time. Moreover, even a lack of stationarity does not need to preclude the use of Markov models. As Baker (Baker, 1989) has noted, stationarity can be assumed as a heuristic device for scenario generation using Markov chains. It is possible to evaluate how well the Markov chain model predicts land use change by using the historical time series to produce "backcasts" of land use for previous points in time. For example, the 1958 to 1968 transition probability matrix can be used as a base to predict forward in roughly 10-year increments to the years 1978, 1990 and 2000. Due to the different sources of data and data-generating processes noted for the years before and after 1984, we can provide "control" forecasts for the newer data using the 1984 to 1990 transition probability matrix as a base year matrix. These forecasts are provided for the years 1997 and 2005. Again, the land use conversion process in the model is governed by a random number generation procedure that draws values that correspond to the transition probabilities in the matrix for each initial land use state. Forecasts covering more than 10 years use the predicted land use distribution from 10 years prior as inputs to the forecast (e.g. forecast land use for 1990 is used as an input, along with the 1958-1968 probability matrix, for a forecast to the year 2000). This links the forecasts forward through successive time steps and

preserves the Markovian principle that future states are only influenced by the present state. Summaries of the accuracy of the forecasts are provided in Table 4.

BASE YEAR MATRIX	FORECAST YEAR	% CORRECT
1958-1968	1978	70
1958-1968	1990	55.2
1958-1968	2000	47.8
1984-1990	1997	84.4
1984-1990	2005	78.5

Tab.4 Forecast accuracy using historical time series data

As the results indicate, the accuracy of forecasts made using the 1958 to 1968 matrix of transition probabilities declines sharply over time. While all long-term forecasts can be expected to decline in accuracy the further they are asked to predict, there is a notable decline between the forecast years 1978 and 1990. This period coincides with the use of different sources of land use data which may not be entirely consistent and which may introduce additional inaccuracy to the forecast. The monotonic decline in accuracy also indicates that errors in forecasts from previous periods are fed forward into subsequent predictions. On the other hand, the forecasts made using a more recent transition matrix (1984 to 1990) as an input show a higher degree of accuracy and a more moderate decline over the second time step. This may be a result of more consistent data as well as a shorter transition period (6 to 8 years). Lastly, we are interested in using the Markov chain model to predict land use patterns several periods into the future. The most recent land use data are available for the years 1997, 2000 and 2005, indicating that the 1997 to 2005 period most closely matches the 10-year transition periods used throughout this study. Thus, a 1997 to 2005 transition probability matrix can be constructed and used for forecasting in 8-year increments. This matrix is reproduced below.

	AIRPOR	COMM	HWY	INDUST	PARKS	PUBLIC	RAILW	RES	VAC	WATER	TOTALS
AIRPOR	0.7388	0.001	0.0068	0.001	0.0325	0.0131	0	0.0055	0.1984	0.0029	1
COMM	0.0001	0.8187	0.0201	0.056	0.0045	0.0227	0.0002	0.0413	0.035	0.0015	1
HWY	0.0004	0.0107	0.9542	0.0054	0.0058	0.0031	0.0002	0.0094	0.0105	0.0001	1
INDUST	0.0004	0.071	0.0099	0.8371	0.0082	0.0086	0.001	0.0106	0.0517	0.0014	1
PARKS	0.0022	0.0036	0.0031	0.0025	0.9128	0.0062	0.0001	0.0116	0.0364	0.0214	1
PUBLIC	0.0001	0.0193	0.01	0.0384	0.0569	0.7364	0.0004	0.0223	0.1091	0.0071	1
RAILW	0	0.0065	0.0142	0.0201	0.011	0.0032	0.9139	0.0168	0.013	0.0013	1
RES	0	0.0024	0.0024	0.0009	0.0041	0.0023	0.0001	0.9634	0.023	0.0013	1
VAC	0.0004	0.0141	0.0099	0.0156	0.0513	0.0057	0.0002	0.0988	0.792	0.012	1
WATER	0.0001	0.001	0.0003	0.0014	0.0136	0.0002	0	0.0055	0.0096	0.9684	1

Tab.5 Transition probability matrix for 1997 to 2005

The 1997 to 2005 matrix is used to forecast forward through three time steps, yielding land use forecasts for the years 2013, 2021 and 2029. These forecasts are shown below in Table 6, along with the land use distribution in 2005, the base year.

	2005	2013	2021	2029	CHANGE (2005-29)	CHANGE (%)
AIRPOR	4047	3273	2674	2266	-1781	-44.0%
COMM	20296	22565	24114	25152	4856	23.9%
HWY	16635	19546	22041	24272	7637	45.9%
INDUST	24503	25961	27040	27620	3117	12.7%
PARKS	74251	81395	86454	89758	15507	20.9%
PUBLIC	18820	16793	15257	14013	-4807	-25.5%
RAILW	1505	1476	1454	1427	-78	-5.2%
RES	195934	211257	223401	233143	37209	19.0%
VAC	200837	171864	149304	131764	-69073	-34.4%
WATER	54160	56912	59249	61573	7413	13.7%

Tab.6 Land use forecasts for 2005 through 2029

Table 6 shows the land use distribution in each forecast year, along with the absolute and percentage changes through each time step. The land use forecasts for each period appear to be sensitive to abrupt, discontinuous changes that occur during the 1997 to 2005 period and are reflected in the transition matrix. The most notable effect is the prediction of a major decline in airport land. While there appears to have been a small decline from 1997 to 2005, this trend is projected out in each of the forecast periods, leading to a predicted decline of 44 percent from 2005 to 2029. This is probably not likely in a growing metropolitan area that anticipates continued growth in air travel in the coming decades. The same can be said of the trend in land used for highways, which is projected by the model to grow by roughly 46 percent. It would be useful to attempt to decompose this predicted growth by class of highway. Interstate and state trunk highway networks are already in place and are not likely to experience sharp increases in the near future, yet county highway networks, which tend to be more robust, may see substantial growth in newly-developing parts of the region. The model also predicts a major increase in residential land use, mostly at the expense of vacant land. This largely reflects the effects of the real estate boom of the late 1990s and early 2000s in the Twin Cities. Due to this reliance on past trends, the model will probably overpredict the demand for residential land use in the 2005 to 2013 period. Once new data become available, this observation can be tested.

3   CONCLUSION

This paper has demonstrated the application of a Markov chain model for fore-casting land use change in the Minneapolis-St. Paul metropolitan region. The Markov chain model has been shown to adequately describe the process of land use change, at least for short to medium-term time horizons. The extremely fine resolution of the land use data produced for this analysis allows for more detailed descriptions of land use transitions over time. The greater availability of data in recent years also allows for models that incorporate shorter transition periods, potentially leading to more accurate forecasts. Still, there are some aspects of the Markov chain model that deserve critical attention, and some directions of extension that could improve the model's output. These will be discussed in turn. One the most desirable qualities of the Markov chain model is its simplicity. It is able to describe the complex and long-term process of land use conversion in terms of simple transition probabilities, making it a potentially useful sketch planning tool. However, this simplicity is also one of its greatest weaknesses. Since Markov chains are essentially projection models, they are not policy-sensitive and cannot easily incorporate the range of policy variables that might be of interest in predicting the impacts of various land use policies. The characterization of Markov chains as projection models also means that there is very little theory to guide their development. Except in cases where they are coupled with other types of models (e.g. McMillen and McDonald's zoning

model), they may not encompass some of the important economic and regulatory forces shaping land use patterns in urban areas. These forces are often masked by the application of the transition probabilities. However, it is possible to introduce some of these factors directly into the model. Some applications have specified the transition probabilities themselves as functions of other variables (Brown et al., 2000; McMillen et al., 1991), thus making it possible to empirically estimate their determinants. One can imagine this being a possible path for introducing the influence of transportation networks on land use change within the MC framework. The use of transition matrices from a single period can also lead to forecasts that project short-term and perhaps discontinuous trends. An example of this was the projection of a major decline in airport land in the Twin Cities through 2029, despite countervailing trends in the underlying forces that drive the demand for airline services. A related matter is the application of transition matrices to residential land. Since housing markets are cyclical and are prone to boom-and-bust cycles, predictions based on a period of strong growth (or decline) may tend to overshoot (or undershoot) actual land use trends. Lastly, the Markov chain model, as applied in this study, does not account for neighbor effects. That is, land use in a particular location may be influenced not only by its previous land use, but also by the land uses of its neighbors. This principle has been incorporated into other types of cellular models of land use, such as cellular automata, which model land use as a function of the states of cells in a defined neighborhood. Modifying Markov chain models to incorporate this influence represents a potentially important improvement in model design. Indeed, there have been a handful of recent experimental efforts to design models with characteristics of both of these types of frameworks (de Almeida et al., 2003; Liu and Andersson, 2004; Pontius and Malanson, 2005). The basic Markov chain framework can also be extended in several directions to introduce greater detail and accuracy to processes of land use change. In addition to introducing neighbor effects, land use cells can be merged with data on the presence of transportation network links (Levinson and Chen, 2005) to describe the interaction between transportation networks and the demand for location among competing land uses. A further division of land use into classes based on intensity of use would also im-prove the model's detail. Residential uses in particular could be classified according to density or building height, along the lines of current zoning classifications. A similar classification scheme could be applied to commercial uses. Finally, more robust measures are needed to account for these additional influences in determining modeled outcomes. The evaluation measures employed in this study were fairly simple, and more elaborate frameworks are needed to model and forecast the interaction of land use with other dynamic processes at work within urban areas.

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A TOOL FOR APPRAISING MOBILITY ENVIRONMENT WITH A PERFECT BASED INDEX MEASURE

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ABSTRACT

Diverse methods, approaches and models have been employed in explaining mobility in both the urban and human context. However, there has been the ever-present drawback premised on data unavailability, "dyrtiness" or scantiness. More so, the techniques and parameters used, does not provide clues about mobility complexities engendered by attributes of "mobility environments", as a result, determinants of mobility complexities are hardly fully described. To narrow the gap, it is conjectured that systematic evaluation of traveler perception of "mobility environments", may provide hints about the degree to which specified spatial units enhance or hinder mobility, by rating such environment with a perception based index construct we hope will help improve assessments of "mobility environments". This need is underscored by the necessity to explore alternative decision support tools, for mobility evaluations, especially where it may be implausible to apply advanced, high end, data hungry models of mobility evaluation. The method involved a two-pronged survey of transport professionals and randomly selected travelers. The professionals helped with "mobility environment" attributes identification and selection of contextually relevant ones from a list of potential attributes of influence, extracted from relevant literature using the Delphi method. Randomly selected travelers were in turn presented with the short listed attributes for rating on a five point Likert scale. Ratings were then used to determine attribute rankings and their commensurate index equivalents, as a basis for classification. Travelers indicated that a high activity mix, high road and pedestrian network density are good mobility enhancing qualities a city should possess. However, aggregate indexing indicated that enhancing development characteristics, mode characteristics, travel and economic attributes, are the most important for the study area. The measures are targeted at facilitating development of cost effective and parsimonious means of identifying urban mobility challenges by local authorities, to provide a strategic pathway for a city's "mobility environments" qualities to be identified and objectively appraised, in order to satisfactorily target interventions at improving both the "mobility environment" and the quality of life of city inhabitants.

KEYWORDS:

mobility appraisal, mobility environment, index measure, mobility influencers, mobility complexities, traveler perception

TeMA

有关土地使用、交通和环境的杂志

用基于认知的衡量指标来评估移动环境的一种工具

ABSTRACT

在解释城市和人类移动环境的过程中，人们已经采用了各种不同的方法、途径和模型。但经常存在因数据无效、"被污染"或缺乏而造成的不足。 而且，所用的技术和参数并未提供关于由"移动环境"属性造成的移动复杂性的线索，因而很难全面描述移动复杂性的决定因素。为了填补这个空白，我们推测，旅行者对"移动环境"认知的系统评价或许可以提供关于指定空间单位增强或阻碍移动性的程度。通过用一个基于指标结构的认知对这种环境进行评级，我们希望能有助于增强对"移动环境"的评估。对移动评估来说，探索决策支持替代工具的必要性突出了这种需求，尤其是当不可能采用需要大量数据的先进高端移动评估模型。这种方法涉及同时对交通专业人士和随机选择的旅行者进行调查。专业人士可以有助于识别"移动环境"的特性，并从用Delphi 方法从相关文献中提出的潜在影响特性的列表中，选择与环境相关的特性。对于随机选择的旅行者，则会给他们一个李克特5分量表，然他们对所列的特性进行评分。然后用评分来确定特性的排名以及与它们对应的指标等价物，以此作为分类的基础。旅行者表明，一个城市应当拥有的增强移动性的好品质包括：较高的活动混合、较高的道路和人行道密度。但合计指标表明，对这个研究领域来说，不断增强的发展特征、模式特征、旅行和经济特性才是最重要的。这些衡量指标的目的是推动开发出具有成本效益和节俭的方法，来识别出地方当局面临的城市移动性挑战，为要被识别和客观评估的城市"移动环境"品质提供一个战略路径，从而进行令人满意的干预，改善"移动环境"和城市居民的生活质量。

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1   INTRODUCTION

Mobility as a phenomenon have been widely studied, its connotations in transportation, accessibility and general human wellbeing have been explored to varying degrees, as exemplified in the works of Patla and Shumway – Cook, (1999), WBCSD, (2004), Oluseyi, (2006), Asiyanbola, (2007), Lotfi and Kooshari, (2009), and Hjorthol et al., (2010). To this end, diverse methods, approaches and models have been employed in explaining mobility in both the urban and human context.   However, there has been the ever present drawback premised on data unavailability, "dirtyness" or scantiness. More so, the techniques and parameters used, according to Hong, (2010) and Isaacman et al., (2011), does not provide clues about mobility complexities facing the individual as a result of the nature of "mobility environments", which according to Soria – Lara et al. (2014), should be understood as a comprehensive planning concept based on the interaction between land use and transport factors, which Hong, (2010) and Isaacman et al., (2011) stated are critical determinant of mobility capabilities of individuals.

Therefore, to harness opportunities that may accrue from evaluating the link between "mobility environments" and how they affect travelers', it will be pertinent to develop other ways of gaining this insight. Hence, it is suggested that tapping into perception of travel by the traveler, as a consequence of the attributes of "mobility environments" from which engendered inhibitors and enhancers of mobility embedded in such spaces can be deciphered, may be one way of achieving this. The growing interest in examining the relationship between the physical environment and active transportation through audits and perception studies, as attested to by Vanwolleghem, et al., (2014), underscores this thinking. Florindo et al., (2009), also stated that, developing operational concepts of mobility are desirable towards measuring or identifying benefits associated with individual movement. To buttress this point Bertolini and Dijst (2003) mentioned that the quality of "mobility environments" depend on the features of each location, but also on individual characteristics, showing that there is a relationship between environmental and individual attributes which shapes mobility perception. Based on the foregoing, it is believed that opportunities and threats to mobility should be inferable from examining how attributes of "mobility environments" affect perception of such space. This line of thought is desirable because it will further deepen the understanding of how percept based determinants of an individual or city's mobility requirement can be identified, especially in terms of broadening the perspective from which mobility dilemma can be evaluated, as a bases for achieving a more effective and traveler centered mobility planning.

Furthermore, studies linking environmental factors to mobility perception or active transportation, such as Hume, et al., (2005) which looked at association between physical environmental factors (perceived and objectively measured), and levels of physical activity in children found a strong association between them. Similarly, a cross-sectional study of more than 1200 primary school children in Australia found associations between children's walking levels and their perceptions of the local neighbourhood's environment (Alton, et al., 2007; Timperio, et al., 2004; Humpel, et al., 2004). Also, importance of environment to mobility disability has been acknowledged, even though the potentially disabling features of the environment are difficult to identify, it is apparent that there are potentially many environmental features that influence the complexity and difficulty of mobility, embedded in "mobility environments" (Patla and Shumway – Cook, 1999). This proves that there are salient perception influencing attributes of mobility, associated with the mobility operating space of individuals. Therefore, perception based studies can be used to gain insight into the array of pervasive factors that might be influencing particular cohorts. Given that, individuals with different travel modes show differences in their perception of important factors influencing mobility Howard et al., (2001).

Thus, understanding the relationships between user perception and experiences can bolster mobility planning and related interventions. For this reason, it is conjectured that a systematic evaluation of traveler perception of mobility influencing attributes of "mobility environments" could provide hints about how certain groups of people perceive them. This paper proposes a technique of appraising perception of "mobility

environments" with an index construct, as a measure of the aggregate type of influence the "mobility environment" is having on travelers. The work seeks to use indicators deducible from the percept of interaction between the moving subject and the containment within which mobility takes place, to rate the extent to which such spaces hinder or foster mobility. It further seeks to evaluate whether it will be practicable to determine "mobility environment" induced dilemma from travelers' perception, and also attempt establishing an index based measure of extent of positivity or negativity of a "mobility environment's" effect on travelers. The technique is proposed as an alternative approach to assessing or describing how "mobility environments" determine mobility perception of urban areas, in order to provide a decision support platform for managing cities, thereby setting the stage for use of traveler perception determined attributes in city planning. Since, ultimately the target of mobility planning is to remove constraints, ease movement and foster adequate accessibility to component areas of a spatial entity, in a manner that will accommodate motorized and non – motorized travelers, as pointed out in Asiyanbola (2007). The paper is structured into five parts, the first part introduces the research and presents issues from related literature, part two sets out the conceptual bases of the argument. Three contains the description of the study area and why it was selected as the study case. The fourth section explains how data was gathered and the method of analysis. Lastly, the fifth part presents discussion on important points, ultimately ending with conclusions.

2 CONCEPTUAL ISSUES AND JUSTIFICATIONS

Due to the exploratory nature of this work, it is necessary to explain some key terms and underpinnings. Despite the development of different practical applications based on "mobility environment", as can be seen in Bertolini (2006), Soria – Lara (2012) or Talavera et al. (2014). There are no strict guidelines on how "mobility environment" can be defined, identified or mapped (Soria – Lara et al. 2014). However, Bertolini and Dijst (2003), asserted that "mobility environment" is defined by the whole of the external conditions, that may have influence on the presence of people in a given location, as defined by features of both the transportation services available there and the activity place itself, underscored by institutional arrangements, such as regulations. Based on this, the concept is described for the purpose of this study as "the totality of three dimensional spaces, within which elements - upon, through, around, and with which mobility take place - are contained, as defined by the guidelines governing the use of such spaces", which collectively influence how such a space is perceived". The idea that perception of a phenomenon is shaped by internal and external factors that could further be classified into tangible and intangible aspects, as described by (Sokolowska, 2014) buttresses this notion. Hence, the attributes of a "mobility environment" are thought to determine how a traveler perceives mobility in such places, so it becomes pertinent to seek out how such an environment can be structured to elicit positive perceptions.

In another sense, "the degree to which an identified "mobility environment" hinder or foster mobility of a group of randomly selected individuals, operating within it, is expected to be related to the attributes of such "mobility environment". So, it is our thought that, the degree to which a "mobility environment" foster or hinder mobility, should be inferable from its rating in relation to an established scale, ranking or interpretation system. This posture is justified by assertions that intangible phenomenon are measurable through scaling, rating or indexing as exemplified by works such as Mingshun (2002), Zaly (2010), Shittu et al. (2015). Against this backdrop, an attempt is made to use traveler's perception of the environment within which travel takes place as a measure of the kind of influence such an environment is having on travelers. The fact that a collection of ideas are needed to achieve the task necessitated a multidisciplinary approach. Most importantly, a number of principles or consensus opinions were identified from diverse literature, upon which the foundation of this work was built, these include:

— the fact that intangible phenomenon are measurable through scaling, rating or indexing.

- an established commitment to importance of the "person" as a fundamental unit of analysis and data derivation (the holistic modeling posture), as a necessary requirement for bottom up solutions that targets human behaviour related conditions;

- as an extension of (ii) above, the established need to incorporate human perception in measurements as a crucial element in understanding human preferences and requirements, because measurements lacking human perceptions are usually faulty.

- the prioritization of self reported factors in the analysis of mobility can more appropriately capture an individual's mobility complexities, thereby providing information that will be helpful in identifying appropriate interventions;

- the inability of abstract models to capture information on nuances underlying perception, which are important indicators of how changes to status quo are reacted to; and

- the need to promote inclusive and functional explore-ability of cities as a fundamental requirement of social participation and inclusion.

At the operational level, "mobility environments" have been used to describe geographical units with homogeneous mobility characteristics, based directly on the idea that mobility planning should play a central role in urban planning (Bertolini and Dijst, 2003). It was also put forward that the concept has been used to facilitate the adoption of particular methodologies to identify and use "mobility environments" from different countries and planning contexts. The direction now in "mobility environment's" study, is aimed at helping planners root policies in the very source of mobility, and also to help identify needs and constraints of individuals as members of different types of social organizations. The thrust is towards fully integrating mobility and accessibility considerations into urban planning and design. In the long run, it is expected that different kinds of "mobility environments" will emerge (Soria – Lara et al. 2014), as a bases for fashioning out better strategies and policies for specific "mobility environments".

3   THE STUDY AREA

Ilorin, a metropolitan area in Kwara state, north central Nigeria was selected for the study. The selection was made because the city exhibits characteristic dualism similar to many developing country cities, as mentioned in (Ahmed, 1996). Thus, Ilorin can be taken as a fair representation of cities in developing countries, more so Nigeria. The city has both organic and inorganic sectors, reflecting both modern and traditional characteristics. The city of Ilorin comprises of 20 political subdivisions known as wards. The city's population was estimated to be 510,444 persons for 2014. Ilorin metropolis sits on an estimated land mass of 111.46 km2.The city has no formal public transportation system, transport services are provided by private informal operators. Expectedly, the city also suffers from inadequate planning data base, as attested to by (Aderamo, 2000). Ilorin, to a large extent exhibits homogeneity in terms of development density, environmental quality, and in transport enterprises (Aderamo, 2003). Efforts to provide adequate transport infrastructure for the city of Ilorin have been adjudged ad–hoc, uncoordinated and poor in (Aderamo, 2008). Figure 1(a), depict Ilorin metropolis in the context of country and state within which it is located, while Figure 1(b), illustrates its political subdivisions known as wards. The socio–economic profiles and infrastructural status of the constituent wards of Ilorin metropolis, are largely similar. Mobility issues are not dealt with in relation to city needs and requirements, as attested to by (Aderamo, 2000), akin to most metropolitan areas of its kind and status in Nigeria.

Fig. 1(a) Ilorin Metropolis in the context of Kwara state

Fig. 1(b) The twenty wards of Ilorin Metropolis

4 DATA ACQUISITION AND ANALYSIS

4.1 DATA ACQUISITION METHOD

Two types of surveys were carried out. The first one targeted the experts, while the second type was directed at general respondents. The experts helped with attribute reduction exercise via the Delphi method. Ten (10) urban planning and transportation professionals were purposively selected from agencies and associated institutions in Ilorin metropolis. Six (6) of whom are field professionals and four (4) from local tertiary institutions, all belonging to the senior cadre. Professionals from planning institutions were selected because they are statutorily responsible for urban planning activities in Ilorin. Representatives from tertiary institutions were targeted because Ilorin metropolis is their main study zone, and for the advisory role they play in policy development. The general survey on the other hand, was carried out by trained research assistants with knowledge of the local language and terrain. The interviews were carried out in respondents' houses and in the streets of the constituent wards of Ilorin, for which information is sought. Respondents

were interviewed and asked to rate attributes such as modal variety, pedestrian network density, activity and land use mix, based on the checklist that emerged from professional contextual evaluation of 57 potential attributes of "mobility environments" harvested from literature. 500 questionnaires were administered, based on Krejcie and Morgan, (1970), Veal, (2006) and Morenikeji (2006), suggestions and in view of the population of the city. This translates into 25 each per ward. In addition, 5 extra questionnaires were added as a precaution to make 30 per ward, in order to make room for substitution in case some are returned unusable at the end of the city wide survey, which usually is the case with survey based data collection exercises. Equal numbers of interviews were conducted in all wards, mainly, because the population figures at the ward level are not officially available. So, there was no base for differing figures. Hence, 25 questionnaires were in turn randomly selected without replacement from the total number of valid questionnaires returned from each ward. The main issues of consideration in sampling for this research were geographic distribution, age, gender, employment status, income, location of activities of daily living and available human and financial resources to the researchers. The targeted age bracket was 18 − 65, normally considered active age range. Interviews were conducted along randomly selected streets by trained research assistants covering specific wards of the city. Approach to respondents' selection was systematic random sampling.

4.2 DATA ANALYSIS

4.2.1 EXTRACTION OF CONTEXTUALLY RELEVANT ATTRIBUTES FROM RATINGS

The professional raters reduced the 57 potential attributes of "mobility environment" harvested from relevant literature to 30 contextually relevant ones to mobility assessment in Ilorin metropolis. The rating of harvested attributes were done on a 5 point Likert scale ranging from 4 − 0, with extremely significant having the highest and not significant the lowest. For instance, there is no formal bus system in Ilorin metropolis, hence a score of (0) is awarded and the attribute end up taken off the list. Only 7 of the 10 participating professionals were available for each of 3 contacts. Therefore, only ratings from these 7 were utilized for further analysis.

S/NO	ITEMS	4 ES	3 HS	2 S	1 LS	0 NS	WEIGHTED MEAN-WM	DECISION R/NR
1	Road Network Characteristics	3	4	0	0	0	3.43	R
2	Public transport cost	5	1	1	0	0	3.57	R
3	Public transport Fare/Distance relationship	3	4	0	0	0	3.43	R
4	Quality of public transport facilities	1	3	3	0	0	2.71	R
5	Land Use Mix	5	2	0	0	0	3.71	R
6	Activity Mix	4	3	0	0	0	4.00	R
7	Modal Variety	3	2	2	0	0	3.14	R
8	Private Modes	5	2	0	0	0	3.71	R
9	Congestion effect on mobility	3	3	1	0	0	3.28	R
10	Effect of time spent waiting at transport stops	3	2	1	1	0	3.00	R
11	Diversity of Movement Channels	5	2	0	0	0	3.71	R
12	Road Network Density	6	1	0	0	0	3.85	R
13	Pedestrian Network Density	6	1	0	0	0	3.85	R
14	Quality of public transport services	2	2	2	1	0	2.71	R
15	Public Transport Service Reliability	4	2	1	0	0	3.43	R
16	Delay factor	3	1	2	1	0	2.86	R
17	Safety attributes of Pedestrian Paths	3	4	0	0	0	3.43	R

18	Perceived Safety of bus stops	2	3	2	0	0	3.00	R
19	Traffic accidents	2	3	2	0	0	3.00	R
20	Road markings and signage	2	4	0	1	0	3.00	R
21	Development Density	4	3	0	0	0	3.57	R
22	Development Pattern	3	3	1	0	0	3.28	R
23	Public transport fare effect on monthly income	4	2	1	0	0	3.43	R
24	Public Modes	3	2	2	0	0	3.14	R
25	Number of transfers on routine trips to work/school/shopping	2	3	2	0	0	3.00	R
26	Public Transport Service Comfort	2	3	1	1	0	2.86	R
27	Distance from transport stops to your destination(s)	4	2	1	0	0	3.43	R
28	Distance to Public Transport stop at your origin	4	2	1	0	0	3.43	R
29	Average travel time to work/school/shopping	3	2	2	0	0	3.14	R
30	Pedestrian Network Characteristics	3	2	2	0	0	2.20	R

Table 1 List of Extracted Contextually Relevant attributes of "Mobility Environment in Ilorin Metropolis

Following professional contextual relevance rating, the weighted mean of entries for each factor were derived to pave way for comparison with the calculated cut-off point. The cut-off point of acceptance or rejection of items rated in Likert scale is the arithmetic mean of individual weights, Morenikeji, (2006), which in this case are 4, 3, 2, 1 and 0. Hence, the cut-off point was calculated to be 2.00, see eqn (1). Therefore, any item with a weighted mean (WM) of 1.99 and below is considered not significant in the context of the study area, while those with WM equal to or above 2.00 are considered significant, WM is derived as shown in eqn (2). The extraction of contextually relevant mobility influencing factors was then done. Table 1 shows the WM values of extracted contextually significant attributes for Ilorin metropolis.

$$\text{Cut-off point} \quad = \frac{\sum_{i=1}^{n} W_i}{n}, \; i = 1, 2, 3.... \; n \tag{1}$$

$$WM = \frac{\sum_{i=1}^{n} W_i F_i}{n}, \; i = 1, 2, 3.... \; n \tag{2}$$

4.2.2 THEMATIC CATEGORIZATION OF CONTEXTUALLY RELEVANT ATTRIBUTES FOR ILORIN METROPOLIS

Here, the contextually relevant attributes are grouped into thematic areas, according to trait similarities. Attributes that collectively describe a certain phenomenon, say city development density, were all classified under such a sub – heading. This is necessary because several factors tend to cluster together in defining specific domains and also in shaping perception of individuals (Sokolowska, 2014). It also enables group by group, as well as item by item comparison. The 9 groups of factors identified and classified descriptively are as presented in Table 3. The categorization then forms the basis for preparing the questionnaires for the general "mobility environment" perception survey targeted at respondents from the 20 wards of Ilorin metropolitan area.

4.2.3 DEVELOPMENT OF ATTRIBUTE RANKING, RANK ORDER OF IMPORTANCE POINTS (ROIP) AND INDEX EQUIVALENTS (IE) TEMPLATE FOR ILORIN METROPOLIS

After ascertaining the number of contextually relevant attributes with the help of local professional urban and transport planners, a factor ranking and Index Equivalent (IE) template was developed. The premise was that since 30 contextually relevant factors were identified, it means ranking can only range from 1st to 30th. Ranking signifies order of importance of a particular attribute, according to respondents' perception in a particular city sub-unit. However, to show true effect, Accentuated Rank Order of Importance Points (ROIP) were assigned to rank positions. The ROIP considered the total number of contextually relevant attributes, as bases for accentuating rankings, using true values of figures to show relative magnitude. Consequently, the highest ranking attribute is assigned 30 points as ROIP, to reflect its magnitude of importance, while the lowest ranking attribute, receives 1 point as ROIP, signifying its low level of influence on traveler perception in the specific city unit within which the attribute has been rated. Subsequently, the general IE for each contextually relevant factors were established by dividing a specific ROIP with the sum of all ROIPs, see eqn (3), this ensures normalization of IE values between 0 and 1, thereby removing the need to attribute separate characteristic units to each factor. Table 2 then becomes the template for iterative index equivalent assignment to attribute rankings for all the wards, according to city wide survey. Note that WM values were also derived from respondents' ratings for ranking purposes, as shown in column 5 of Table 3.

$$IE_i = \frac{ROIP_i}{\sum ROIP} \qquad i = 1, 2, 3.... 30 \tag{3}$$

RANK ORDER (RO)	ACCENTUATED RANK ORDER OF IMPORTANCE POINTS (ROIP)	INDEX EQUIVALENT (IE)
1st	30	0.065
2nd	29	0.062
3rd	28	0.060
4th	27	0.058
5th	26	0.056
6th	25	0.054
7th	24	0.052
8th	23	0.049
9th	22	0.047
10th	21	0.045
11th	20	0.043
12th	19	0.041
13th	18	0.039
14th	17	0.037
15th	16	0.034
16th	15	0.032
17th	14	0.030
18th	13	0.028
19th	12	0.026
20th	11	0.024
21st	10	0.022
22nd	9	0.019
23rd	8	0.017

24th	7	0.015
25th	6	0.013
26th	5	0.011
27th	4	0.009
28th	3	0.006
29th	2	0.004
30th	1	0.002
Total	465	1.000

Table 2 Attribute Ranking, Rank Order of Importance Points *(ROIP)* and *(IE)* Template

4.2.4 TRAVELER RATING OF MOBILITY ENVIRONMENT ATTRIBUTES FOR WARDS IN ILORIN METROPOLIS

For this exercise, rating was done on a five point Likert scale ranging from 5 – 1, reflective of type of influence and degree to which contextually relevant mobility influencing attributes affect respondents' mobility, with strongly positive having the highest, that is 5 points and strongly negative the lowest, that is 1 point. After respondents' rankings for all 20 wards in Ilorin metropolis were received. Results obtainable for one of the 20 wards in Ilorin metropolis that is Adewole ward is presented in Table 3, as an example. Then, Average Category Index (ACI), which is the mean IE value for a specific thematic category of a "mobility environment" Index (xMEI), that is the sum of ACI's of all categories for a ward were derived as depicted in eqns (4) and (5) respectively. The x connotation against xMEI identifies a specific ward appropriately.

$$ACI_{mc} = \frac{\sum_{i=1}^{n} IE_{mt}}{n}, \quad i = 1, 2, 3 \ldots n \tag{4}$$

$$xMEI = \sum_{i=1}^{n} ACI_{mt} \quad i = A, B, C \ldots I \tag{5}$$

S/NO	ATTRIBUTE DESCRIPTION	W_iF_i	n	$\frac{\sum W_iF_i}{n}$	RANK ORDER	IE	ACI
A	**Network Characteristics**						
1	Diversity of movement channels	77	25	3.08	10th	0.045	
2	Road network density	77	25	3.08	10th	0.045	
3	Pedestrian network density	68	25	2.72	25th	0.013	0.034
B	**Development Characteristics**						
4	Development density	78	25	3.12	5th	0.056	
5	Development pattern	76	25	3.04	14th	0.037	
6	Road characteristics	78	25	3.12	5th	0.056	
7	Pedestrian network characteristics	78	25	3.12	5th	0.056	
8	Quality of public transport facilities	85	25	3.40	1st	0.065	0.054
C	**Density of opportunity**						
9	Land use mix	71	25	2.84	19th	0.026	
10	Activity mix	75	25	3.00	15th	0.034	0.030
D	Mode characteristics						
11	Modal variety	78	25	3.12	5th	0.056	
12	Private modes	81	25	3.24	2nd	0.062	
13	Public modes	77	25	3.08	10th	0.045	0.054
E	**Travel characteristics**						
14	Number of transfers on routine trips to	64	25	2.56	27th	0.009	0.036

	work/school/shopping						
15	Average travel time to work/school/shopping	81	25	3.24	2nd	0.062	
F	**Transport accessibility factors**						
16	Distance to public transport stop at your origin	69	25	2.76	23rd	0.017	
17	Distance from transport stops to your destination(s)	71	25	2.84	19th	0.026	0.022
G	**Economic factors**						
18	Public transport cost	69	25	2.76	23rd	0.017	
19	Public transport fare/distance relationship	78	25	3.12	5th	0.056	
20	Public transport fare effect on monthly income	73	25	2.92	17th	0.030	0.034
H	**Operational Characteristics**						
21	Congestion effect on mobility	71	25	2.84	19th	0.026	
22	Effect of time spent waiting at transport stops	72	25	2.88	18th	0.028	
23	Public transport service reliability	67	25	2.68	26th	0.011	
24	Public transport service comfort	64	25	2.56	27th	0.009	
25	Delay factor	70	25	2.80	22nd	0.019	
26	Quality of public transport services	79	25	3.16	4th	0.058	0.025
I	**Safety factors**						
27	Safety attributes of pedestrian paths	47	25	1.88	30th	0.002	
28	Perceived safety of bus stops	53	25	2.12	29th	0.004	
29	Traffic accidents	74	25	2.96	16th	0.032	
30	Road Markings and signage	77	25	3.08	10th	0.045	0.021

WMEI

Table 3 Rank Order of Perception Ratings of Mobility Influencing Attributes for Adewole ward

Table 3, illustrates results for Adewole ward, where a wMEI of 0.310 was derived. The least contributor to wMEI index for Adewale ward in terms of thematic categories was the "safety factor" group. Specifically, "safety attributes of pedestrian paths" ranked the lowest, which is 30th position, with a weighted mean value of 1.88 and IE of 0.002, meaning that the largest proportion of raters, consider safety characteristics of pedestrian paths as unfavourable to them. The highest ranking attributes for this ward was "quality of public transport facilities", a pointer to a relatively good perception of public transport facilities, which for this case, refers almost entirely to bus stops, mainly utilized by informal public transport providers. The "development characteristics" and "modal varieties" categories tied on ACI contribution of 0.054 to xMEI as perceived for Adewole ward, which means that, respondents' perceived development density of the area quite positively, just as they believe the choices of modes available to them are favourable, even though most of the respondents prefer to use private modes. This is possibly because of the unfavourable distance to public transport stops at respondents' origin, which turned in a low IE of 0.017, along with public transport cost. The "network characteristics" and "economic factors" categories also turned up with equal ACI of 0.034 for the ward, the public transport "fare/distance" relationship under the "economic factor" group was particularly rated high, coming 5th in terms of positive influence on respondents' mobility, meaning that respondents consider public transport fare versus distance generally acceptable, even though overall cost are perceived not to be so. The "public transport accessibility" thematic category on the other hand, turned up with a low ACI of 0.022 for the ward, signifying a need for priority intervention in both "public transport accessibility" and "safety" areas. If the general perception of "mobility environment" of Adewole ward is to improve from a grade level 8 good "mobility environment" rating to a better status on the mobility environment ratings interpretation table, as shown in Table 4.

MEI VALUE RANGE	DESCRIPTIVE RATING CHANGE INDICATOR	MEI INCREMENT INDICATOR	INTERPRETATION
= 0.5850		32.5	Exceptional Mobility Environment
0.576 – 0.584	1	32	
0.558 – 0.575	2	31	
0.540 – 0.557	3	30	
0.522 – 0.539	4	29	
0.504 -0.521	5	28	
0.486 – 0.503	6	27	
0.468 – 0.485	7	26	
0.450 – 0.467	8	25	Excellent Mobility Environment
0.432 – 0.449	1	24	
0.414 – 0.431	2	23	
0.396 – 0.413	3	22	
0.378 – 0.395	4	21	
0.360 – 0.377	5	20	
0.342 – 0.359	6	19	
0.324 – 0.341	7	18	
0.306 – 0.323	8	17	Good Mobility Environment
0.2925 – 0.305		16.25	Satisfactory Mobility Environment
0.288 – 0.291	1	16	
0.270 – 0.287	2	15	
0.252 – 0.269	3	14	
0.234 – 0.251	4	13	
0.216 – 0.233	5	12	
0.198 – 0.215	6	11	
0.180 – 0.197	7	10	
0.162 – 0.179	8	9	Fair Mobility Environment
0.144 – 0.161	1	8	
0.126 – 0.143	2	7	
0.108 – 0.125	3	6	
0.090 – 0.107	4	5	
0.072 – 0.089	5	4	
0.054 – 0.071	6	3	
0.036 – 0.053	7	2	
0.018 – 0.035	8	1	Poor Mobility Environment

Table 4 Mobility Environment Rating Interpretation Table

The premise here is that, the perception of a "mobility environment" improves positively as "mobility environment index" (MEI) tend towards the max, in this case 0.5850 achievable index points, while" mobility environment" perception deteriorates negatively as "mobility environment index (MEI) tends towards the minimum achievable points, which is 0.018. The figures literarily denote the degree to which a spatial unit enhances or inhibits mobility. Therefore, it is expected that the higher the MEI value, the higher the perceived positivity of influence of "mobility environment" by that spatial unit and vice versa.

$$CMEI = \frac{\sum_{i=1}^{N} xMEI_i}{n}, \quad i = 1, 2, 3, ..., n \tag{6}$$

S/NO	WARD NAME	WARD MOBILITY LEVEL INDEX (WMSLI)	WARD RANKING BY MSLI VALUE	PERCENT CONTRIBUTION OF WARD
1	Adewole	0.310	12th	4.90
2	Babooko	0.316	8th	5.00
3	Balogun Ajikobi	0.316	8th	5.00
4	Balogun Alanamu	0.302	17th	4.77
5	Balogun Fulani	0.308	16th	4.87
6	Balogun Gambari	0.329	5th	5.20
7	Magaji Are	0.310	12th	4.90
8	Magaji Badari	0.300	18th	4.74
9	Magaji Gari	0.324	7th	5.12
10	Magaji Ibogun	0.315	10th	4.98
11	Magaji Ogidi	0.300	18th	4.74
12	Magaji Ojuekun	0.313	11th	4.95
13	Magaji Okaka	0.325	6th	5.14
14	Magaji Oloje	0.334	2nd	5.3
15	Magaji Zarumi	0.330	4th	5.21
16	Oke Ogun	0.334	2nd	5.3
17	Sabongari 1	0.309	15th	4.88
18	Sabongari 2	0.310	12th	4.90
19	Uban Dawaki	0.298	20th	4.71
20	Zango	0.339	1st	5.4
	Cumulative MSLI	6.322		100
$CMEI = \frac{\sum_{i=1}^{n} xMEI_i}{n}$, i = 1,2,3,…n		0.316		

Table 5 Derivation of CMSLI Value for Ilorin Metropolis

5   THE STUDY AREA

From the general overview of the 20 wards, the difference between the highest and lowest XMEI contribution is 0.041 index points, which signifies only a two (2) stage drop or climb for the highest contributor or the lowest contributor to be at par, respectively. It can then be deduced that the status of the wards "mobility environment" in terms of effect on perception of mobility are similar and not significantly different from one another. Even though, the major contributing attributes to the shades of perception reported for each ward differ. The lesson here is that aggregate description attributes of "mobility environment" may produce a generalized outlook that might not be reflective distinct geographical units. This reiterates the belief of Bertolini and Dijst, (2003), that "mobility environments" are geographical units with homogeneous mobility characteristics. The general outlook of "mobility environments" in Ilorin metropolis further proves this point because it presents a quite homogeneous picture of different wards, irrespective of the fact that some wards developed entirely organically, while others had some planning history or interventions in the course of their development. It may then be concluded that the disjointed and piecemeal approach to planning in the metropolis underscored by lack of continuity has resulted into a scenario where advantages accruable from occasional planning are eroded by the disadvantages of the lack of concerted planning.

More so, the highest ranking positively influencing attributes of mobility were private modes, rated 1st, in 16 of the 20 wards, with an IE of 0.065 in all cases. This agrees with assertions in the literature that private means of movement are usually preferred by travelers, unless conscious efforts are instituted to reduce its use from several fronts, so as to reduce the side effects of over motorization, which is usually compounded

by inadequate planning, as is the case in Ilorin metropolis. This also shows that perception based indices are adequate in eliciting probable determinants of mobility preferences and dilemma. On the contrary, attributes of public modes were generally perceived negatively; thereby ranking lowest that is 30th, with IEs of 0.002 in 45% of cases. This without doubt reflects the highly decentralized nature of the sector, due mainly to its total informal private ownership, and the lack of service quality enforcement of public transport modes in the metropolis. This attribute of public modes also explains the possibility of having such diverse characteristics in public transportation within one city. This is underscored by the fact that some wards are serviced by only rickshaws, or motorcycles, or taxis or minibuses, while others are served by a combination of taxis, minibuses, and motorcycles, leading to a different array of public transport mode choices available for each ward. Furthermore, route choice is basically governed by "cream skimming", where the lucrative routes are over supplied and the less profitable ones neglected.

In terms of utility, the index based "mobility environment" appraisal technique is developed basically to provide an alternate assessments procedure aimed at simplifying mobility planning decision making, especially where the normal gamut of required data and information to run sophisticated mobility evaluations are lacking. It also enables dimensioning and classification that allows a "mobility environment" to be assessed with respect to its peculiarities, be it covert or overt, in order that the complexities of mobility suffered by individual traveler become clearly understood. Besides, the measures generated from the application of the MEI technique provide justifiable reasons for project and programme design and selection for specific districts of identified cities. The tool is also useful in that it offers urban mobility planning and improvement decision support criteria for resource allocation, project prioritization and programme assessment. In addition, the tool also provide the bases for comparative analysis of needs and budgets in a manner that targets the overall mobility objectives of a city, besides enabling the assessment of goal(s) achievement. Budgeting tasks can be dealt with by using rankings of factors to determine priority projects and programmes, on the basis of how they fare on the ranking table. Future expenditure requirements can also be gleaned from simulating preferred positions of factors against city goals or targets, or by expert re-ordering of ranks by allocating weight of importance. In practical terms, the bases for mobility need projections and trend analysis in hitherto "mobility environment" attribute indeterminate areas have been presented, as a precursor to achieving goals of urban sustainability and livability.

In conclusion, the deeper understanding of underlining explanations of "mobility environment" induced mobility complexities by authorities responsible for urban mobility planning and management will improve responsiveness on the part of decision makers, leading to an improved and positively perceived "mobility environment" and quality of life. This research is expected to stimulate further enquiries into ways of quantitatively capturing perception based indicators from "mobility environments", as inputs in urban mobility assessments. First, the work presents an alternative mobility appraisal technique to complex data hungry models. This tool uses easily gathered data to facilitate realistic situational mobility evaluations, thus, permitting some measure of conscious management to begin in settings where inadequate mobility data and skilled manpower bedevil the sector. The study also strives to bridge the need gap for a parsimonious technique of assessing mobility, from the angle of environmental qualities. This serves to reduce the negative implications of indeterminate and indescribable mobility environment situations, thus enabling reasonable evaluations as a basis for local solutions and interventions. The tool's usage of individual percept of mobility influencing attributes enables a decent capture of some measure of mobility complexity determinants from the "mobility environment", by this means prioritizing the real essence of mobility planning, which is meeting Instrumental Activities of Daily Living (IADLs), an important determinant of quality of life. An attempt has been made in this study to develop a tool for deriving a percept-to-index construct, which can be used to describe "mobility environments", it will still be necessary to evaluate the extent to which the MEI technique can be relied upon to depict future changes, from evaluation of ex-post-facto ratings by new groups of respondents, after the implementation of MEI based programmes and

project. In other for the tool to be a reliable instrument of measuring the achievement of short and long term goals of mobility planning. The belief is that, if factors that shape human perception of a phenomenon can be identified, they will go a long way in helping decision makers arrive at more acceptable decisions.

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IMAGE SOURCES

Fig. 1(a): Source: Kwara State Town Planning Authority

Fig. 1(b): Source: Kwara State Town Planning Authority

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ABSTRACT

Changes in the usage of a particular urban or regional area have immediate effects on transportation, such as the development of a new multimodal terminal within a city, or the creation of a business park in its outskirts. Thus far, this correlation has been under-researched at a national level in Greece. As a result, its effects on trip generation and passenger flows has been underestimated at the planning level, leading to the implementation of projects that are neither viable nor sustainable. This paper proposes that land use changes ought to be considered in tandem with transport-related changes at the planning stage. To this effect, we present a three-step methodology for an integrated approach to capturing future trip generation: the identification of future trip-generating poles within the study area; the development of scenarios related to the probability of these changes occurring and their potential magnitude; an estimation of future trends in passenger flows. The methodology is applied to the Metropolitan area of Thessaloniki, Greece. Using data obtained from development plans, national statistical services and research projects' and studies' findings, we estimate future trip-generation subsequent to land use change. Data is processed and evaluated by a local experts' group, representing various key-disciplines of the area's planning stakeholders.

A LAND-USE APPROACH FOR CAPTURING FUTURE TRIP GENERATING POLES

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TeMA

有关土地使用、交通和环境的杂志

ABSTRACT

特定城市或地区性区域用途的改变（如在城市中建设新的多模式终端或在市郊创建商务园区）会立即对交通产生影响。但在希腊全国层面，人们对它们之间的关联到目前为止并未进行充分研究。因此，在规划层面低估了土地利用改变对出行生成和乘客流量产生的影响，导致实施了既不可行又不可持续的项目。本文认为，在规划阶段，考虑土地利用的变化时，应与交通相关的变化一起进行考虑。为此，我们提出用一个包含三步的综合方法来捕捉未来的出行生成：在研究区域内识别未来的出行生成极；创建与出现变化的概率及其潜在的量级有关的情景；估计乘客流量的未来趋势。这个方法应用于希腊塞萨洛尼基的大城市区域。通过利用从开发计划、国家统计机构以及研究项目结果和学习结果中获得的数据，我们在土地利用变化之后对未来的出行生成进行估计。数据的处理和评估由代表该地区规划利益相关者各主要学科的一个本地专家组进行。

用土地利用的方法
找到未来出行生成极

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1   INTRODUCTION

Land use and transportation are two core factors whose interaction is directly linked to sustainability of modern cities (Wegener, 2004). According to the European Environment Agency (EEA, 2010) one of the goals to make urban environment more sustainable is to ensure equal access to resources and services and thus enhance accessibility that is the general measurement of spatial separation of human activities (Morris et al., 1979). Concerning passenger transport, accessibility is the degree to which land use and transport systems enable people to reach specific activities or destinations (Litman, 2003; Geurs and van Wee 2004a). Apart from transport and land use components, Geurs and van Wee (2004a) identify temporal constraints (availability of opportunities at different times of the day etc.) and individuals' characteristics as the four components that affect accessibility.

Enhanced accessibility is a key element that affects trip generation and distribution. However, travel behavior is equally affected by other socio-economic (price of travel, income level of household) and socio-demographic (gender, age, education level) factors as well as land use and urban design characteristics (Boarnet and Crane, 2001). Cervero (1998) estimate trip frequency based on socio-demographic, land use and street connectivity variables. Socioeconomic changes directly affect the number of trips conducted within an area according to Preston (2001). To an extent, this number is determined by factors such as area population and population density (Boarnet and Crane, 2001; Levinson, 1976). Other socioeconomic changes include income, vehicle ownership and employment status (Koppelman and Pas, 1984).

These changes account for increased/decreased mobility within an area and therefore influence the total number (and purpose) of trips conducted. Van Wee (2002) indicates that density, land use mix, neighborhood design and distance to public transport connections are the main land use characteristics that affect travel behavior. Cervero (1996) concludes that neighborhood design and land use mix influence at various degrees motorized and non-motorized commuting mode choice.

The same author studied the influence of neighborhood on mode choice for non-motorized trips and identified that land use mix can improve urban mobility through reducing motorized traffic, encourage car sharing and promote shared-use parking schemes (Cervero and Radisch, 1996). Based on each land use (either existing or future), different trip generation rates are produced, and therefore an analysis of such changes is necessary. It becomes obvious that trip generation is directly affected by land use in a complicated way.

The interest in the interaction of land use and transport has risen since the mid-60s, when it was established that land use inventories, future land use demand and land use plans along with socio-economic indicators (employment, population forecasts, etc.) are an integral part of the transportation planning process (Schlager, 1965). During the same period, Schlager identified the forecasting of population and employment as the first function of any planning sequence (including that of transportation), succeeded by the determination of future land use changes.

By then it was already evident that the advent of mechanized transport means, had and would continue to significantly shape the way space is structured. Had it not been for the revolutionary change transport mechanization brought to travel speed, the effects on land use and land cover would not have been correspondingly large (Webster's and Paulley, 1990). Understanding the nature of this bidirectional link, where changes in any transportation-related aspect (extending from transport mode based technological advances to car-ownership rates) are responded by land use, and vice-versa, is thus central if policies of either discipline are to be reliably predicted.

The impacts of land use and transport planning on transport demand can be estimated through three distinct methods (Wegener, 2004): by asking people regarding their travel behavior in relation to alternation in certain factors; by observing the transport decisions of travelers under different conditions and by simulating human decision making through models. A number of mathematical models exists that try to

identify the effects of land use on transport at both aggregate and disaggregate levels using well-established methodologies. However, there is no established representation of the converse relationship (Mackett, 1993).

Geurs and van Wee (2004b) identified the framework for Sustainability Impact Assessment by reviewing various operational land-use/transport interaction models based on land use, transport, accessibility, economic, environmental and social impacts definition (Geurs and van Wee, 2004b). Advances in mathematics support progress in modelling land use and transport interaction. However, a widely applied general model for addressing properly the issue does not exist (Wilson, 1998).

Badoe and Miller (2000) purport that the main reason for this methodological weakness is the existence of gaps in our understanding of the interaction. The main drawbacks of the current models include according to Hunt et al. (2005): excessive spatial aggregation, excessive reliance on static equilibrium assumptions (with associated assumptions of large time steps and lack of path dependencies), overly aggregate representations of households and firms, as well as a lack of representation of individuals as decision-making units separable from their households, lack of endogenous demographic processes, lack of endogenous car ownership processes and reliance on four-stage travel demand modelling methods.

Taking into account that trip generation is a decisive parameter for all planning activities related to future investments and policy interventions on a national, regional and urban level, as the literature suggests, it is a field where authorities often use forecast and estimates (Gordon, 1994; Giuliano and Hanson, 2004). Trip generation is therefore an issue whose thorough and detailed investigation can justify efforts towards a certain direction or predict the future sustainability of a project (Ortuzar and Willumsen, 2001). Moreover, it is a crucial element of land-use development, as the identification of future demand for travel can help determine whether a planning measure ought to be implemented in a certain location. It can also serve to prioritize measures in order of significance, so as to provide planners and stakeholders with guidance through selected measures when planning, but also while implementing those measures.

In the current study, an effort has been made towards the capturing of trip generation through methodological framework of land-use approach. More specifically, future trends in passenger flows are estimated through the identification of existing and potential trip generating poles and the development of various future scenarios. The proposed methodology manages to relate land use changes in tandem with transport-related changes at the planning stage. In the next parts, the proposed methodological approach is being elaborated. Then, the methodology is being applied in the Metropolitan area of Thessaloniki, Greece resulting in useful outcomes.

2 METHODOLOGICAL APPROACH

The basic rationale for the development of the methodology, depicted in Figure 1, is the combination of various parameters and sectors related with trip generation (either directly or indirectly), such as land use, transport planning and economy. These sectors act as sources of information that thoroughly map the existing situation and any change in the latter will provide a detailed insight on future trends in passenger flows. The methodology consists of three steps, which are discussed in detail in the following sections.
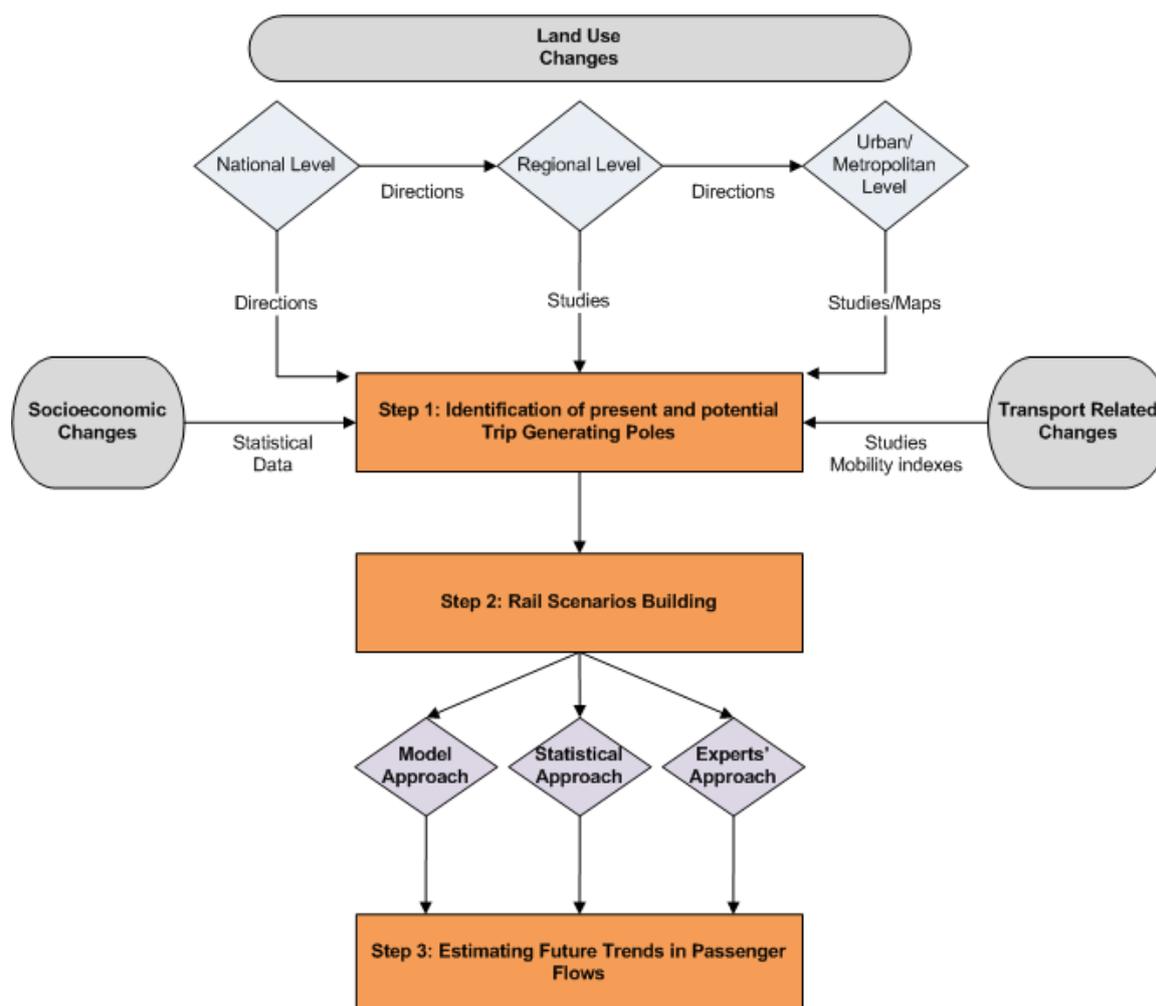
Fig. 1 Proposed methodology for identifying trip-generating poles and estimating future trends in passenger flows

2.1 STEP1 - IDENTIFYING EXISTING AND POTENTIAL TRIP GENERATING POLES

The first step of the methodology deals with the identification of present and potential trip-generating poles. As depicted in Figure 1, the following areas are directly associated with trip generation:

– Land-use changes;

– Socioeconomic changes;

– Transport related changes.

2.1.1 LAND-USE CHANGES

In order to accurately estimate future trends in passenger flows, it is important to map land uses, whose change directly influences the number of trips conducted within an area.

According to the Institution of Transport Engineers (ITE, 1976), land uses related to business, industry, education, health and leisure account for the highest trip generation rates in urban environments. Moreover, it is important to define the magnitude of each land use change in spatial terms (international, national, regional, and urban/metropolitan).

Land use changes are often included in national, regional and urban development plans of each country, depending on the population and extent of the area they refer to (Figure 2). Such plans include national development plans (e.g. General Plans for Spatial planning and Sustainable development (GPSPSD), Special Plans for Spatial planning and Sustainable Development (SPSPSD)), which provide guidelines and determine

strategic directions of planning on a national level. General plans concern a wide variety of sectors and refer to a target year, in which the desired change/measure is planned to be implemented (approximately a period of 15-20 years since the development of the plan). Special Plans are dedicated to specific sectors and the respective changes therein (business, tourism, aqua/agriculture, renewable energy sources). On a national level, regarding sectorial planning and development, National Operational Plans are also conducted, including sectors such as transport, environment, energy, telematics and tourism.
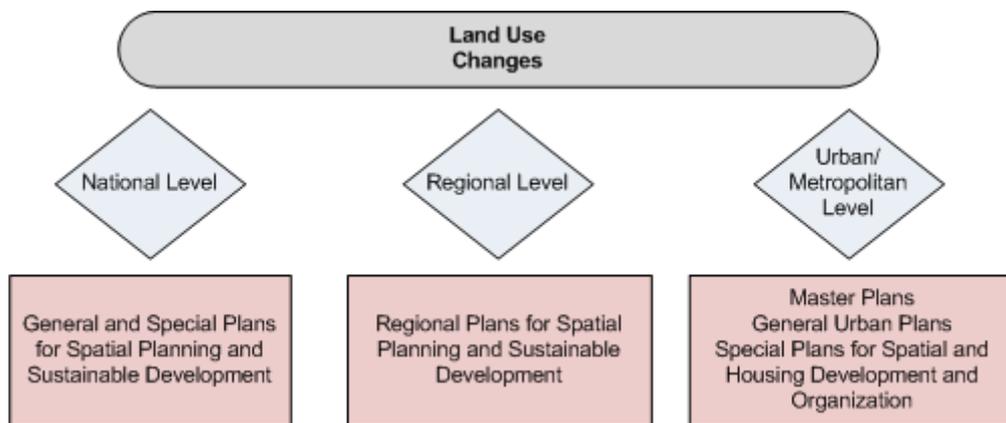
Fig.2 Identification of Land use changes at various levels

Such plans also include regional development plans (Regional Plan for Spatial Planning and Sustainable Development (RPSPSD)), which contain specifications of the General plans at regional level and provide analyses of the current situation and proposals concerning urban organization, land use definition and transport infrastructure. Also at regional level, Operational Plans are conducted, concerning geographic regions not always in compliance with administrative region boundaries.

Finally, urban/metropolitan development plans also contain information on land use changes (Master Plans (MP), General Urban Plan (GUP) and Operational Plans of each municipality). In detail, Master Plans provide general guidelines concerning metropolitan areas while General Urban Plans provide analyses of the current situation and direct suggestions concerning house organization, transport infrastructure and land uses. Regarding the lowest planning level, municipalities lay out the strategy, developmental vision and specific actions and measures, as well as funding sources, through operational plans.

2.1.2   SOCIOECONOMIC CHANGES

Figure 3 summarizes various socioeconomic characteristics whose change would significantly influence future flows of passengers.
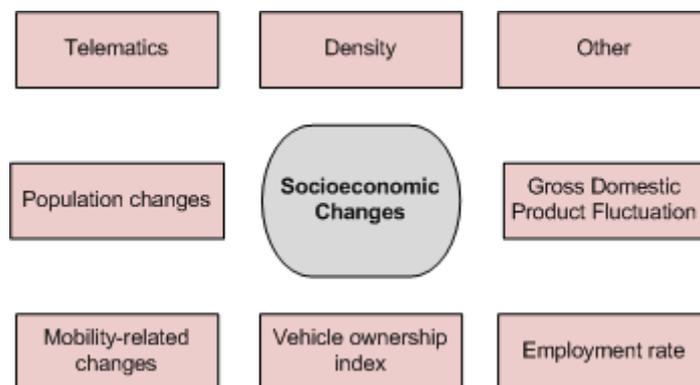
Fig. 3 Identification of socioeconomic changes

Data regarding socioeconomic characteristics of areas and regions are often found within national statistical services or in specific surveys, statistical institutes and intergovernmental organizations (ELSTAT, 2014). These services include detailed, yet often not analyzed, data on potential trip-generating parameters such as population, vehicle ownership, changing density in certain areas, and employment. Studies at regional and urban level, often financed through national funds, may also contain similar data. In addition, certain data concerning the demography of areas and regions are often contained (in numerical form) in the Development Plans identified above, as well as in Operational Plans conducted by each municipality. Operational plans contain analyzed demographic characteristics both at regional and urban/metropolitan level and provide further data concerning fields of employment, business and population changes.

3.1.3   TRANSPORT RELATED CHANGES

Transport-related changes concerning the implementation of new infrastructure or the modification of existing ones (e.g. turning a railway station in a multimodal hub), the introduction of new transport services or lines and connections (both for public and private transport), are directly associated with generation of trips and are depicted in Figure 4.
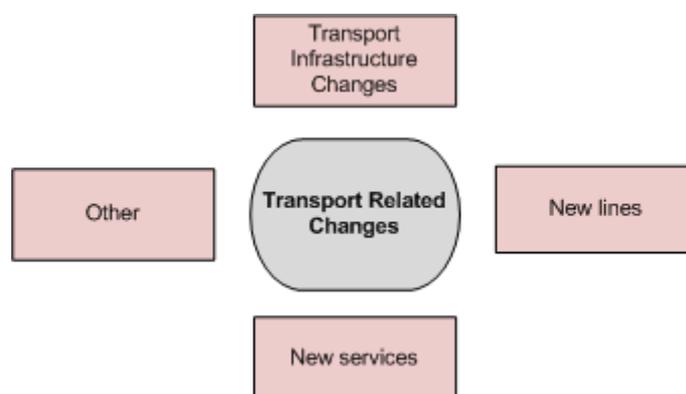
Fig. 4 Identification of transport related changes

Development plans described in previous sections are not limited to reporting on land use changes, future planning directions or residential developments, but also contain information related to transport issues. As all of the above poles are correlated rather than being isolated from one another, similar sources may be drawn upon to identify trip-generating poles.

3.2   STEP 2 - SCENARIOS DEVELOPMENT

As it is rather unrealistic to assume that all actions and measures described in development plans or studies will be implemented in the future, scenarios can be developed based on the probability that certain changes might be realized or not. This probability can be assessed by relevant experts (Hsu, 2007) who can evaluate the changes identified in Step 1 and decide on the probability of a change being implemented based on various factors, such as:

─   Support in the planned change by the private sector;

─   Accomplished legal procedure for the implementation of the change;

─   Size of change;

─   Political and societal support in favor of the change.

In addition, the significance of these changes should also be taken into consideration, as some changes are more important than others are, and should thus be examined separately. In that sense, it is proposed that developed scenarios describing the changes identified in Step 1 are classified based on a probability-

significance index into 3 classes as depicted in Figure 5. The development of the probability-significance index can be an output of experts' opinions or can be stated within Development Plans as priorities for each change.
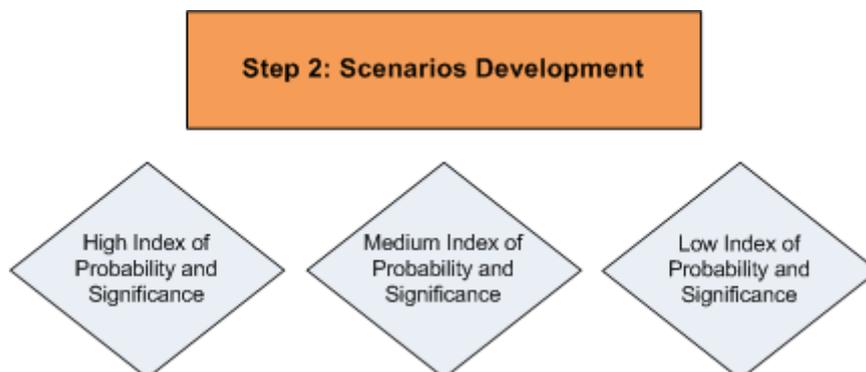
Fig. 5 Scenarios classification based on Probability-Significance Index

Another important aspect that has to be taken into consideration is the target year these scenarios refer to, in order to assure a common approach for the final evaluation.

3.3 STEP 3 - ESTIMATING FUTURE TRENDS IN PASSENGER FLOWS

The issue of quantifying future trends in passenger flows, based on trip generating poles identified at the previous step, is rather challenging and demanding. Data are not often available, or when available, not in a format easily quantifiable. Figure 6 summarizes several approaches for estimating future trends in passenger flows.
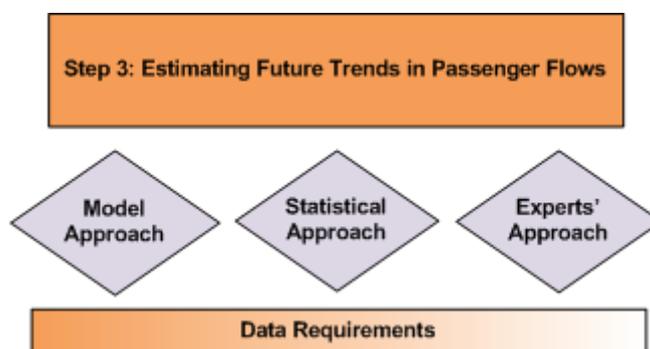
Fig. 6 Approaches for estimating future trends in passenger flows

Models able to integrate land use data (e.g. extent of area, number of places of employment), transport-related data (e.g. trips per citizen according to age) and socioeconomic data (e.g. income per citizen) can be used in this step to quantify future passenger flows. Models have the advantage of being able to accurately predict future trends in passenger flows, by taking into account several parameters. However, data requirements are significantly high, rendering the process difficult and labor-intensive. Alternatively, a statistical approach can be followed. Such an approach involves exploiting data (to the extent that they are available) and estimating future passenger flows based on general assumptions that reveal overarching trends. For instance, based on income change, population change and vehicle ownership, a future trend can be deduced, revealing the tendencies of a particular region in these areas. Therefore, future trends can be calculated by taking into account the particular identity of the region. Finally, experts from various related sectors, such as business, academia, research, public authorities, can be recruited in order to assess

available information (for instance a city's planning direction towards becoming an industrial area) and estimate passenger flows in a percentage format, indicating future changes (e.g. +5%).

4   AN APPLICATION

In order to assess the applicability of the proposed methodology, a case study is presented under this section.

4.1   THE CASE OF THESSALONIKI, GREECE

Thessaloniki is the second largest city in Greece, currently accommodating 1.006.730 citizens in its metropolitan area. Situated in Northern Greece, Thessaloniki covers a total of 1.455,68 km2 with an average density of 16.703 inhabitants per km2 (Stamos et al., 2012). Due to its geographical location, Thessaloniki plays an important social, financial, and commercial role in the national and greater Balkan region, in part because of the development of a transportation hub within the city's limits. According to the General Statistical Secretariat, the total number of vehicles in the city exceeds 777.544, including private cars, heavy vehicles and motorcycles, while approx. 1,8M trips are conducted in the city on a daily basis (Politis et al., 2012; Stamos et al., 2013; Mitsakis at al., 2013). Figure 7 depicts the municipalities of the Metropolitan area of Thessaloniki that are examined herein.
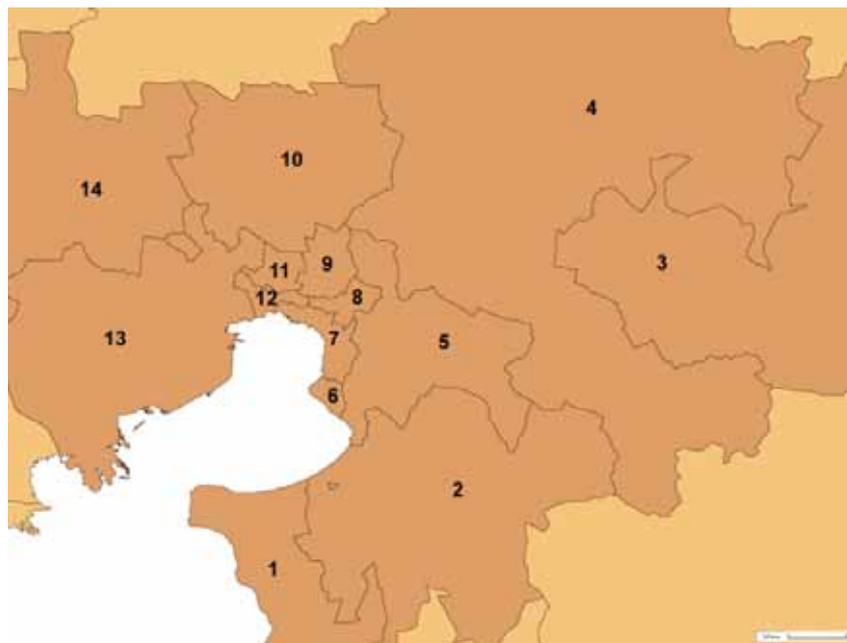
Fig. 7 Municipalities within Thessaloniki prefecture (scale refers to 10km)

4.2   MAPPING OF TRIP GENERATING POLES

4.2.1   LAND-USE CHANGES FOR MUNICIPALITIES

With regard to the metropolitan area of the city, the Master Plan (MP) suggests the conservation of the industrial area and the reinforcement of competiveness among the industries and smaller craft businesses. Furthermore, a sound allocation of scattered industries throughout Thessaloniki's metropolitan area is advocated in order to minimize negative impacts to the urban environment. The MP also suggests the promotion of research and innovation and the utilization of natural resources, historical environments and business activities in order to create and promote new forms of tourism within the area (City of Thessaloniki,

2009). Besides the MP, which is generally considered as a guideline for strategic development, specialized General Urban Plans (GUP) have been developed for each municipality included in Thessaloniki's Greater Area. The GUPs conducted for the municipalities suggest the development of business centers, such as malls, in the western part of the city and the organization of an industrial area, again in western Thessaloniki.

In addition, a concentrated allocation of business hosts in the western part of the metropolitan area is suggested, e.g. of universities and technological institutes. Furthermore, the development of health-related units in the western part of Thessaloniki is recommended in order to provide all citizens with equitable access to health services, which are currently concentrated in the Eastern part of the metropolitan area of Thessaloniki. In order to provide citizens with proper athletic facilities, the GUP suggests the development of athletic cores in specific urban centers within the region. Finally, regarding the touristic development of the metropolitan area, the promotion of special forms of tourism such as agro-tourism and spa-tourism are proposed and allocated circumferentially in the greater region. Table 1 summarizes the most characteristic land use changes for municipalities within the hub of Thessaloniki.

NAME	CHANGE	SECTOR	TARGET YEAR	SOURCE	PROBABILITY	MAGNITUDE
Greater Thessaloniki area	Conservation and organization of industrial area and reinforcement of competiveness of industries and smaller craft businesses	Industry	2022	MP	H	Regional
Greater Thessaloniki area	Consolidation of scattered industries	Industry	2022	MP	L	Local
Greater Thessaloniki area	Research infrastructure development	Business	2022	MP	L	Regional
Delta	Displacement of Thessaloniki's international fair to the western part of the agglomeration	Business	2022	MP	H	Local
Lagkada	Promotion of spa-tourism infrastructure	Tourism	2022	MP	H	Regional
Pylaia	Creation of hospitals exclusively related to oncology	Health	2022	GUP	L	International
Thermaikos	Creation and organization of an area concerning fish products	Business	2022	MP	L	Regional
Lagkada	Creation of new veterinary university in the eastern part of the agglomeration	Education	2022	GUP	L	International

Pylaia	Creation of new Polytechnic university in the northern part of the agglomeration	Education	2022	GUP	L	International
Thermi	Creation of new geologic university in the eastern part of the agglomeration	Education	2022	GUP	L	International
Ampelokipoi-Menemeni	Creation of a business park in Laxanokipoi area	Business	2022	GUP	H	Regional
Eastern Thessaloniki area	Development of commercial center	Business	2022	MP	M	Regional
Thermi	Organization of an innovation business zone	Business	2022	MP	L	Regional
Delta	Promotion of sports tourism and agro-tourism	Tourism	2022	MP	H	Regional
Western Thessaloniki area	Development of commercial center	Business	2022	MP	M	Regional

Table 1 Land use changes for municipalities within the hub of Thessaloniki

4.2.2 SOCIOECONOMIC CHANGES FOR MUNICIPALITIES WITHIN THE HUB OF THESSALONIKI

Information and data described herein are obtained from a research project recently conducted for Thessaloniki's agglomeration (Morfoulaki et al., 2011). The project aimed to provide a suite of services for travelers, in order to assist them in everyday mobility-related decisions by providing real-time mobility-related and environmental conditions information, optimal route planning based on traveler-defined criteria (fastest, shortest, cost efficient and environmentally friendly routing), public transport information and routing services, ride sharing and user awareness tools.

In the framework of this project, 5.000 household phone surveys and Road Side Surveys (RSS) at 40 locations with 33.000 participants were executed between October and November 2010. Based on the surveys, the average number of persons in a household is estimated at 3,03 and the respective average of driving license holders per household at 1,75. Additionally, 58% of all citizens hold a driving license and 71% of the population owns at least one private car (Mitsakis et al., 2013).

The average number of trips per person is 2,08. About 89% of the survey participants stated that they usually execute up to two trips per day: one trip for various purposes (work, education, leisure, etc.) and one trip for returning home. Among various trip purposes, 47,6% of the trips are conducted for work and 26,8% for leisure. The percentages for shopping, education and other purposes are 12,9%, 5,8% and 6,8% respectively (Mitsakis et al., 2013).

The modal split analysis reveals that the majority of trips is conducted with private vehicles (67% private cars, 4% motorcycles and 4% taxis), while 23% is conducted with public transport (PT) and 2% with non-motorized modes of transport (NMT). Based on the RSS results, the average vehicle occupancy is 1,44. 65% are single occupancy vehicles, while 28% and 6% of the vehicles travel with 2 and 3 passengers respectively. Concerning the vehicle type distribution, this is estimated as follows: 77% private vehicles, 5%

motorcycles, 2% taxis, 11% vans and 5% trucks. The total travel demand for a typical weekday is estimated in the range of 1.300.000 vehicle trips. On a daily average, the city center attracts a total of 11,5% of all trips (Mitsakis et al., 2013).

4.2.3 TRANSPORT RELATED CHANGES FOR MUNICIPALITIES WITHIN THE HUB OF THESSALONIKI

As mentioned above, transport-related changes concern the implementation or modification of transport infrastructure and the introduction of transport lines and services. Regarding transport infrastructure-related changes, the MP for the city of Thessaloniki proposes the overall reinforcement of the role of public transport in high-density areas so as to provide equitable access to all citizens.

The promotion of multimodality is a crucial part of future transport planning in Thessaloniki, in order to increase the effectiveness of public transport and address passenger safety issues. Additionally, the MP provides directions concerning the organization of municipal mobility centers in order to control traffic and minimize congestion at a local level. The upgrade of Thessaloniki's airport and harbor is also included, as well as the upgrade of the rail and bus station into regional transport stations. Table 2 summarizes the most characteristic transport-related changes planned for municipalities within the hub of Thessaloniki.

4.3 SCENARIOS DEVELOPMENT

At this step, changes that are both highly probable and of regional to international magnitude are isolated, so that they can be handed over to experts for assessment (Table 3).

NAME	CHANGE	TARGET YEAR	SOURCE	PROBA BILITY	MAGNITUDE
Thessaloniki	Reinforcement of the role of public transports	2022	MP	H	Local
Thessaloniki	Equitable access for all citizens, throughout networks and public infrastructure, and formation of a fair pricing system	2022	MP	H	Local
Thessaloniki	Promotion of multimodality in transports in order to increase effectiveness and safety	2022	MP	M	Local
Thessaloniki	Reinforcement of Thessaloniki's role as an international node of freight transport	2022	MP	M	International
Thessaloniki	Development of public transport consistency in order to provide service in high density areas	2022	MP	H	Local
Thessaloniki	Organization of Municipal mobility centers	2022	MP	M	Metropolitan
Thermi	Upgrade of International Airport of Thessaloniki "Macedonia" into an international node of passenger transport	2022	MP	H	International
Thessaloniki	Upgrade of International harbor of Thessaloniki and functional	2022	MP	M	International

	unification with the urban environment of Thessaloniki				
Thessaloniki	Upgrade of passenger rail station into regional centers	2022	MP	M	Regional
Ampelokipoi-Menemeni	Upgrade of passenger bus station into regional centers	2022	MP	M	Regional
Thessaloniki	Creation of a united system for bike transport in order to help decongest the transport network and promote sustainable mobility	2022	MP	H	Metropolitan
Thessaloniki	Railway connection throughout the region	2022	GUP	M	Metropolitan
Thermaikos	Improvement of Michaniona's harbor and connection with Pieria	2022	GUP	M	Regional
Ampelokipoi-Menemeni	Creation of terminal subway stations in western Thessaloniki	2022	GUP	L	Metropolitan
Kalamaria	Creation of terminal subway station	2022	GUP	L	Metropolitan
Thermaikos	Creation of terminal subway stations in the airport area	2022	GUP	L	Metropolitan

Table 2 Transport infrastructure changes for municipalities within the hub of Thessaloniki

NAME	CHANGE	SECTOR	TARGET YEAR	PROBABILITY	MAGNITUDE
Metropolitan area of Thessaloniki	Conservation and organization of industrial area and reinforcement of competiveness of industries and smaller craft businesses	Industry	2022	H	Regional
Delta	Displacement of Thessaloniki's international fair to the western part of the agglomeration	Business	2022	H	International
Lagkada	Promotion of spa-tourism infrastructure	Tourism	2022	H	Regional/International
Pylaia	Creation of hospitals exclusively related to oncology	Health	2022	H	International
Ampelokipoi-Menemeni	Creation of a business park in Laxanokipoi area	Business	2022	H	Regional
Eastern Thessaloniki area	Development of commercial center	Business	2022	M	Regional/International
Delta	Promotion of sports tourism and agro-tourism	Tourism	2022	H	Regional/International

Western Thessaloniki area	Development of commercial center	Business	2022	M	Regional/Intern ational
Thessaloniki	Reinforcement of Thessaloniki's role as an international node of freight transport	TI/Freigh t	2022	M	International
Thessaloniki	Organization of Municipal mobility centers	TI	2022	M	Metropolitan
Thermi	Upgrade of International Airport of Thessaloniki "Macedonia" into an international node of passenger transport	TI/Air	2022	H	International
Thessaloniki	Upgrade of International harbor of Thessaloniki and functional unification with the urban environment of Thessaloniki	TI/Marine	2022	M	International
Thessaloniki	Upgrade of passenger rail station into regional center	TI/Rail	2022	M	Regional
Ampelokipoi-Menemeni	Upgrade of passenger bus station into regional center	TI/Bus	2022	M	Regional
Thessaloniki	Creation of a united system for bike transport in order to help decongest the transport network and promote sustainable mobility	TI/Bike	2022	H	Metropolitan
Thessaloniki	Railway connection throughout the region	Ti/Rail	2022	M	Metropolitan
Thermaikos	Improvement of Michaniona's harbor and connection with Pieria	TI/Marine	2022	M	Regional

Table 3 Medium and highly probable changes in the hub of Thessaloniki

4.4 ANALYSIS OF TRIP GENERATING POLES – TREND ESTIMATIONS

In order to estimate future trends in passenger flows, the experts' approach described above has been used for the hub of Thessaloniki and a DELPHI approach has been adopted (Hsu, 2007). Experts were asked to assess present and future trip generating poles scenarios, based on the current status of the metropolitan area of Thessaloniki and the proposed/planned future developments.

The experts' group consisted of 4 transport engineers (freelancers), 2 researchers (employed at Hellenic Institute of Transport), 4 research associates (employed at the Hellenic Institute of Transport), 3 university professors (Aristotle University of Thessaloniki) and 2 municipal employees (civil servants) dealing with transport planning at urban level.

The experts had the following input at their disposal, in order to estimate a future passenger flow percentage change:

- Scenarios of future changes based on the probability and magnitude of each identified change;
- Numeric changes in land use, socioeconomic and transport-related changes for the hub of Thessaloniki;
- Number of trips currently conducted within the hub of Thessaloniki;
- Number of trips currently originating from outer zones and destined to the hub of Thessaloniki;
- Purpose of trips (home-based trips, work, leisure, education, other);
- Trip generation rates from previously existing traffic studies for the hub of Thessaloniki.

At the first stage of their assessment, experts estimated the percentage change from current to future number of passenger flow individually. At the second stage, results were gathered and disseminated to the group. Experts then reexamined their results, taking into consideration the ongoing economic crisis as well as other related socioeconomic conditions.

The provided scenarios of future changes in land use and transportation can be grouped in two general categories, the one being the development of new infrastructure and therefore the creation of new land uses and the other being the reinforcement or upgrade of existing land uses.

The lowest percentage change in future passenger flows according to experts will be +6% and the highest percentage change will be +9%. Moreover, the analysis revealed that in case of new infrastructure the trip generation will focus on motorized traffic. The percentage of private transport or use of public transport is highly correlated to the level of service the new land uses are expected to have as regards public transport coverage.

On the other hand, according to the respondents, upgrade of existing infrastructure can lead to generating more non-motorized traffic (cycling, walking) than motorized taking into account that the existing land uses are part of a mix land use subsystem that enhances non-motorized trips. This fact is in line with results from various other studies that elaborate on the advantages of mix land use (Cervero, 1996) and on the results from regression models (Boarnet and Crane, 2001).

5 CONCLUSIONS

This paper addresses the need to consider land use change and transportation in tandem in relation to trip generation. Land use and transportation are two intimately interdependent sectors that affect accessibility and ultimately travel behavior. Apart from accessibility, travel behavior is also affected by various other factors most of which are related to socioeconomic and socio-demographic criteria.

These criteria play an important role when it comes to identifying the impacts of land use and transport planning on transport demand. Various studies have tried to determine these impacts by developing methodologies in order to identify travelers' behavior either through questionnaire surveys or by simulating human decision making through models. However, current studies have so far been incomplete and underdeveloped especially for Greece where transport planning and land use development are two separate non-correlated processes.

Our suggestion here includes a three-step methodology that integrates the two sectors and allows planners to develop more efficient land use and transportation policies.

Through this methodology various scenarios are developed based on estimates for future changes in social, economic and demographic sectors as well as on proposals and strategic planning of areas and regions regarding future development of transportation and land use.

The results of the methodology's implementation in the case of Thessaloniki Prefecture reveals that the creation of new trip generating poles and the increase of trips' generation and distribution go hand in hand with the type of land use development and modifications as well as changes in provided transport services of an area. The estimated impacts can be determinant factors for decision making on urban or regional future

development. Therefore, the methodology laid out in this paper can be used as an evaluation tool that can help the strategic planning of future actions, measures and projects.

Our contribution undoubtedly constitutes a first step in the direction of integrated decision making at the planning process regarding land use and transportation. Nonetheless, additional research is needed in order to succeed in developing an accurate assessment of the complex interactions between land use change and transportation.

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TOURISM AND MOBILITY

BEST PRACTICES AND CONDITIONS TO IMPROVE URBAN LIVABILITY

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ABSTRACT

This paper considers the relation between tourism and mobility and tries to highlight how tourism can act as a driving urban function in order to promote more sustainable lifestyles. Tourism and mobility are strictly connected: the moving from the usual residential place for leisure or entertainment represents the essential condition of tourism. There is no tourism without physical displacements, as the WTO definition affirms, highlighting that the movement of people is connected to two different mobility forms. On one hand, the tourist displacement is generated by the need to reach the destination (transit/access mobility). On the other hand, flows are generated by tourist activities at destination (visit, stay, entertainment, etc.) and it could be defined as an internal mobility. In both case, tourism represents a factor of human and environmental pressure. The WTO (2012) estimates that tourism mobility is responsible for 5% of CO_2 emissions (referred to air travel) and points out that a change in the styles of tourism consumption is necessary also to meet the challenges of climate change that present cities must face. Traditionally, tourism and transport have been considered separately and mobility has been seen as a prerequisite rather than an integral part of the tourist activity; rarely this connection has been investigated in tourist planning and in mobility planning. The movements of visitors had a marginal role before the acknowledgment of the sustainable mobility paradigm, which introduced the concept of efficiency in transport system connected to the reduction of the environmental and social impacts encouraging modal shift in order to contrast the car-dependence. In the context of these considerations, this article tries to underline how tourism could play a strategic role in promoting sustainable way of moving inside the city if it will be mainstreamed within the government process of urban transformation. As a "pervasive" urban activity, tourism involves different sectors (public and private) and different social levels and it can act as an "accelerator of changing" to improve a new mobility culture and to change users behaviors. Which are the conditions needed to activate this change? This is the main question this paper tries to answer also considering some significant examples oriented to integrate tourism promotion with mobility planning.

KEYWORDS:

tourism-mobility integration, urban livability, urban transformation

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旅游业与移动性：
改善城市宜居性的最佳实践和计划

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ABSTRACT

本文研究的是旅游业与与移动性之间的关系，并尝试突出旅游业能成为一种可以推动更可持续生活方式的强劲的城市智能。旅游业是当今城市经济中的一个重要组成部分，同时也是人类和环境压力的一个因素。世界旅游组织（UNWTO2012）预测，旅游业占到了5%的二氧化碳排放（涉及航空旅行）。该组织还警告，为了应对现代城市必须面对的气候变化挑战，需要改变旅游业的消费方式。考虑到旅游业的增长趋势（预计到2030年会有18亿国际游客，UNWTO 2014），需要制定有效的缓解措施。在这些缓解努力中，技术进步是一个重要的工具，但它单靠自己无法解决气候变化问题。因此，为了有效地化解运输部门面临的压力，需要采取混合措施，包括技术改进、监管和基于市场的措施以及行为改变。技术创新（产品和流程）的贡献是非常重要的，但为了真正起作用，它必须整合到城市转型的治理过程中。旅游业需求中出现的变化（可理解为城市用户特殊需求类型的一种表达）的确表明，人们正日益关注旅游业消费。而且与这些变化相对应，那些旨在增加城市对游客吸引力的城市政策也日益以创新服务的定义为导向，以此支持和促进城市旅游业。这其中就包括推动将旅行方式转变为使用汽车（可持续移动性），并成为城市竞争力的一个战略要素。基于这些考虑，本文将提议分析一些旨在将旅游业与移动性整合作为城市系统新成就的最佳实践。

1   TOURISM AND MOBILITY INTERACTION

"Tourism is a social, cultural and economic phenomenon, which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes. These people are called visitors (which may be either tourists or excursionists; residents or non-residents) and tourism has to do with their activities, some of which imply tourism expenditure". The definition is by the World Tourism Organization (UNWTO/OMT), the main international institution of the United Nations system aimed at spreading sustainable tourism development particularly in developing countries.

In the context of the scientific literature, tourism represents the set of movements generated by the search for places and activities that are different from usual and have no economic motivation (Miossec 1976, Page 2003, Cohen 2004). In this definition, tourism depends on the coexistence of at least three conditions: 1) a displacement from the residence place to a different one; 2) an overnight stay (twenty-four hour minimum to be considered as a tourist); 3) a motivation that is different from work that activates the displacement. Origin, duration and motivation of the move are the variables for which tourism is defined and classified. Such a definition underlines that mobility is essential to tourism.

Whatever the definition, or the distinction among typologies of tourism, it is undeniable that there is a close connection between tourism and transport. The growth and evolution of tourism has been intrinsically connected to the development of the transport system: it is known that railways and then the airplane decisively contributed to its growth and diffusion as a "mass" phenomenon, in a relatively short time. The importance of transport is then decisive in the planning phase of tourist activities, accessibility having a strong influence on the choice of a destination and, in this sense, it can constitute a competitive factor. This is only one aspect of tourist mobility (external component). The second aspect concerns the displacements to visit the chosen destination. Both types of displacement are characterized by a high concentration of space-time affecting the operation and organization of the urban system concerned.

Page (2005) refers to a "tourist transport system" which is a complex system combining the physical movement of visitors using one or more forms of transport (the logistical component) and the travel experience (the experiential component). Both components of the tourist transport system demonstrate the system's unavoidable environmental, economic and social impacts.

Tourism, in fact, despite having a role in the economy is also a catalyst for negative impacts on the environment (emissions of pollutants due to the increasing volume of traffic; increased waste; noise; consumption of primary resources; etc.) and more generally on urban livability (quality of services, social integration, well-being and safety of the resident population).

The balance between economic development and environmental protection is the main challenge that the cities that decided to invest in tourist activity, maybe more than any other, are called upon to face.

The European commitment to achieving sustainability objectives, including the development of tourism, has led to the production of documents and codes of conduct aimed at supporting both the realization of integrated public policies (convergence of goals between different stakeholders) and raising awareness of tourists (compared to the needs of local communities; reduce consumption; navigation optimization , etc.). One of the priorities consists in reducing the CO2 emissions generated by tourist mobility in Europe (Tourism Sustainability Group final report "action for more sustainable European tourism").

In the report Climate Change and Tourism: Responding to Global Challenges[1], international and domestic tourism, from transport and accommodation are estimated to represent between 4.0% and 6.0% of global emissions (fig. 1).

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[1]   The report was presented in the context of the Second International Conference on Climate Change and Tourism, in Davos, on October 2007. It highlighted the vulnerability of the sector to climate change and the impacts of tourism on climate itself. It underscored the need to develop the tourism sector in a sustainable manner in order to mitigate greenhouse gas emissions firstly deriving from transports and accommodations.

|	CO₂ (Mt)
Air transport	517
Other transport	468
Accommodation	274
Activities	45
TOTAL	1,307
Total world [1]	26,400
Share (%)	4.95
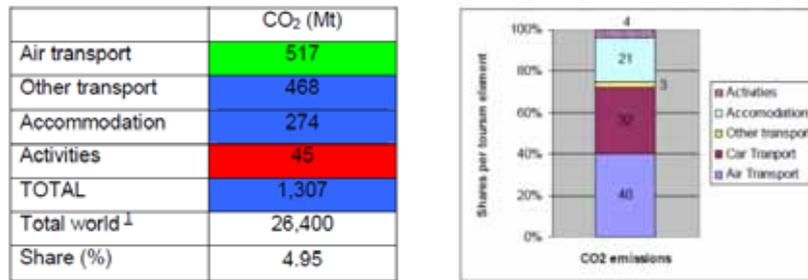
Fig. 1 Emissions from tourism and contribution of various tourism sectors to CO2 emissions. In the left table, the color of each grid cell represents the degree of certainty with respect to the data and underlying assumptions. Green represents a degree of uncertainty of +/10%, blue +/25% and red +100%/50% (Source: Report on Climate Change and Tourism: Responding to Global Challenges, 2007)

In Italy, tourist mobility is largely characterized by the dominance of car use and by a trend of cities as a preferred destination. At present, indeed, cities have become one of the preferred tourist destinations (Page and Hall, 2003) generating a new form of tourism that can be defined as urban tourism2. The presence of cities in the "tourist experience" shows the change that has been increasingly affecting tourist demand. Indeed cities have become the "object of tourist desire" as they are the place where more experiences can be lived contemporarily and they represent a perfect destination for a short holiday.

The need, therefore, to provide infrastructure and services aimed at encouraging forms and modalities of tourist transport more compatible with the demands of sustainability (environmental, social, economic) becomes a priority to make cities livable. Complicated and a long term issues, if we consider that the realization of these objectives (as well as an indispensable collaboration between different stakeholders, public and private, involved in the planning, promotion and management of tourism) requires also a substantial behavioral change by the user.

As regards Italy, the relationship between public entities responsible for managing tourist flows and private operators is often confrontational. Coordination between the different skills, instead, it would be necessary for the creation of an integrated tourism system. The supply and quality of services for tourist activity plays a significant role and affects mainly the degree of attraction of a city making it more competitive.

City planning actions (intended as the search for an order according to a plan) should mostly focus on this last component (the supply of urban services and facilities) to minimize the negative impacts generated by tourism on the city, envisaging an improvement of the conditions of use of the city itself.

At present, tourist activity still seems to be intended as "other" and it is seldom integrated within the urban planning process. Policies for urban promotion, however, seem to concentrate mostly on city branding, rather than on the definition of strategies aimed at making cities able to support an additional urban load expressed by tourist demand. Referring to these premises, this article is aimed to underline how tourism could represent an urban drive function able to promote more sustainable lifestyles especially referring to mobility issues. In the first part, tourism characteristics are explored with particular reference to mobility. The second part considers some European examples where the integration tourism-mobility represents an occasion to improve the diffusion of a sustainable way of moving. In the conclusion, the paper tries to individuate conditions that could improve integration between tourism and transport.

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2   Urban tourism has been investigated in literature, for more in-depth analysis see Ashworth G. and Page S.J. (2010) Urban tourism research: Recent progress and current paradoxes, Tourism Management 32 (2011) 1-15, Elsevier; Edwards D., Griffin T., Hayllar B. (2008) Urban Tourism Research Developing an Agenda, Annals of Tourism Research, Vol. 35, No. 4, pp. 1032–1052, 2008; Bramwell B. (1998) User satisfaction and product development in urban tourism, Tourism Management, Volume 19, Issue 1, February 1998, Pages 35-47, Elsevier.

2   TOURIST FRUITION AND URBAN MOBILITY

The spatial-temporal movement represents the essential component of the tourist activity in the absence of which there is no tourism. The motivation of tourist displacements is also a key element in defining the characteristics of tourism demand. Tourists are "temporary citizens" who, although for a concentrated period, express a demand for services and facilities to which the city must answer, in terms of performance, amenities and space (urban supply) (fig. 2). Tourism, therefore, represents an additional urban load that, if not properly planned and managed, can affect the balance and the organization of the city. In this sense, the relationship between tourism and urban activities is often confrontational and it affects the mobility system. Within tourist cities, in fact, an overlap occurs between at least two different types of mobility. On the one hand, the daily displacement flows, generated by residents and daily users (users and city commuters). On the other hand, occasional users (tourists and one-day visitors) generate displacements.
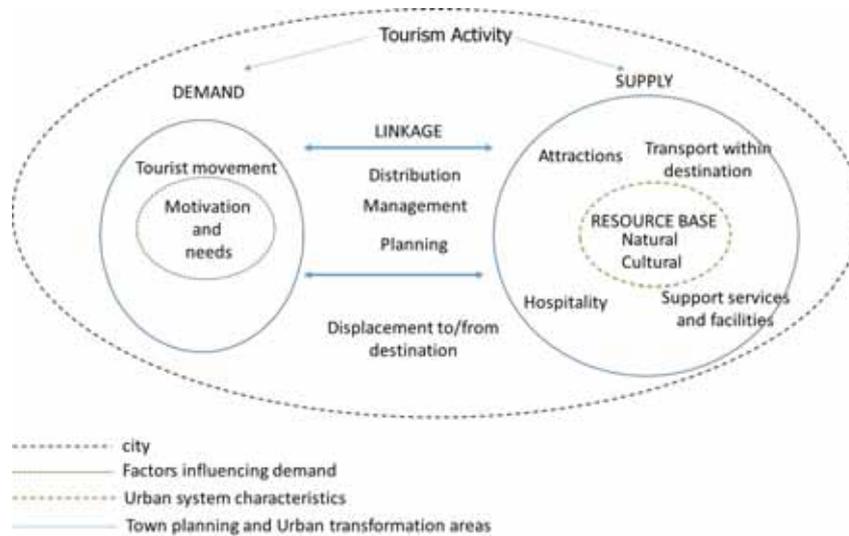
Fig. 2 Conceptual scheme of the tourism system referred to the component of demand and the component of urban supply. Urban Planning can act on the supply component in order to address tourist demand towards more compatible ways of fruition of urban resources (rielaboration from Lubbe, 2003)

This overlap creates congestion (traffic, air and noise pollution) affecting particularly the central urban areas. These flows tend to be concentrated in urban areas, mainly characterized by the presence of attractors, artistic and architectural historians, at specific times of the year. These considerations should be the object of an integrated mobility planning, considering tourist mobility as part of the urban motility system (meant as the set of displacement generated to carry out urban activities).

Leisure mobility (including tourist component), in fact, represents an important section of urban displacements (work, study, family management, commissions, etc.) and represents the 24% of total displacements (ISFORT, 2013). Data show the predominance of the use of the car for these displacements even though there is a low propensity to reduce car use in favor of public transport (Figg. 3, 4, 5).

The situation in Italy, in fact, is characterized by a prominence of car users whose habits are hard to change (fig. 6).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
▪ LEISURE	30,8	28,6	29,6	29,6	33,9	32,7	32,5	32,8	28,7	23,1	24,2
▪ FAMILY MANAGEMENT	26,3	28,2	23,4	31	31,3	32,3	32,2	32,1	35,9	42,1	39,7
▪ WORK AND STUDY	42,9	43,2	42	39,5	34,9	35	35,3	35,2	35,4	34,8	36,1
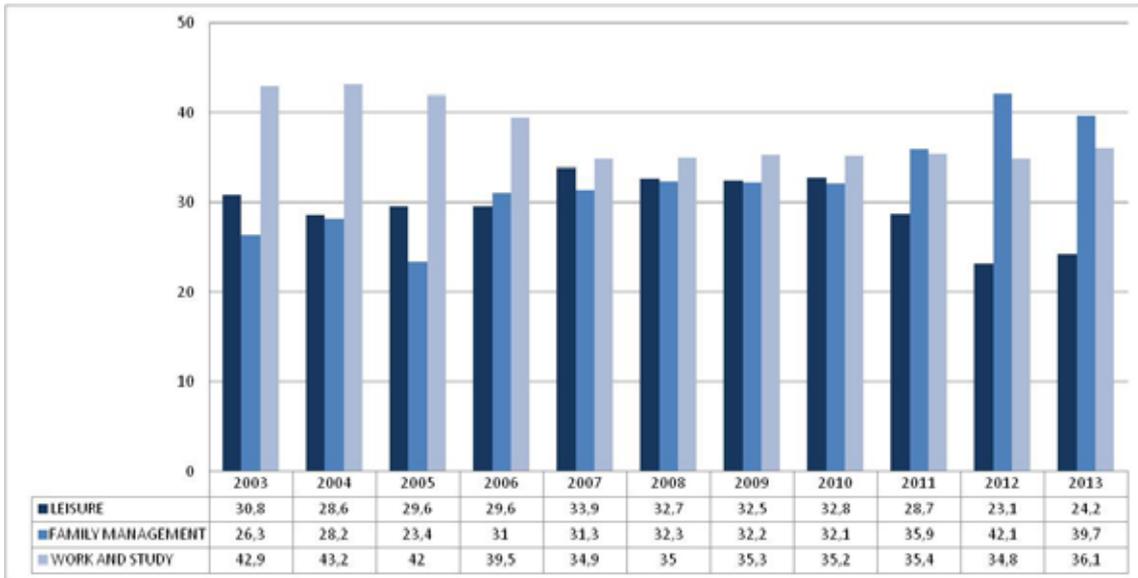
Fig. 3 Urban mobility by motivation in Italy (elaboration on ISFORT data 2013)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
decrease the use of the car	17	9,7	19	18	33,3	37	34,5	35,4	36,4	40,6	36,2
increase the use of public transport	18	11,6	21,2	18,1	39,5	41,8	40,5	43,1	40,2	42,6	36,8
decrease car and increase public transport	10,5	5,6	12	9,9	22,6	25,2	23,8	25,1	25,9	29,5	24,6
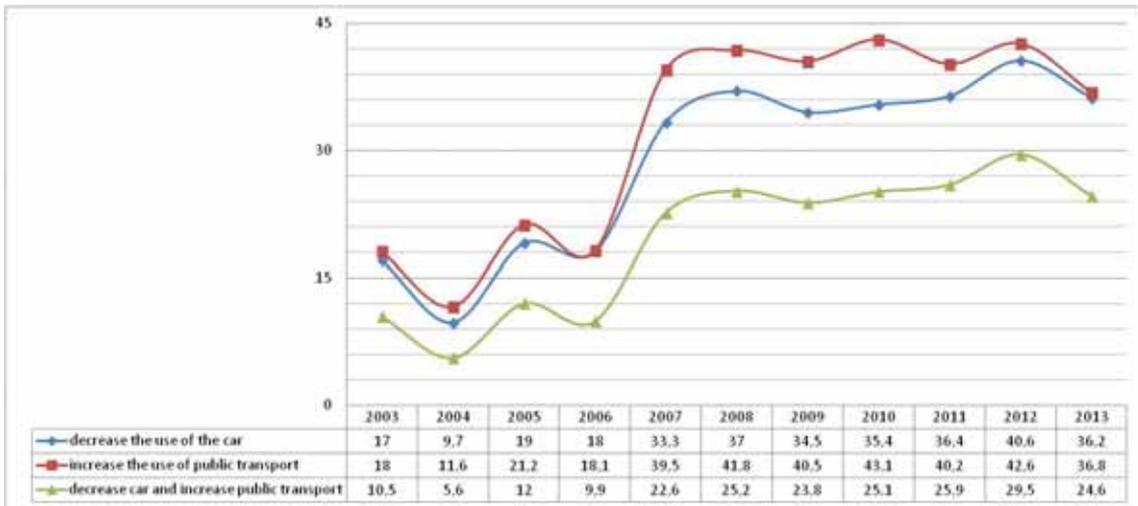
Fig. 4 Customers' propensity to reduce the use of car, in Italy: decrease car and increase public (green); decrease the use of the car (blue); increase the use of public transport (red).
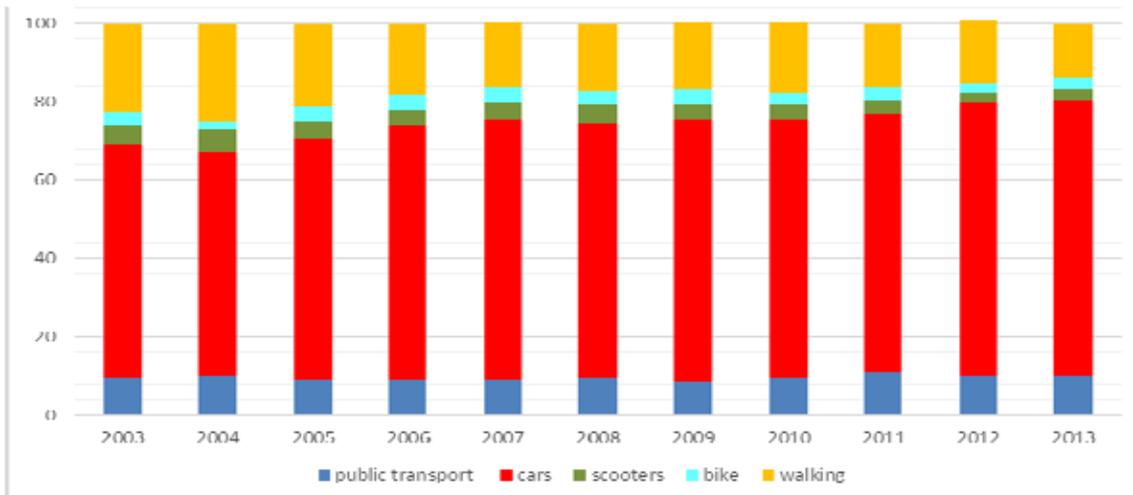
Fig. 5 Percentage of displacement by means in Italy: public transport (blue), cars (red), bikes (green), scooters (turquoise), walking (orange)
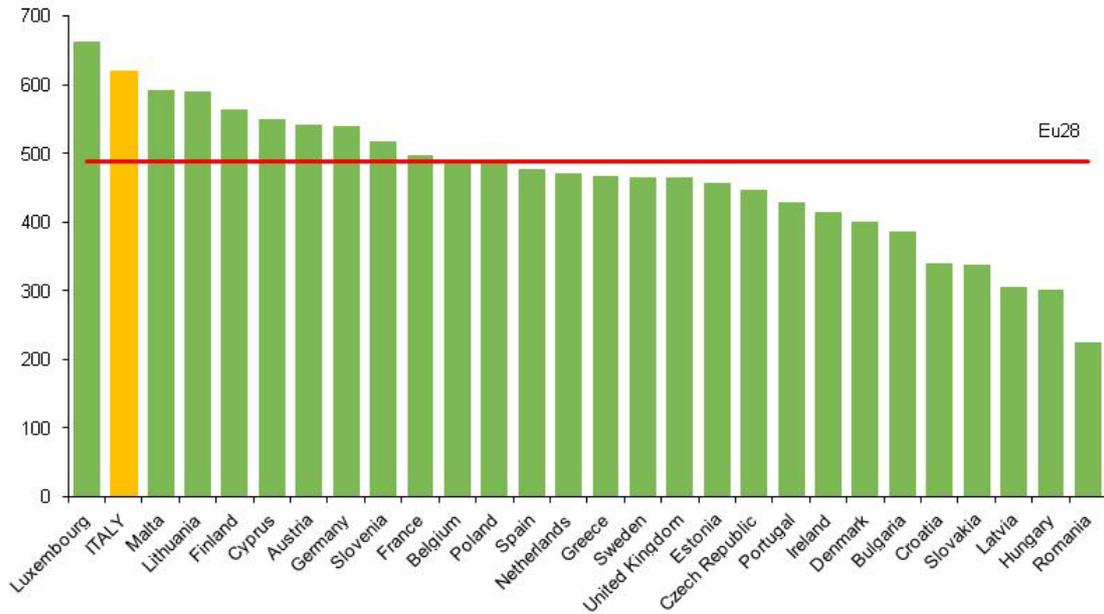
Fig. 6 The number of cars per thousand inhabitants (motorization rate) allows one to measure the negative impact of congestion on the road system mainly due to the density of vehicles in use. In Italy, the motorization rate increased from about 501 cars per thousand inhabitants in 1991 to about 621 in 2012, one of the highest rates in the world and the second in Ue28. (Elaboration on data from ISTAT 2012)

At present and especially as it concerns the Italian situation, mobility is overbalanced towards road transport and private cars. Italy is among the EU countries that have the highest motorization rate (Eurostat 2014), even though data show that there is a general propensity to reduce the use of the private car. Really, the Italian situation is characterized by a large difficulty to affirm a new mobility culture based on more sustainable forms of urban mobility, despite a prolific production of laws and roles referred to emergency of adopting alternative ways of moving to minimize negatives impacts of urban mobility on the human health and on climate change.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
car dipendence	64,4	62,7	65,3	68,6	70,1	69,3	71	69,4	69,5	72	72,9
soft mobility	25,9	27,1	25,2	22,2	20,6	21	20,7	21,1	19,6	18,7	16,8
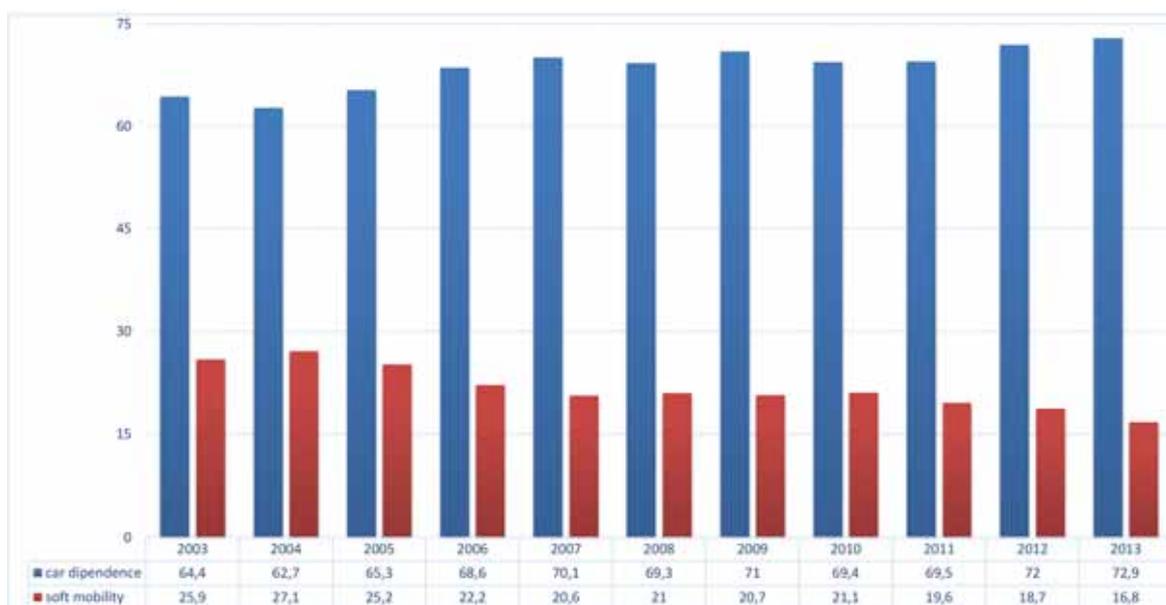
Fig. 7 Despite the general European trend, in Italy the "soft mobility" is not yet affirmed. In this case, soft mobility considers pedestrian and cycle displacements (Elaboration on ISFORT data)

A recent study referred to European cities[3] (Pieralice and Trepiedi, 2015) shows the correlation between the urban mobility policies and modal choices and proposes an experimental mode to define an Index of Sustainability[4] to evaluate the effect of these policies. Authors define four dimensions of urban sustainable mobility, particularly referred to:

— social sustainability as it concerns the accessibility aspect;

— social sustainability as it concerns the livability conditions;

— environmental sustainability;

— economical sustainability.

These dimensions have to be contemporarily considered in order to define policies and intervention that could have some efficacy according a holistic vision of the problem.

Authors elaborate a ranking on the base of the value that the Index assumes, referred to a sample of 22 European countries. Analysis underline how sustainable mobility depends on different variables and it is not strictly connected to the motorization rate nor to the GDP. It depends on a mix of factors that refer to culture, at both social and administrative level, and to the governance ability in promoting and acting policies aimed at the diffusion of forms of mobility alternative to the use of the private cars. Authors define this attitude as an "innate sustainability" that characterize some countries rather than others. The top of the ranking, in fact, with some exceptions probably due to a lesser economic availability, is occupied by those European countries that have a deep-seated tradition in policies and practices of sustainable mobility.

What seems to be relevant is the proposal to test the index within the General Transport Plan of Rome (Italy) in order to improve the performances expected by the plan in a five-year period. This proposal seems to be particularly significance especially referred to Italian situation as it concerns the present organization of the mobility planning. In Italy, in fact, the urban mobility system is regulated by different plans, acting at different territorial level (tab. 1). Within these plans, tourism rarely is considered as a part of mobility system and interventions and/or measures vary according the importance that it assumes within the objectives of urban development policies.

TERRITORIAL LEVEL	PLAN	OBJECTIVES	TOURISM INTERATION
NATIONAL	General Transport Plan	To define a common approach to transport policies	WEAK
		To coordinate skills among different administrative levels	
REGIONAL	Regional Transport Plan	To assure integration among transport services	MEDIUM
		To provide new infrastructure	
LOCAL	Urban Mobility Plan	To define long-term strategies for the mobility system also between multiple municipalities	STRONG
LOCAL	Urban Traffic Plan	To define a set of coordinated interventions to improve public and private urban mobility (vehicular pedestrian, cycling).	VERY STRONG

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[3]   The study investigates the impacts of the modal split in the European context and considers a large number of data by different sources Eurostat, Eltis, Epomm-Tems, Isfort-Audimob, Ispra.

[4]   The Sustainable Index results from four components: weighted index of motorization; index of accidents; mobility index, pollution index by PM10.

LOCAL (sectorial)	Urban Parking Plan	Rationalization of the urban supply for parking; Considers different typologies of parking demand.	STRONG
LOCAL	Sustainable Urban Mobility Plan	Proposes a different approach to the urban planning according to a strategic approach referred to participation, evaluation and integration principles.	VERY STRONG

Tab. 1 Organization of mobility system by plans in Italy. The last column refers to the level of interaction among mobility policies and tourism planning

Local level represent the place where interaction between tourism and mobility could occur and SUMP[5] seems to be the technic tool to improve this objective. The sustainable urban mobility plan (SUMP) introduce a new approach to the mobility planning according the indication given at European level via the Action Plan on Urban Mobility (2009) and the Transport White Paper (2011). It refers to a planning concept able to address transport-related challenges and problems of urban areas in a more sustainable and integrative way. This plan proposes a different approach to the mobility planning, posing more attention to the involvement of the social component (citizens and stakeholders) and promotes a new mobility culture based on a long-term vision of benefits deriving by shared solution to the issues of urban mobility[6]. The innovative approach that SUMPs want to affirm represents a first point of convergence expressed by the idea of a collaborative planning among both different administrative levels and sectors involved in urban mobility management. Assuming that tourism can be consider as a component of the urban mobility, these plans should indicate possible sustainable strategies and measures to reduce the impacts of tourist flows on the urban mobility system. Strategies could be balanced between pull measures (incentives) and push measures (restraints) promoting sustainable ways of moving and visiting the city.

"Pull measures" refer to mobility polices aimed at promoting a "car-free tourism" and they should focus on:

— *functional actions* (mainly concerning the administrative level):
  – tariff integration among different operators of public transport both at local and regional level;
  – strengthening of the public transport supply;
  – modernization of the means (use of zero-emission vehicles for the public transport such as: electric bus,
  – extension of the operation time of the public transport;
  – institution of public transport lines connecting the attractive poles[7] inside the city;
  – integration between urban planning mobility and land use;
  – prevision of sectorial plan to integrate the urban traffic plan (urban parking plan, mobility cycling plan[8]; pedestrian mobility plan; etc);
  – improve urban road safety;

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5   The mobility policies undertaken at European level in the last decade (Action Plan on urban mobility, in 2009 and Transport White Paper, in 2011) indicate the Sustainable Urban Mobility Plan (SUMP) as a new mobility planning tool able to face the energy and environmental problems and the inefficiencies of urban transportation, introducing an integrated approach to the traditional mobility planning approach.

6   The guidelines elaborate for the European Commission and for the Executive Agency for Competitiveness and Innovation show principles and objectives of SUMP. Benefits of SUMP are substantially referred to ten points: 1) improving quality of life; 2) create economic benefits; 3) contribute to a better health and environment; 4) make mobility seamless and improve accessibility; 5) make more effective use of limited resources; 6) public support; 7) prepare better plans; 8) using synergies, increasing relevance; 9) fulfilling legal obligation; 10) moving towards a new mobility culture.

7   "Attractive poles" refer to elements (building, museum, exhibition centers, etc.) that exert a pull on tourist flows acting as "urban magnets".

8   In Italy, the law 366/1998 set the rules for the funding of the cycling mobility.

- widespread dissemination of information;
- involvement of stakeholders for economical support;
- planning of campaign of information to involve citizens;
- adopting and promoting the sharing mobility (car sharing, bike sharing);
- incentives for residents who do not own a private vehicle and/or do not exceed a defined threshold of km per year;
- free loan of eco-vehicles (bikes and electric cars) for some categories of users (associations, schools, administrations) to improve the use of sustainable means of transport;
- data sharing;
- adoption of a systemic approach to the urban issues.

— *physical actions* (mainly concerning the quality of urban spaces):
- design of an integrated network of public transport;
- improving dedicated lanes for public transport;
- realization of soft mobility paths (cycling and pedestrian);
- building of pedestrian paths both in central and in peripheral areas;
- planning of connected parking areas for bus tourists;
- design of bus stop as "active poles" of urban services supply (information; safety; integration with urban function, etc) located in strategic points of urban area;
- individuation of strategic points to manage mobility flows inside the city;
- requalification of significant places for citizens;
- improving green areas and paths inside the city;
- defining and promoting urban image.

"Push measures" refer to mobility polices aimed at dissuade the car use by imposing restrictive actions that should focus on:

— *functional actions* (mainly concerning the administrative level):
- taxation to access in urban central areas (congestion charging, pass for tourist bus, road pricing);
- imposition of a tourist tax;
- improving the number of traffic restricted areas within the city;
- increasing the limited speed zones (zone 30);
- design a web portal for the exchange of information related to tourist mobility;
- establishing a call-center dedicated to diffuse information about tourist access by coach and cars
- access restraints and taxation for no eco-vehicles;
- institution of park and ride areas

— *physical actions* (mainly concerning the quality of urban spaces):
- planning the localization of smart sensor to control accesses to the historical centers or in other sensible urban areas;
- creation of a network of parking areas outside the central zone of the city;
- design of a network of "city gate" acting as check-point for the measurement and the management of the incoming tourist flows;
- planning of the short-term parking areas;
- design of park and ride areas as equipped zone to manage incoming urban tourist flows;
- design of an efficient system of signage;
- use of GPS system to allow visitors to choose the permitted driveways itineraries inside the city.

2.1 RESTRICTIVE MEASURES: THE CASE OF THE LOW EMISSION ZONES (LEZ)

Among the restrictive mobility polices adopted in the last decade and aimed at improving the quality of air in the cities, the institution of the Low Emission Zone (LEZ) could be particularly significant also referred to the tourist use of the city. The aim of the LEZ is to preserve sensible urban areas (mainly corresponding with historical center) from pollution caused by traffic (production of PM_{10} in particular).

In the case of London, the institution of LEZ (2008) covers most of Greater London (about 1579 square km, 7.7 million of inhabitants) disposing limited of accessibility to vehicles that do not respond to the fixed standard. The measures, then, refer to the state of the mean on the base of "the polluter pays" principle and they aim at a drastic reduction of polluting emission produced by large vans, light commercial vehicles and other special vehicles, public or private. By 2016, measures will be more restrictive also for public transport means that will be comprises in the EURO 6 category or will be composed by hybrid vehicles. The restraints will interest also ambulances and campers. Strict measures will interest also tourist buses whose accesses will be forbidden if they will not respect the standards. The institution of LEZ is adjunctive to the Congestion Charge Zone that is applied to the central part of London and it is substantially different from this. LEZ operates 24 hours a day, for every day while the CC operate from 7.00 to 18.00 p.m. five days a week. In Norway, the National Transport Plan (2014-2023) instituted some LEZ combined with other system of prizing (road prizing) to access the central core of the main cities (Oslo, Bergen e Trondheim).The revenues will be used to improve the supply of public transport and to create new infrastructures dedicated to the soft mobility (pedestrian and cycling). The French *Versament Transport* date back to the Seventies and represents the main revenue allowing the public transport authorities to invest in better quality of the public transport services. This measure can be applied to the tourist cities with a population of less than 10.000 inhabitants and it represents an economic contribution of the visitors to the improving of the public services supply. Restriction measures indubitably constitute a revenue for tourist cities representing a contribution of tourists for the use of services and infrastructures, they are also the object of dissenting views and they can change by country to country according to the specific objectives of their policies.

2.2 INCENTIVE MEASURES: THE BIKE SHARING SYSTEM AS SUCCESS PUBLIC SERVICE

The practice of bike sharing has widely spread in the recent year as one of the main alternative urban services to reduce traffic pollution in the cities. The revolutionary idea refers to free use of a bike that can be picked up and returned in specific locations and dates back to the Sixties, when in Amsterdam was proposed the White Bike program based on the free use of bike to move in the city[9]. From its origin, this public service has changed both for the necessity to improve the customer tracking and for the development of the bike technologies. The evolution of the bike sharing program and its diffusion as a component of the system of urban transport supply passed through three different generations and it rapidly has spread in European cities more than in other parts of the world (DeMaio, 2010). At present, bike sharing represents one of the "smarter model" of urban service using technology both to use and to manage the service. The current smart generation of bike sharing system bases on a variety of technological improvements, including electronically-locking racks or bike locks, telecommunication systems, smartcards and fobs, mobile phone access, and on-board computers. In the meantime, a new generation of bike sharing already is affirming a model aimed to improve efficiency, sustainability, and usability of the service to better diffuse the use of bike for urban displacements. This is being accomplished by improving deployement of bikes, installation, powering of stations, tracking, pedal assistance bikes and other business models.

Despite the large recourse to this system as virtuous urban practice, the use of bike sharing for tourists is not still diffused due to the difficulty to access the service for a temporary user typology as tourist is. The most diffuse systems, in fact, propose a yearly subscription or present high level of difficulties to rent the

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[9]   The program had not the expected success as the bikes were stolen or throw in the channels.

bikes. These difficulties mainly refers to the lack of information, to the only use of local language, to the duty of age limits, to the restrictions for categories of user different from residential. Nevertheless, the integration of cycling and enhancement of the urban cultural heritage is an increasingly success urban practice to promote more sustainable way of visiting the cities. In 2012, a recent comparative survey (EuroTest, 2012) referred to a sample of forty European cities highlighted the characteristics to define the efficiency of the bike sharing system, especially as it concerns tourist use. If we compared the ranking elaborated by Eurotest (2012) and the ranking of the Top Cities destinations Ranking elaborated by the Euromonitor International (2014) some discrepancy stand out between the quality of the bike sharing system and the level of tourist attractiveness. London, Barcelona and Amsterdam, for instance, do not match high level for the quality of the bike sharing system while occupy high positions in the destination ranking. Although the limits of these rankings and of their comparison, it is possible to make some considerations about how to improve the use of bike sharing to promote sustainable tourism mobility. In particular, present systems should be integrated by technical measures aimed at:

— optimize the urban deployment of the stations;

— definition of planning criteria for the stations localization (i.e. closeness to strategic urban function; network among attractiveness, and so on);

— integration with the local public transport to encourage the modal split;

— facilitate the procedure to access the service;

— improve the quality of information to use the service;

— increase the quality of the means;

— design stations as integrated poles of urban services.

These indications should be supported by the coordination among public administrative and private operators. The involvement of private investors could improve the quality of the service and, at the same time, could reduce the costs both for fabrication and the management of the whole system (installations, purchase of the equipment, etc.) for the administration. There is no ideal model of provision, as it depends by different factors (population, size of the city, number of daily users, etc.) but it could be reasonable to indicate the mix private-public model as one of the more actionable.

CITIES	SYSTEM	EUROTEST EVALUATION	POSITION IN THE EUROTEST RANKING	POSITION IN THE EUROMONITOR INTERNATIONAL RANKING	NUMBER OF TOURIST ARRIVALS (MILLIONS)
Paris	Vélib'	very good	2	5	15,2
Brussels	Villo!	very good	3	55	2,9
Berlin	Call a bike	very good	4	37	4,3
Milan	BikeMi	very good	9	24	5,8
Munich	Call a bike	very good	13	57	2,8
Prague	Homeport Prague	very good	19	21	6,2
Dublin	Dublinbikes	good	21	49	3,3
Vienna	Citybike Wien	good	22	28	5,1
London	Barclays Cycle Hire	acceptable	28	4	16,7
Barcelona	Bicing	acceptable	36	25	5,5
Amsterdam	OV-fiets	very poor	39	27	5,2

Tab 2 Comparison between Eurotest evaluation of the bike-sharing system in 40 European countries and the Euro-monitor International Ranking of the most visited destinations in the world. Table contains only cities that are present in the both rankings

3   TOURISM AS "ACCELERATOR" OF CHANGE

This paragraph is aimed to underline how tourism could play a strategic role in the promotion of new forms of fruition and visit the city that could be more sustainable for the urban and the environmental system. This assumption refers also to the change that occurred in tourist demand due to the innovation technology. This radically changed the way to communicate and amplified the experiential component of tourism. Referring to this component it is possible to state that tourists represent the ideal typology of urban users to test the effects of innovative policies aimed at shifting by the actual unsustainable behaviors to smarter use of the resources and better lifestyles.

Tourism can be considered as an urban activity as it is concentrated in cities expressing a specific demand of use services and facilities that, in origin, have not been designed for tourist use. As a pervasive activity[10] where social component has a fundamental role, tourism can influence behaviors and plays a driving role in promoting more sustainable use of cities (soft mobility, decrease of waste production, water use reduction and energy consumption, etc.). In this vision, town planning has to play a key role in driving the urban system towards compatible states of equilibrium characterized by appropriate and innovative use of resources and of energy in particular. The integration between tourism development goals and urban planning targets would maximize positive aspects of tourism and minimize the impacts that it generates the city's organization.

Considering the present challenges that cities have to face, and first of all the adaptation to climate change in order to implement urban resilience (Colucci, 2012), the emerging paradigm of a "smart city" could be an opportunity to promote an effective change in the use of cities both at a social and an administrative level. The smart city concept seems to highlight that, from a town planner's point of view, the actual challenge consists in making cities more efficient referring to the quality of services, the reduction of environmental impacts (polluting emissions) and the control of energy consumption, by means of innovating technologies (ICTs) capable of supporting the management, monitoring and functioning of cities. The active role of the human factor (citizens, residents, city users, tourists) is becoming increasingly important also because it can significantly affect the success or not of a city as a tourist destination and then on its level of competitiveness.

Tourism, being characterized by "transversality" and "pervasivity"[11], can play a strategic role of driving function able to shift the system towards urban smartness conditions that necessarily engages a physical, functional and social component of the urban system. In this sense, the "smartness" can identify a condition of possible equilibrium (between tourist demand and supply) where the city achieves widespread urban quality levels for all categories of users: residents, city users, tourists.

The change that is characterizing the current tourist demand (from tourism to "smart tourism")[12] denotes an improvement of tourist behaviors and consumptions, and promotes a new model of use for the city according to the sustainability paradigm. Although sustainability in tourism is still an object of debate, at present, it refers to a new approach in tourist supply chain (transport, hospitality, entertainment) rather than to a tourist typology. The present tourist demand, however, is more careful about environmental questions making the sustainability principle one of the factors that influences the choice of a destination.

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[10]   In spite of the global crisis, tourism has had an uninterrupted growth over the past six decades. International tourist arrivals have increased from 25 million globally in 1950, to 278 million in 1980, 527 million in 1995, and 1133 million in 2014 (UNWTO 2015). At present, tourism involves all different social levels, being a cross activity, affecting several sectors (mobility, hospitality, leisure, etc.).

[11]   Transversality refers to the multiplicity of sectors (public and private) involved in tourist development. Pervasivity refers both to the possibility that ICT offer to share experiences and emotion in real time. This deeply change in communication is emphasized during the tourism experience. Actually, tourists share their opinion and emotion on social networks that, at present, represent also the main source for the analysis of tourist phenomenon.

[12]   Buhalis et al. (2014) defines the characteristics of a smart tourism destination referring also to tourists. A smart tourist profile is proposed in La Rocca R.A. (2014) The role of tourism in planning the Smart City, in TeMA Journal of Land Use, Mobility and Environment, Vol 7, n.3 e-ISSN 1970-9870.

In this sense, the promotion of a "sustainable destination" (i.e. zero emissions hotels, management and recycling of waste production; alternative energy applied to lighting of monumental areas and public buildings as well as to the private building sector, etc.), represents a factor of improving its attractiveness and competitiveness[13] of a city.

Tourism can be both a tool to activate new forms of sustainable facilities and services, at the level of supply (involving private and public sector) and as a means of affecting social behaviors, at the level of demand (social component). The spread of ICT has deeply changed the way of sharing emotions and experiences among tourists introducing a "real time" dimension in which distance is almost dissolved. This transformation inevitably affects the tourist supply system chain, oriented at capturing the customers' preferences, but at the same time, it is also a possibility in order to promote new forms of supply that can modify tourist behaviors.

4   SUSTAINIBLE TOURIST MOBILITY FOR THE FRUITION OF CITIES AND REGIONS: EUROPEAN EXAMPLES

This part wants to propose some reflections about the potentialities connected with the planning of new forms of supply in order to activate virtuous behaviors able to reduce impacts of tourism mobility both at local and regional scale. In this framework and referring to the above mentioned considerations, tourism can play a strategic role acting as an accelerator of change promoting more sustainable lifestyles. Tourist demand, indeed, is evolving towards behaviors and practices that are more responsible of the energy consumptions and, then, more selective and quality oriented. This propensity requires a substantial rearrangement in the planning processes of tourist supply that need to be oriented towards the definition of new services and facilities to satisfy the demand exigencies. The need of a change in the tourism consumptions has been expressed at European level both in policies and in declarations to promote sustainable and responsible tourism. This interests mobility as the main responsible of the production of negative effects on environment and on human health. Nevertheless, the integration between development objective and safeguard exigencies is still not effective, even though some significant best practices demonstrate that limiting negative impacts of tourism is possible without reducing its positive economic effects.

In the following, the selected example identify best practices oriented to the definition of innovative forms of tourist fruition aging as pull factors for the development of destination.

4.1   THE PROMOTION OF A CAR-FREE TOURISM DESTINATION IN THE ALPINE REGION

In the context of the above mentioned considerations and referring to the European context, in recent years, tourism has become one of the key elements to promote sustainable mobility on both a large and a local scale. In the first case, interventions and projects aimed at promoting car-free tourism through the use of low-pollution intermodal forms of travel (cycling, public transport, collective transports) connecting different tourist destinations inside a region. In this vision, tourist destinations are part of an equipped network that connects the different poles of attraction and its realization often activates the requalification of paths and itineraries closely connected to the territorial memory and history.

The success of this type of initiative is strongly based on two fundamental conditions.

The first one concerns the coordination among different administrative levels engaged both in the planning of transport and in regional planning, considering an integrated approach to mobility and land use to gain

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[13]   Criteria for destination pointed out by the Global Sustainable Tourism Council propose and establish standards for sustainability in tourist destination recognizing tourism as a potent tool for both preserving resources and reducing poverty (see http://www.gstcouncil.org).

the objective of a real change in tourist behaviors. The second one refers to the building of an efficient information network able to spread and share objectives and implementations of the projects.

Related to this second condition, the project Alp Infonet (2007-2013) aims to promote the Sustainable Mobility Information Network in the Alpine Space. Based on the idea that the diffusion of information could improve the use of public transport rather than private, the project proposes to integrate the already available information platform in the Alpine Space by providing travelers with comprehensive information about sustainable transport modes beyond regional and national borders. The main objective is to stimulate the use of public transport to visit and to reach the Alpine Space in order to reduce the impact of tourist mobility on the environment. In the name of the Alpine Convention[14] and acting in a collaborative perspective, the five partner (Austria, France, Germany, Italy, and Slovenia) undertake to disseminate the objectives of the project with no discrimination in dissemination of information. This will permit them, on the one hand, to share economic advantages coming from tourist flows, on the other hand, to mitigate the impacts deriving from tourism on the Alpine region.

4.2   THE "CITY MOBIL" PROJECT FOR A SMART MOBILITY

The interventions at a local scale mainly are connected with the issues of urban requalification of urban public spaces. Promoting sustainable mobility in the city deals with three main issues: 1) safety of users; 2) integration with local public transport; 3) information, reception and management of the tourist flows.

At this level, technologies seem to have a major role in supporting the success of the projects leading some scholars to talk about a "techno-centric approach" (Papa and Lauwers, 2015) focused on infrastructural innovation to promote a "smart mobility".

Self-driving cars could represent the most significant example of this typology even though they are still considered with skepticism, especially because they will not reduce the use of cars in the city although, if the use of them will really spread, it will surely revolutionize the way we drive and use the car.

Cybercars belong to the same typology and are utilized also for a tourist target. They are electric driverless minibuses, connected to a sophisticated device that assures security and reliability of the displacement. They could be used for tourist displacements in urban context utilizing specific and reserved path.

At present, this kind of vehicle is the focus of the European project "City Mobil" aimed at testing this technology in some pilot cities. The city of Brussels is testing the possibilities of creating an automated shuttle system to connect the main tourist attractions. One limit of the project, apart from the high cost of the vehicles, is the lack of rules that can insure the use of cybercars also from a legal point of view. Until now, the Highway Code regulates the circulation of cars, pedestrians and cycles and does not consider automated vehicles. Some experts envisage their use as complementary to the supply of local public transport, especially for tourist use.

4.3   THE SEEMORE PROJECT: NEW PERSPECTIVES FOR TOURISM CONSUMPTIONS

Integration tourism-transport aimed at promoting more sustainable forms of displacement to visit destinations is the main objective of the SEEMORE (2013-2015) project (Sustainable and Energy Efficient Mobility Options in tourist Regions in Europe) based on the idea that it is possible to integrate tourism within the general planning of displacements. According to this main concept, the SEEMORE project aims at promoting sustainable mobility in tourist destinations. It refers in particular to eight coastal tourist European

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[14]   The Alpine Convention is an international treaty between the Alpine Countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) as well as the EU, for the sustainable development and protection of the Alps. (http://www.alpconv.org).

regions[15] where interaction between visitors and mobility has been implemented by the definition of a set of local actions: mobility information packages for tourists; communication and awareness-raising campaigns; improved sustainable mobility options; integrated products for leisure and mobility; integrated planning processes taking the needs of tourists into account.

The centerpiece of the project is the cooperation among stakeholders, civil and transport administrations, as well as the integration between tourist and transport information by the use of efficient and clear planning to enable tourists to visit destinations by using public transport and cycling.

The development of the SEEMORE project allows us to underline some interesting conditions that could improve the definition of active urban policies aimed at integrating tourism and transport:

- public transport should be marketed as an integral part of the holiday experience;
- cooperation between transport and tourism sector;
- the mobility of visitors and leisure transport should be an integral part of the Sustainable Urban Mobility Plan.

The first condition refers to the opportunities that the use of public transport could offer for tourists in terms of lower costs for displacements and a more integrative way to visit the destination. An audio application for smart phones could turn a public transport trip into a guided visit. For the second condition, an active cooperation between the hospitality sector and the transport sector should be activated. For instance, by the training of staff about the offers of public transport or the sale of tickets at the hotel reception, or by integration with the use of bikes among the public supply of urban services. For the third condition, the occasion given by the introduction of SUMPs should be better fostered by the definition of methodologies to manage urban tourist mobility. At present, the main difficulties refer to the availability of data to measure the impacts of urban tourist flows, this difficulty could be overcome by the application of open data in defining strategies of tourist development and territorial management (Las Casas et al., 2014).

4.4 POLICIES TO INTEGRATE TOURISM AND MOBILITY IN FRANCE

The report "Transport urbains et tourisme" analyzes the supply of services for tourist mobility in France and highlights the lack of integration between tourism and mobility in an urban context especially as it concerns the application and the web sites. The only case of integration refers to Paris with the application "Visiter Paris en metro". The study concludes by stating that among the French agglomerations tourist mobility is not yet considered as an element of the global tourist supply system (fig. 8).

5   TOURISM AND MOBILITY: CONDITIONS FOR SUITABLE INTEGRATIONS

Tourism is still categorized as a form of mobility that is different from the others inside the city, representing in some cases, an inconvenient element for residents and regular city-users. Indeed, tourism is a factor of disequilibrium but what this article tries to state refers to the possibilities of reducing tourist impacts by the integration of this activity within the urban planning process. As mentioned above, tourism could represent a driving function to shift present cities towards more sustainable states and in this sense it represents a resource not only for its indubitable economic value as an industry. The promotion of sustainable mobility in cities adds a global value to city-life for both tourists (as a tourist product) and residents (as a better quality of urban public space). At the same time, tourist travel habits can act as a generator for global change in actual lifestyle even though a concrete integration has not yet been reached. Considering the analyzed examples some conditions emerge, acting as pull factor for the activation of possible integrations tourism-mobility.

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[15] The eight region involved were: Provincia Forlì-Cesena (Italy), Choczewo, Pomerania (Poland), Dobrich District (Bulgaria); Mallorca, Balearic Islands (Spain); Limassol (Cyprus); Bohuslän (Sweden); Malta; Madeira (Portugal).

Fig. 8 The report Urban Transport and Tourism, elaborated by Cerema in 2014, shows the lack of integration between tourism and mobility services in the main French urban agglomeration. Paris (green) is the only case where integration occurs; Metz, Tours and La Rochelle (grey) are cases of only tourism applications; Lille, Rouen, Nantes, Bayonne, Toulon, Grenoble, Nancy, Strasbourg (orange) refer to only transport applications; Rennes, Bordeaux, Lyon, Mulhouse, Avignon, Montpellier, Toulouse, Marseille, Nice (blue) are cases of dissociated application transport-tourism.

− *Cooperation between public and private actors*

The first level regards administrative conditions to assure the co-operation between local authorities, transport and tourism companies, in order to obtain the integration objectives. Protocols to share data and information among public and private actors should be drafted. This could have a double benefit. On one hand, cooperation and data sharing would permit a real monitoring of tourist flows, on the other hand it would allow the definition of integrated policies aimed both at promoting and governing the urban system. Cooperation between the hospitality sector and the public administration, for instance, could activate positive interventions of requalification of urban public space, the allocation of costs and the sharing of benefits for both (public and private stakeholders).

− *Dissemination and information sharing*

Another positive effect of cooperation is the possibility to combine different products in an integrated supply (for instance a combined ticket for public transport and attractions; an audio guide for public transport or for cycling routes, a reduction in the entrance price for visitors using public transport to reach the place, etc.).

The information availability is another indispensable condition to steer tourists in making their choice of modal displacement and of routes. In this sense, it is possible to state that interventions should concentrate in disposing actions aimed at implementing the knowledge of tourists, acting on the availability of information rather than on the tourist way of moving. The design of on line platforms that are freely accessible and able to inform tourists about the possibilities of moving inside the destination using public transport seems to be one of the solutions that is more likely to be achieved. Moreover, through an appropriate authentication procedure, tourists should be able to access the wi-fi network and to connect to an urban platform.

− *Virtual and physical planning integration*

− The aforementioned "digital condition" has to be reflected in the physical state. In other words, if intelligent platforms can contribute to the diffusion and the rationalization of information, it is necessary to have an efficient network of mobility (infrastructures and services) in order to promote car-free tourism inside a destination. In this sense, the tourist component can be integrated in the urban demand and it should be considered in the design of the mobility plans at both urban and regional level. These plans should define strategic actions to improve sustainable forms of mobility, among these:

- increasing the supply of public transport;

- improving the quality of the service of the public transport (i.e. trained staff; equipped vehicles; etc.);

- caring of the design of the public transport stations;

- establishing car pooling for short and long distance journeys;

- strengthen the network of pedestrian paths within the city;

- promoting the use of bike-sharing through installations in strategic points of the city;

- institutionalizing of innovative sharing modes of displacement (i.e. taxi sharing);

- design of equipped and interconnected cycling network;

- predisposing a network of equipped parking;

- design of up-to-date and reliable signage in different languages.

These measure should be mainstreamed within tools of mobility planning at different scale, introducing a different vision to mobility planning aimed to integrate the issues of tourist mobility, in order to promote more sustainable way of moving inside the city.

6 CONCLUSION

This article has tried to underline how the planning of urban mobility (composed by the set of displacements to conduct urban activities) could assume a strategic role in improving urban livability. Mobility represents the sector able to increase a more sustainable way of life. In Europe, since the second half of the Nineties, the concept of sustainable mobility has tried to contrast the use of private vehicles in favor of less polluting modes of travel based on the need to safeguard public health. Nevertheless, car dependence continues to prevail, although there is an increase in the propensity to change behaviour of use (ISFORT 2013).

If this, on one hand, represents a positive trend, it is not yet sufficient to activate the change needed to face the challenges that our present cities have to face (climate change, energy and water saving, dependence by fossil energy, etc.) and also considering that vehicular mobility is the biggest culprit regarding urban pollution and thus global warming. The contribution that some forms of mobility, more compatible with environmental requirements, can provide was also shown by the increasing interest of the industry proposing "green engines" to "zero emissions", all, however, aimed at improving the efficiency of the vehicles rather than "car dependence". What this article tries to state, also by taking some European examples into account, is the consideration that in order to achieve the objectives of sustainability the search for "green technologies" is no longer enough, but the need for actions that are able to spread awareness of both users and decision-makers. In the context of these considerations, tourism as a pervasive activity could improve the change towards more a sustainable lifestyle acting as a driving function to promote alternative ways to use the city. In this sense, it is no more an agent of disequilibrium but an accelerator to change mobility behaviors. The "smart city" concept, even though its difficulties need to be clearly defined, can contribute towards the changes needed, but a holistic vision is needed to be efficient. A smart city approach should aim at improving the quality of urban life through the integration between technology components and social exigencies. The considered examples showed that transformation is based on a collaborative approach in order to activate measures and interventions aimed at improving livability and a better quality of life. At the same time, the involvement of citizens and city-users within the process of urban transformation has to be achieved. The potentialities of tourism as a key function to activate new forms of sustainable facilities and services, at the level of supply (involving the private and public sector) and as a means of affecting social behavior, at the level of demand (social component) should be investigated and integrated more successfully within the global process of urban transformation planning. At the end of these reflections, further context conditions that could act as lever of changing could be

indicated in order to define direction toward suitable change more attentive to the emerging exigencies of cities. These conditions refer to:

- integrated approach to the mobility issues by a general renewal of the government process of urban transformation;
- intermodality that means to adopt a "network logic" at both operative and planning level;
- implementation of investments programs aimed at improve the ecological networks and local services related to urban planning;
- improving the diffusion and application of urban policies aimed at supporting soft mobility;
- adopting more integrated approach oriented to the best use of technology for improving quality of urban life;
- innovation of the government process, in terms of territorial integration, transparency and participation.

Acting on these different "component of the change" and considering the factors occurring to adopt sustainable mobility seem to be the way to shift cities towards better state of urban livability.

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TeMA

COUNCIL TAX POLICIES AND TERRITORIAL GOVERNANCE

ANALYSIS AND OUTLOOK OF A DIFFICULT RELATIONSHIP

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ABSTRACT

In recent years, the dependency of local public finance from various forms of taxation related to urban development and real estate has become increasingly evident in Italy. Nevertheless, to date no organic relationship seems to have been established between fiscal policies, on the one hand, and urban planning, on the other.

This article examines the ties linking the two areas, focusing on different types of taxes and discussing the aspects that have come to influence the area of planning, with special regard to territorial competition, urban equalization, building rights and land consumption mitigation measures.

TeMA

有关土地使用、交通和环境的杂志

ABSTRACT

近些年在意大利，地方公共财政已经变得越来越依赖与城市开发和房地产相关的各形税收。但到目前为止，财政政策与城市规划之间似乎并没有建立有机联系。

本人将研究连接着两个领域的纽带，聚焦于不同类型的税收，讨论会影响规划的各个方面，并特别涉及区域竞争、城市均衡、建筑权利和土地消耗缓解措施。

议会税政策与地方治理：
一种艰难关系的分析与展望

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1 INTRODUCTION

In the last twenty years, the introduction of new local taxes, ICI and IMU in particular, has made clear the link between tax and urban policies. This link is anything but new: tax reform was an alternative to failed urban reforms already in the Sixties (Sullo, 1964), not to mention Constitutional Court decisions on pre-emptive expropriation of buildable land (Sandulli; Spasiano; Stella Richter, 2007).

In those year, taxes were seen as an instrument for the reuptake of urban income, or for the mitigation of big disparities as a consequence of land transformation. The link between the two policies is nowadays far more complex and integrated with planning instruments, because taxes on urban transformation are increasingly high and because urban planning legislation is getting more and more complex, what surely has an impact on the whole planning process.

On the other hand, the economic framework since 2007 is having an impact both on real estate market and on urban planning, with unexpected phenomena still waiting for in-depth studies (Cutini, Rusci 2015).

In such a context, governing the territory in a broad sense (i.e. with regard to the economic dimension that makes governance possible) pose the risk for fiscal and economic policies to subordinate planning choices to budget needs. This is what has already happened in the past, in times of expanding market, thanks to the possibility to partly use urban fees for local expense financing, thus converting urban expansion into a fuel for public policies. Such a phenomenon is true even today, in an abnormally long recession, with the aim to raise funds in order to comply with budget obligations deriving from European policies.

Once again it seems that in Italy territory governance still remains linked to expansive and transformative dynamics, instead of conquering its own strategical and political dimension. This leads to operating tools more oriented towards projects and space than towards programs and systems.

In a phase when urban expansion and resources for urban planning and public works cannot be taken for granted, these are the reason why territory governance risks being out of game, replaced by more specialized disciplines, pertaining to the economic and legal field, which are less able to read and organically envisage the complexity of a territory.

Beside that, urban planning policies are traditionally pro-cyclic ones: the trend is to strengthen obligations and charges during stagnation, and to deregulate and de-tax when economy is growing (Curti, 2004). Such a trend reduces the capability of urban planning to identify new strategies for emerging problems. As an example, let's simply think of the many measures which were adopted to contain land consumption (e. g., Tuscany's Regional Law n. 65 of 2014), or to capture land capital gain: the paradox is that such measures were substantially missing during the big urban and economic expansion in the Nineties.

It is therefore interesting to study the influence that all the different elements pertaining to various disciplines are having on territory governance, with a clear impact in terms of land planning and policies. In this article we analyse from an urban planning viewpoint the consequences of new fiscal instruments on planning, paying special attention not only to problems, but also to unexpressed potential in management tools: urban equalization above all, transfer of development rights, and land consumption mitigation measures.

2 TAXATION AND TERRITORIAL GOVERNANCE

Local government taxation is obviously most directly impacting on territorial governance and can be divided into two broad categories: levies relating to urban development, i.e. the various forms of building fees (urban taxation); levies on real estate, basically IMU and ICI (property taxation). A third form of contribution has come into being recently, a non-strictly fiscal one: urban equalization, which - as we shall see - shares some traits in common with more traditional levy instruments.

The adoption of fiscal federalism at council level, together with a progressive – and programmed – weakening of transfers from the State, has led to a very strong link between council budgets and real

estate: in 2012, IMU alone accounted for 30.69% of total municipal income (source: ISTAT, MEF – Ministry of Economy and Finance), thus establishing a direct dependence of local finance on economic cycle and real estate market (Ferri, Adobati 2011), as well as on urban growth as we shall see.

Urban planning taxation – meaning those charges for primary and secondary urban developments as defined in Law n. 10 of January 28, 1977 – represents a *una tantum* (one-time only) levy for building activities, according to the principle of quid pro quo in which a tax is due corresponding to the marginal benefit from private use of public good and services. Development charges plus a tax on construction costs – introduced by the aforementioned law – constitute the contribution to the making of a town. This link between tax (charges) and performance (works) was originally intended to exclusively cover the site development and land expropriation costs (art. 12 of Law 10/1977). However, this link has been weakening with the implementation of the law: since 2001, DPR (Presidential Decree) n. 380 allows for a part of those charges (varying between 50 and 75% in different years' budget laws) to cover current public expenditure. Many researchers (Ancillotti 2007; Agnoletti 2008; Pileri 2009; Curti 2004) think that eliminating such an earmarking of planning fees has led to promoting urban expansion, especially in market expansion times, with the risk of territorial policies being subject to budget needs, instead of strategy and sustainability goals (Curti 2004). The share of construction fees on total municipal income varies greatly depending on territorial specificity and market conditions and is quite limited if compared to other fiscal income. Let's take into exam the provincial capitals in Tuscany and Venetia (Tab.1).

Fig.1 Buildable area

MUNICIPALITY	TOTAL INCOME	CONSTRUCTION FEES	SHARE
Massa	100.171.819	1.524.856	1,52%
Lucca	99.261.485	2.959.762	2,98%
Pistoia	102.061.139	2.218.311	2,17%
Prato	223.577.386	8.052.736	3,60%
Pisa	146.951.385	6.927.818	4,71%
Firenze	717.942.846	6.870.868	0,96%
Livorno	185.702.887	8.266.554	4,45%
Arezzo	84.046.498	2.952.859	3,51%
Siena	106.017.175	2.141.037	2,02%
Grosseto	95.201.875	3.497.718	3,67%
		AVERAGE	2,96%
Belluno	33.485.810	395.387	1,18%
Treviso	90.640.667	2.883.175	3,8%
Vicenza	165.613.519	3.087.702	1,86%
Padova	350.199.886	6.061.571	1,73%
Venezia	724.533.007	11.282.233	1,56%
Verona	390.940.987	5.785.699	1,48%
Rovigo	51.899.953	838.564	1,62%
		AVERAGE	1,80%

Tab.1 Shares of construction fees on province capital budget in Tuscany and in Venetia, 2012.
(Author's elaboration on data from MEF)

In the case of Tuscany, the share of construction fees was on average 2.96% in 2012; as for Venetia, the average was 1.80%. Noteworthy values are the peaks in Pisa and Leghorn, with a share close to 5%.

The ratio between construction fees and new authorised volumes – i.e. land take, as a matter of fact – is biased by several variables (intended use, urban typology, implementing party), and by the impossibility of taking into account fees paid in the form of direct works by the entrepreneur. This practice is quite common in Italy, where the promoter is often the builder himself.

In Tuscany, the comparison between the three-year periods after and before the implementation of DPR 380/2001 does not show any discontinuity to be attributed to the possible use of construction fees for public expenditure financing.

Thus, whereas a direct influence of charge revenue on planning choices is difficult to ascertain, it is clear that a policy of urban development containment would be contrary to the needs of local governments in terms of budget resources.

In areas where urban development pressure is traditionally higher, a policy for dramatic reduction of land take – though desirable – would lead municipal budgets to default. If we take a look at the municipalities on the coast of Tuscany (tab. 2), a Region which has recently adopted very strict legislation preventing the use of agricultural land for urban development (L.R. 65/2014), average share of construction fees in municipal budgets exceeds 5%, topping well over 10% in Forte dei Marmi, Montignoso, Castagneto Carducci and Capalbio. As elsewhere in Italy, this shows the need of an integrated management of territorial governance and tax policy: otherwise, good measures of landscape safeguard risk succumbing to the need of safeguarding budgets.

MUNICIPALITY	TOTAL INCOME	CONSTRUCTION FEES	SHARE
Capalbio	5.708.595	614.691	10,77%
Orbetello	32.139.241	505.043	1,57%
Monte Argentario	22.975.938	1.426.834	6,21%
Magliano in Toscana	5.513.043	290.378	5,27%
Grosseto	95.201.875	3.497.718	3,67%
Castiglione della Pescaia	24.521.657	1.670.609	6,81%
Scarlino	9.664.598	262.970	2,72%
Follonica	30.770.633	1.558.866	5,07%
Piombino	45.291.707	984.624	2,17%
San Vincenzo	16.232.596	981.368	6,05%
Castagneto Carducci	11.227.306	1.156.158	10,30%
Bibbona	7.640.488	450.000	5,89%
Cecina	28.718.587	1.907.530	6,64%
Rosignano Marittimo	50.642.492	1.507.215	2,98%
Livorno	185.702.887	8.715.718	4,69%
Pisa	146.951.385	6.927.818	4,71%
San Giuliano Terme	35.278.817	1.261.401	3,58%
Vecchiano	9.235.785	373.360	4,04%
Viareggio	174.881.761	1.894.146	1,08%
Camaiore	47.588.999	2.862.402	6,01%
Pietrasanta	54.964.418	1.713.615	3,12%
Forte dei Marmi	33.056.332	4.403.346	13,32%
Montignoso	10.712.525	1.286.427	12,01%
Massa	100.171.819	1.514.856	1,51%
Carrara	88.690.554	1.600.022	1,80%
		AVERAGE	5,28%

Tab. 2 Share of concession fees in budget of coastal municipalities of Tuscany, 2012. (Author's elaboration on data from MEF)

Non "one-off" taxes, i.e. levies on a tax base corresponding to property stock on the municipality territory, show a completely different picture. In contrast with planning fees, income deriving from this kind of taxation is determined a priori, as linked to the quality of existing building stock in the single municipality. Its tax base is therefore less mobile and more uniformly distributed on the territory. This allows a more precise fine-tuning of tax policies, both in terms of income and investment programming.

The percentage share of property taxation on total municipal income has greatly increased in the last years, owing to a combination of higher taxes and lower State transfers. Taking into exam the same sample of towns, here are the results (tab. 3).

MUNICIPALITY	TOTAL INCOME	TOTAL TAX ON PROPERTY	SHARE
Massa	100.171.819	22.261.970	22,22%
Lucca	99.261.485	26.700.000	26,90%
Pistoia	102.061.139	22.144.619	21,70%
Prato	223.577.386	40.951.000	18,32%

Pisa	146.951.385	35.742.552	24,32%
Firenze	717.942.846	176.545.092	24,59%
Livorno	185.702.887	54.785.232	29,50%
Arezzo	84.046.498	24.507.920	29,16%
Siena	106.017.175	26.100.001	24,62%
Grosseto	95.201.875	23.393.660	24,57%
		AVERAGE	24,59%
Belluno	33.485.810	8.305.246	24,80%
Treviso	90.640.667	21.504.590	23,73%
Vicenza	165.613.519	35.863.516	21,65%
Padova	350.199.886	110.722.267	31,62%
Venezia	724.533.007	105.863.849	14,61%
Verona	390.940.987	94.171.011	24,09%
Rovigo	51.899.953	14.840.612	28,59%
		AVERAGE	24,16%

Tab. 3 Shares of property taxes on province capital budget in Tuscany and in Venetia. 2012. (Author's elaboration on data from MEF)

Average share of property income on total municipal income is 24.59% in Tuscany and slightly lower in Venetia, topping at around 30% in towns like Padua, Leghorn and Arezzo.

The Imposta Comunale sugli Immobili – ICI, similar to property tax in the UK and the USA – was introduced in Italy in 1992 as an extraordinary measure made permanent in 1993 by Decree n. 504 of 1992, as an answer to public finance crisis. After a long set of integrations and modification, it was eventually replaced in 2012 by IMU (Imposta Municipale Unica, Single Municipal Tax), by summing up the old ICI with income tax on property. Tax base for IMU has remained the same as for ICI, but with a much higher levy since the multiplier on cadastral rent raised from 100 to 160, as tax rates also were increased: tax rate was 0,4% for ICI, but for IMU it may vary between 0,46 and 1.06%.

As tax base is made up by cadastral rent, the resulting income for a single municipality depends on the nature of its real estate stock: type of property (cadastral category) and reference market value (cadastral rent) are very important in this respect. Bonuses and exonerations exist for primary residence, whereas on other intended uses taxation is heavier and generates much more tax income (fig. 2).
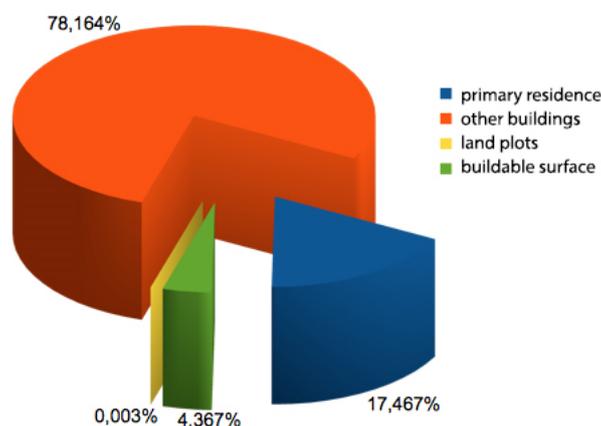

Fig. 2 IMU income distribution by cadastral category (Source: Ministero dell'Economia e delle Finanze - MEF)

This means that tax income of a single municipality is heavily influenced by the presence on its territory of intended uses other than primary residence (tertiary, production, commercial): the municipalities with more production and commerce on their territory will get higher revenue from property tax than, say, others with the same population, same provided services but less presence of those functions.

Since commercial and productive activities are more mobile and highly sensitive to tax differences (S.Piperno, S.Piazza, G. Pola 2006), local governments may have an interest in reducing tax rates in order to attract tax-paying activities, with possible tax competition phenomena.

Big shopping centres, for instance, receive customers from wider areas but contribute solely to the budget of their own municipality, even in case of a small one. They have thus a very variable impact on council finance: if we take some of Tuscany's malls (tab 4), the percentage goes from 0.33% for Centro Commerciale Aurelia Antica to higher values for bigger shopping centers (the so-called "outlets"): Val di Chiana (4,24%), or Barberino del Mugello (4,10%).

	CENTRO COMM. "I GIGLI"	BARBERINO DESIGNER OUTLET	VALDICHIANA OUTLET VILLAGE	CENTRO COMM. AURELIA ANTICA
municipality	Campi Bisenzio (FI)	Barberino di Mugello (FI)	Foiano della Chiana (AR)	Grosseto (GR)
population	45.279	10.840	9.552	81.536
total budget income	36.464.211	11.993.246	7.978.644	95.201.875
total tax income	23.577.578	7.666.010	3.578.463	60.911.333
cadastral rent	186.095,06	513.546,74	224.406,89	281.299,66
IMU rate	1,06%	1,06%	0.99%	1,06%
IMU due	113.918,09	314.367,64	151.626,13	203.506,24
share on tax income	0,48%	4,10%	4,24%	0,33%
share on total income	0,31%	2,62%	1,90%	0,21%

Tab. 4 Share of shopping malls on municipal tax income. (Author's elaboration on data from MEF)

In the above cases, municipalities decided to apply maximum rate to commercial activities, i.e. 1,06%, with the sole exception of Foiano della Chiana, meaning that there is no tax advantage. However, the relationship between highly contributing function and their location may trigger forms of territorial competition by which municipalities take the role of undertakings perfectly able to compete on the same territory (S.Piperno, S.Piazza, G. Pola 2006). It goes without saying that such competition does not necessarily lead to ideal location choices from a territorial point of view.

Even in term of tax legislation, this configures a distortion of fiscal federalism principles. Attribution to local governments of those taxes having a mobile tax base (e.g., construction fees) and an unequal geographical distribution is therefore not advisable, since this could engender phenomena of tax competition, horizontal treatment disparity and tax migration (Lattarulo 2012; Giarda 2002).

The strong link between municipal budget and nature of real estate stock even seems resilient to intermunicipal or wider area planning; on the contrary, it favours choices increasing fiscal independence of a given municipality.

In France, where this phenomenon is particularly evident, tax powers were transferred to supra-municipal bodies by the introduction of *taxe professionnelle unique*; a choice which seems quite difficult in Italy after the abolition of Provinces.

It is clear that the location of highly contributing structures goes beyond commercial and urban planning policies; policy making cannot ignore the influence of these structures on budget reality. In the past this kind of influence did not lead – at least in Tuscany – to tax competition policies, but in a future in which tax resources are bound to remain scarce it would be wise to identify instruments allowing control and integrated management of such aspects.

Beyond these two contribution modes, a third one came to be added in recent times: this is urban equalization, in a variety of possible forms in highly diversified regional models.

Urban equalization does not strictly belong to tax instruments; still, it has an impact on the public city through private sector involvement. Like planning fees, urban equalization is a one-time contribution for a development plan. Charges imposed by urban equalization vary on the basis of different local provisions and formulas: from monetary contributions (value equalization) to the more common transfer of areas or building rights (volume equalization) (Stanghellini 2013).

The classical goal of urban equalization is twofold: equality of treatment for individuals and bodies intervening in urban transformation, on one hand, and an efficient allocation of the resources it generates, on the other (Micelli 2011). In such way, urban rent can be redistributed among all owners of involved areas and a quota of this yield can revert to public sector. The different equalization formulas, which nowadays are well tested, originate form the diverse modulation of those aims.

Forfeiture and compensability of urban constraints, along with the ever growing difficulty for public finance to sustain expropriation costs at market value, have converted equalization into the normal and preferred method for acquiring public areas, a method that experienced a very quick diffusion and implementation in recent years.

Back to its two main aims, urban equalization has a double action: between individual owners of the areas to be transformed (horizontal equalization), so as to redistribute development right in an uniform way; and between individuals and public sector – vertical equalization –, by giving back to society part of urban rent through the transfer of public areas.

In the case of "horizontal" equalization we are dealing with a tool that is quite in line with the provisions of Law 1150 of 1942, whose Article 23 states that development quotas shall be distributed in accordance with land plot value, regardless of permitted uses on the areas. This form of equalization is not socially redistributive and has no influence on fiscal capability of municipalities, because the grand total remains unchanged. On the other hand, "vertical" equalization redistributes part of the yield through the transfer of areas or development rights. Vertical equalization can thus be compared to tax levy, albeit a non monetary one, as based on the quid pro quo principle.

It should be mentioned that, owing to its dependence on economic expansion, urban equalization in both varieties – compensative and redistributive – is highly vulnerable to market recession: if no new areas are to be transformed and economic yield remains unchanged, the quid pro quo between individuals and public authority cannot take place (Micelli 2011).

Urban equalization is sometimes coupled with various form of monetary equalization in order to guarantee better balance between private and public sector, or with aim-oriented forms of contribution for the execution of public works, or again with fees on added value to be used in different budget posts.

Without denying the difficulty of determining such added values – all the more in the turbulent market of a crisis time -, this latter kind of equalization seems most interesting nowadays, as it is less dependent on economic expansion and can be used in urban renewal programs. Last but not least, it can be used as an incentive or disincentive in particular urban strategies or interventions.

Fig. 3 Urban landscape

In more recent times, equalization has assumed an important role in redistributing costs and benefits of structures at an intermunicipal level. This form of equalization, called territorial equalization, does not happen between public and private sector, but between public bodies of same or different level.

As we have seen in the case of shopping malls, the presence of structures capable of capturing users form a wider area is determining for municipal finance, with possible phenomena of territorial and tax competition with no regard to efficient and sustainable spatial planning. These big structures use large-scale infrastructures, but they only contribute to their own municipality, thus completely distorting the fiscal federalism principles.

Just as urban equalization, territorial equalization as well has a double goal: firstly, it aims to equality through a correct distribution of the costs and benefits of a given structure on the territory; secondly, territorial equalization has a more economic objective, i.e. a better allocation of resources by taking advantage of all possible scale economies and agglomeration forms. Territorial equalization should therefore intervene in a very wide spectrum of disciplines: environmental, economic and financial, but also social and institutional ones (Piperno, Piazza, Pola, 2006), in order to assure coherence among different levels of governance.

Examples of territorial equalization remain very limited and mostly confined to the tax field, generally mimicking the French *taxe professionnelle unique* (TPU) by which administrations put in common those resources deriving from the productive structures they share; or even the US experience of tax base sharing (TBS), in which it is tax base what is shared. In Italy, the first example of such legislation is Emilia Romagna's Regional Law n. 2/2000, allowing the creation of mutual funds between local authorities to be financed by planning fees and tax revenue from shared structures. A similar provision was recently adopted by Tuscany (Regional Law n. 65/2014), prescribing territorial equalization for all plans on undeveloped land situated outside already developed areas. Also in this case a mutual fond is foreseen. In other Italian Regions (Venetia, Lombardy, Umbria) less explicit reference is made to equalization, which is left to negotiation and agreements between administrations (Mazzeo, Pinto 2011). Challenges in implementing

such measures derive both from the difficulty of estimating monetary compensation for environmental impact, and from the difficulty of identifying the managers of the shared resources. This latter difficulty became greater with the abolition of provinces. It is easy to demonstrate that the implementation of planning at wider area scale requires the contextual assumption of tax sharing instruments, in order to balance tax revenue and to avoid the risk of planning choices based on too high tax income expectations (Stanghellini 1999). The ultimate goal is thus to prevent forms of tax competition that would undermine institutional cooperation.

3 TAXATION OF AVAILABLE AREAS FOR CONSTRUCTION

Bearing in mind the goals of this article, building land represents an interesting element, for several reasons: first, it constitutes an intersection point between urban planning and tax and finance disciplines; besides, there is a link between planning and expansion resulting in areas for construction as an end product.; furthermore, building land is the economic factor around which urban rent is formed, thus representing the most important economic factor in the building development process. In past times, urban rent formation was the object of a lively ideological debate about taxing land added value. This debate, though, did not lead to real reforms and had the sole effect of introducing INVIM, a new tax on property revaluation (Decree n. 643 of 1972), finally abolished in 1992 and replaced by ICI, nowadays IMU.

In comparison to building taxation, whose tax base is defined by a revaluation of cadastral rent (Laws n. 662 of 1996 and 214 of 2011), taxation on building plots posed several challenges regarding both the conditions for the application of tax and the definition of tax base. The condition for such taxation depends, first of all, on the definition itself of building land for tax purposes. Such a definition was established for the first time with the introduction of ICI (art 2.1/b of Decree n. 504 of 1992): building area is defined as the "area usable for construction in accordance with general urban planning instruments, or on the basis of actual possibilities of construction...". This definition gave rise to several interpretation problems: for instance, there was disagreement on the prerequisite for taxing, successively identified as: the need for immediate use and thus the approval of implementing acts (Court of Cassation, decision n. 21644/2004); the regional approval of the general instrument (Court of Cassation, decision n. 16751/2004); the simple inclusion of that area in the general instrument even if not yet approved (Court of Cassation, decision n. 19750/2004). In the view of such uncertainty, it was initially clarified that a given area is to be considered as buildable "when it may be used for construction on the basis of the general urban planning instrument, even if the corresponding implementing act are still pending of approval" (art. 11/M.16 of Law n. 248/2005). Subsequently, Decree Law n .223/2006 came to add that an area is buildable on the basis of the general instrument, regardless of approval of said instrument and its implementing plans: this means that, for tax purposes, an area is to be considered buildable following the mere adoption of the strategic instrument.

Both legislating bodies and Court of Cassation (decision n. 25506 of 2006) did state that added value from urban development has its origin in the very moment when for a given area a transformation is foreseen even in a distant future.

Aside from legal interpretations, the consequence of such decisions led to a mismatch between the definitions of "buildable" in use in urban planning, on one hand, and in tax policies, on the other. As a matter of fact, if the mere adoption of a general instrument is sufficient for an area to be considered buildable and thus taxable, you need definitive approval of that general instrument, plus of operational and implementing ones, in order to have building rights confirmed on that very area. If we consider building rights as a productive cycle starting when first expenditure is made, this mismatch leads to longer timing because taxes are due sooner.

In the case of Tuscany, where a distinction between general and operational planning is made, the time lapse between start of taxation and approval of implementing plan is on average five years (fig. 4)
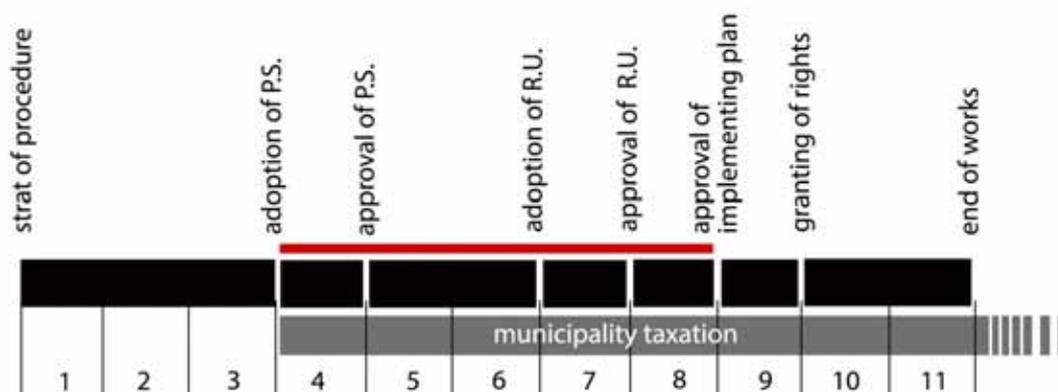
Fig. 4 Duration of planning process in Tuscany (Source: IRPET and Osservatorio permanente della Pubblica Amministrazione)

From a mere fiscal viewpoint, revenue levied in this time lapse, assuming a base rate of 0.76%, amounts to 3.80% of total value of the area, reaching 5.30% in case of maximum tax rate (a widely applied 1.06%). This is enough to erode a significant part of added value originated from the prevision of building on that land, and the erosion can become even bigger in case of further delay.

With such a definition of building land for tax purposes, time becomes an essential issue not only in terms of interest due on capital, but also – and above all – because of land rent eroding possible added value form the transformation. In economic terms, building land looses its value as shelter investment in favour of production. In a not so distant past things were different: numbers were different, and the impact of interest payments was sensibly lower than a yield whose obtainment was certain. Besides, the flowing of time didn't trigger extra costs: before 1993, transformation into building land didn't involve a change of tax regime.

This loss of value in time, plus uncertainty about land rent because of market changes, has been triggering unexpected phenomena: in Tuscany, out of a sample of municipalities (54% of regional total surface), 63% had received requests from individuals asking for revocation of building rights in areas which were already in planning instruments (Cutini; Rusci 2015).

In some cases (Altopascio, Arezzo, Bientina) this phenomenon took such proportions that public administrations have worked out specific instruments for facing revocation requests ("varianti in riduzione", variations for reduction). This phenomenon is unusual in Italy, a country where planning policies of the past fifty years were driven by a rush to transform land into building plots.

In order to mitigate distortions linked to advance tax paying, some local governments identified corrective factors taking into account specific conditions of a given area, thus reducing levy on land still awaiting development. From one side, this reduces the injustice of taxing plots which de facto do not constitute building land; from the other, a new factor of discretion and complexity is introduced in the determination of taxable values, thus giving rise to a great debate, currently still out of the courts.

IMU inherited from ICI the provision according to which the taxable value of a building plot equals its market value at January, 1st of fiscal year (art. 5 of Law 214/2011), in spite of the fact that common statistical or benchmarking data are missing. Tax determination is left to estimates, which, by their very nature, are influenced by evaluator's discretion and market fluctuation. For these reasons, local bodies were given power to autonomously determine reference values (Law Decree n. 446/1997), partly renouncing to their ability to conduct inspections if the owner accepts the estimate. Such estimate should ascertain market value keeping into account all implicit and explicit factors established by Law Decree n. 504 of 1992: geographical situation, urban parameters, intended use, charges and market prices for similar property. However, when examining municipalities' decisions, estimates often do not match market value: this is partly because defining and adapting estimates to every single transformation is objectively difficult, partly because there is

a tendency to underestimate so as to avoid possible litigation. On the other extreme, cases are given in which pre-crisis estimates are much higher than market value.

In the absence of comparable statistical data, resorting to market value is inevitable for building plots. Nevertheless, it is self-evident that such a practice involves a very volatile tax base owing to market opacity (Morano 2014) and strong fluctuations, with high costs for both estimation and inspection. Proposed solutions (Morano 2014; Ciuna 2010) are based on the definition of uniform and codified estimation methods, with the risk those methods could not match real estate quotations.

4 CONCLUSIONS

For over twenty years now, local taxation and urban planning have been regarded as two strongly interconnected areas that do not dialogue. "Taxation and new urban planning legislation" was the title of a paper presented in 1995 at the 21st Congress of Istituto Nazionale di Urbanistica – INU (Stanghellini 1999). Since then, some proposals were turned into operational measures: such is the case of equalization, ICI-IMU and tax benefits (for principal residence and for renovations); other proposals still await implementation (e.g., cadastre reform).

This debate led to overcome the idea that, in decision making, urban planning must be subordinate to local taxation or vice-versa. Nevertheless, new forms of synergy and coordination between the two areas are still to be identified.

The widespread idea that urban planning taxation remains perfectible (Lattarulo 2012) is justified by the absence in Italy of a coordination between fiscal, productive and territorial policies. To scholars, it is clear that the impact of local tax policies (which often aim to respond to short-term budget contingencies) ends up having a determining and lasting influence on space planning, especially in terms of site choice and investment forms preferred by entrepreneurs.

Our analysis casts light on two important elements, bound to be crucial in the next future. On the one hand, the relationship between urban planning and local taxation: spatial and functional choices in planning have an increasingly strong influence on municipalities' fiscal capacity, and guidelines and options in the area of taxation decide the destiny of urban planning provisions. The second element, on the other hand, is the link between local taxation and real estate market as established by fiscal federalism: both revenue from planning fees and income from property taxation (IMU) are subject to real estate market fluctuations, just as local expenditure cycles depend on real estate cycles (Curti 2004).

Territorial governance and local taxation appear today like two equal but opposite forces in local policy: environmental and social sustainability in local governance often seems to collide with financial sustainability and autonomy imposed by fiscal federalism.

If we take into exam the main topics for the urban planning agenda of the last ten years, contradictions in this relationship are self-evident: land consumption mitigation, wider area planning, territorial equalization seem to be antithetical to the needs of financial autonomy imposed on municipalities by fiscal federalism.

As shown, revenue from new development (urban planning fees, construction fees) in some municipalities accounts for more than 10% of total municipal income, thus becoming indispensable for covering current expenditure with a parallel loosening of permitted use. This tendency to linking urban programming to budget needs involves undeniable challenges; but it is also true that dramatic measures of land consumption containment, as those implemented by Tuscany in recent times, might lead in present conditions to the collapse of many local realities.

Even in the case of real estate taxation, which is far more consistent than urban planning fees, there is strong contradiction between territorial and fiscal policies. The amount of tax revenue is dependent on the quality and above all the function of property stock; the more its prestige and the greater the number of other types than principal residence (second houses, production, commerce), the higher tax revenue will be.

It is therefore clear that this strict link between special functions and tax revenue involves forms of tax competition, while hindering supra-municipal planning and the various modes of territorial equalization experimented today. If for urban planning one can envisage shared decision making between municipalities of a same geographic area, those same municipalities will be hardly open to share fiscal income deriving from location choices of wider structures.

Ultimately, gradual cross-linking between municipal revenue and property market variations in the last 20 years (Curti 2004) (this is especially true for planning fees) seems antithetical to stability in the provision of services.

The cadastre reform initiated with Delegated Law n. 23 of March, 11 of 2014 (at the moment the reform is blocked by Government awaiting local tax details) seemed to be an opportunity to establish a link between planning choices and local tax management, thanks to the proposals for a wider and richer property database, plus the correction of present cartography, thus enabling better data exchange between planning and collecting bodies. Many of the aforementioned structural challenges remain nevertheless unresolved: the relationship between rent and property market fluctuations, above all, with a clear contradiction between real market values, which are variable, and cadastral estimates, which are fix.

During these last twenty years, studies and proposals in the areas of taxation and urban planning – i.e. how to manage value added generated by planning – have aimed at two goals: (1) containment of public expenditure through fiscal federalism, making as far as possible provision of services conditional on fiscal capacity of a single municipality; (2) a fairer redistribution (private to private, private to society) of revenue generated by urban transformation, by identifying alternative formulas to those condemned in constitutional court decisions.

The building-up of a substantial urban rent from land regime has been amply studied and challenged by urban planners for over 50 years. It was the basis for the various forms of taxation in time (INVIM, ICI, IMU). This same urban rent fuelled (albeit minimally, owing to inadequate norms) changes in public town; with the introduction of equalization, nowadays it represents a reservoir for future local body resources.

Today, the goal of integrating tax and planning policies appears suddenly changed with the additional need to identify strategies for guaranteeing interventions in an economic context by which real estate investments and plans cannot be taken for granted: just think of the aforementioned example of building rights revocation requests.

This new framework, which apparently might suggest better environmental sustainability in the future, and which some people see as a desirable bursting of a real-estate bubble with no economic foundation, poses severe challenges to public authorities, because local finance and property market are so strongly linked. In this economic context, the first currency to be devalued is the urban planning one, i.e. money paid by private sector to municipalities to compensate for urban transformation through equalization and tax paying.

In other words, local bodies are today business partners running the risk of sharing with the private sector losses caused by the market weakness.

Without denying the challenges posed by the private acquisition of urban rent, it is also true that in recent years we have seen a complete overturning of the economic context without a similar overturning in urban planning action and goals, which remain bound to nowadays marginal topics.

In the light of the above analysis, the link existing between local taxation and urban planning is an indisputable fact. What is still missing is a correct management of this very link by those bearing the responsibility of managing and planning. Potentially positive synergies remain thus unexpressed, and challenges stay unresolved.

An integration between tax instruments and spatial planning appears both useful and necessary to reactivate public policies capable of guiding investments and interventions, even in the absence of expansive dynamics, through forms of tax modulations taking into account the main criteria (such as energy, social questions,

location criteria etc); or through incentives and new tools for joint management at territorial scale. Quoting Robert Venturi, our challenge is to pursue a difficult whole through an inclusive process, instead of an easy whole through exclusion.

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IMAGE SOURCES

Cover image: Competition project – Spinea Italy S. Rusci, G. Ariganello, A. Cipriani

Fig. 1: Francesca Benelli 2015

Fig. 3: Francesca Benelli 2015

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TeMA

Journal of
Land Use, Mobility and Environment

REVIEW PAGES

CITIES, ENERGY AND MOBILITY

Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. During the last two years a particular attention has been paid on the Smart Cities theme and on the different meanings that come with it. The last section of the journal is formed by the Review Pages. They have different aims: to inform on the problems, trends and evolutionary processes; to investigate on the paths by highlighting the advanced relationships among apparently distant disciplinary fields; to explore the interaction's areas, experiences and potential applications; to underline interactions, disciplinary developments but also, if present, defeats and setbacks. Inside the journal the Review Pages have the task of stimulating as much as possible the circulation of ideas and the discovery of new points of view. For this reason the section is founded on a series of basic's references, required for the identification of new and more advanced interactions. These references are the research, the planning acts, the actions and the applications, analysed and investigated both for their ability to give a systematic response to questions concerning the urban and territorial planning, and for their attention to aspects such as the environmental sustainability and the innovation in the practices. For this purpose the Review Pages are formed by five sections (Web Resources; Books; Laws; Urban Practices; News and Events), each of which examines a specific aspect of the broader information storage of interest for TeMA.

01_WEB RESOURCES
The web report offers the readers web pages which are directly connected with the issue theme.

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02_BOOKS
The books review suggests brand new publications related with the theme of the journal number.

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03_LAWS
The law section proposes a critical synthesis of the normative aspect of the issue theme.

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04_URBAN PRACTICES
Urban practices describes the most innovative application in practice of the journal theme.

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05_NEWS & EVENTS
News and events section keeps the readers up-to-date on congresses, events and exhibition related to the journal theme.

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TeMA

有关土地使用、交通和环境的杂志

评述页

城市、能源与移动性

TeMA从城市规划和流动性管理之间的关系入手，将涉及的论题逐步展开，并始终保持科学严谨的态度进行深入分析。在过去两年中，智能城市课题和随之而来的不同含义一直受到特别关注。学报的最后部分是评述页 这些评述页具有不同的目的：表明问题、趋势和演进过程；通过突出貌似不相关的学科领域之间的深度关系对途径进行调查；探索交互作用的领域、经验和潜在应用；强调交互作用、学科发展、同时还包括失败和挫折（如果存在的话）。评述页在学报中的任务是，尽可能地促进观点的不断传播并激发新视角。因此，该部分主要是一些基本参考文献，这些是鉴别新的和更加深入的交互作用所必需的。这些参考文献包括研究、规划法规、行动和应用，它们均已经过分析和探讨，能够对与城市和国土规划有关的问题作出有系统的响应，同时还对诸如环境可持续性和在实践中创新等方面有所注重。因此，评述页由五个部分组成（网络资源、书籍、法律、城市实务、新闻和事件），每个部分负责核查TeMA所关心的海量信息存储的一个具体方面。

01_WEB RESOURCES

The web report offers the readers web pages which are directly connected with the issue theme.

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02_BOOKS

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04_URBAN PRACTICES

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05_NEWS & EVENTS

News and events section keeps the readers up-to-date on congresses, events and exhibition related to the journal theme.

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01

CITIES, ENERGY AND MOBILITY

REVIEW PAGES: WEB RESOURCES

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In this number
SUSTAINABLE MOBILITY POLICIES IN EUROPE AND ITALY: REVIEW, RESOURCES AND TOOLS

In the last decades, sustainable mobility policies at urban scale have gradually seen an increasing interest by the European Commission as they represent some of the key strategies for 'sustainable cities' (Colucci, 2012). The first policy proposals, the "Citizens' Network", date back to 1995 and 1998. They resulted in the launch of a series of initiatives based upon a "best practice" approach. In 2001 Transport White Paper "European transport policy for 2010: time to decide" suggested 60 specific measures to be taken at EU level in the transport sector. In 2005, in order to reduce the energetic and environmental impact of transport, the European Commission adopted the Green Paper "Towards a new culture for urban mobility" whose key issues are: free-flowing and greener towns and cities, smarter mobility and urban transport which is accessible, safe and secure for all European citizens. In 2009, the European Commission adopted the Action Plan on urban mobility. In 2011, Transport White Paper "Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system", had a vision for the future of European transport until 2050. It recommended profound changes in the strategic planning and proposed a series of objectives and concrete measures that focused on transport integration. Moreover, a European Commission study on mobility plans, which were implemented in Europe, places Italy among the countries with a well-established transport planning with its regulatory support and availability of guidelines (Orchi, Valentini 2014). In Italy the Law 340/2000 (art. 22) introduced the PUM (Plan for Urban Mobility) as a long term (10 years), systemic and integrated planning instrument for managing mobility in urban areas. This law did not become immediately operational for lack of both necessary funds and the inadequate definition of the approval procedures for plans. This law and the national guidelines, issued in 2005, promote sustainable approaches aimed at reducing levels of congestion, pollutant and noise emissions and energy consumption. In addition, they promote other more general issues like safety, accessibility and the use of sustainable modes of transport, focusing on land use-transport integration. Such scientific and regulatory efforts in the field of urban mobility appear to assume an increasing emphasis. They underline the need to limit the environmental impacts of transport systems and to encourage sustainable mobility policies.

In this number we present three important web resources: the first one, the Transport Research and Innovation Portal, gives an overview of research activities at European and national level; the second one, Bump mobility, provides city planners, environmental and technical officers in local authorities, with the knowledge and skills to plan and manage sustainable mobility; the last one, Eltis portal, facilitates the exchange of information, knowledge and experiences in the field of sustainable urban mobility in Europe.

TRIP | Transport Research and Innovation Portal
http://www.transport-research.info/

The main objectives that lie at the basis of the development of the Transport Research and Innovation Portal (TRIP) are twofold. The first objective is to improve access to knowledge in the European Research Area and beyond through the appropriate dissemination and promotion of the transport research results. The second objective is to reinforce the link between transport research and transport policy through the provision of accurate, timely and complete information on key deliverables of transport research projects.

Once in the homepage, users can choose to give an overview to research activities at European and national level by clicking on the left navbar. *Country profiles* provide a summary on the organization of transport research in the European Research Area countries: 28 Member States of the European Union and Iceland, Norway and Switzerland. This section includes also overviews for some additional countries like USA, Brazil, etc. At European level, the most important research programme is the Seventh Framework Programme (FP7) which is a multidisciplinary programme devoted to responding to the challenges of making transport more sustainable over the seven-year period (2007–2013). FP7 will be followed by Horizon 2020 which is to run from 2014 to 2020. It is part of the drive to create new growth and jobs in Europe and it has three key objectives: excellent science, competitive industries and better society. Within the institutional framework of transport research, users can find some quick links to founding sources and support initiatives. By clicking one of the countries listed in Country profiles section, you can get information about the related government strategy for research and innovation in the field of transports and about the organizations responsible for the institutional framework and funding. The *Programme* and *Project* sections contain detailed information on national, European and international programmes and projects respectively. TRIP database for projects and programmes can be accessed by selecting the transport theme, the funding origin or the partner. Project information is provided on three levels: *Short profile* includes information on origin and funding of the project, thematic transport themes and available contact point; *Profile* in addition to the above includes background, objectives and methodology; *Results* provide information on key project outputs and final reports that can also be downloaded. In the *Publications* section the series of Policy Brochures and Thematic Research Summaries provide a broader overview of the research conducted at European level and its input into the policy-making process. *Compendium* presents an overview of transport research and funding organizations in the European Research Area. It is available in a digital mapping environment in which relevant organizations involved in transport research and funding are presented on the map of Europe. The *Research Summaries* are focused on transport themes, like "Climate policy and energy efficiency", "Multimodal transport", "Environmental impacts", etc. The *Policy brochures* contained in this section focus on the sustainability of the European transport system and can be downloaded. The themes are smart and competitive railway system, smart and sustainable logistics, employment in transport sector, etc. For each Policy Brochure some videos are regularly released by TRIP. The videos highlight the key elements of the related publication. The *Events* section encloses calendar of high-level international transport conferences whilst the *Newsroom* section contains news of the latest in transport research, policies and innovation, including monthly e-Newsletters. Totally, TRIP showcases over 7300 projects and their associated documents and more than 300 national, European and international transport research programmes. Research and business communities can identify research needs and business solutions; source ideas and partners for new transport research and demonstration projects; use the website to spread knowledge about your own project results. Public service providers can implement innovative solutions and share and find out about good practices in Europe. Investors and technology brokers can source investment opportunities.

BOOSTING URBAN MOBILITY PLANS
http: // www.bump-mobility.eu/

BUMP provides city planners, environmental and technical officers in local authorities, with the knowledge and skills to plan and manage sustainable mobility in urban and peri-urban areas. Moreover, BUMP supports the most committed towns and cities to produce their own Sustainable Urban Mobility Plans.

In BUMP homepage banner, users can rapidly access to the four steps to make urban mobility more sustainable: learn, share, develop and raise. In *Learn* section, users can find a common training programme that can be delivered through six modules on the SUMP process. By clicking on the links provided it is possible to download the 'Integrated support package for the production of Sustainable Urban Mobility Plans (SUMPs)' leading the reader through the training program and providing details on individual issues and a full set of training materials. All training services were provided free of charge to the local authorities selected as beneficiaries through a public call. Local authorities then appointed their representatives as participants in project activities among their planners, environmental and technical officers.

Share section introduces the second step, which consists in the mutual learning stage. In this stage, participants can share expertise and viewpoints on mobility planning and management issues through a series of interactive activities (world-café and role-play sessions) aimed at fostering exchanges among participants coming from different countries. From this section, reader can also download the "Report on mutual learning activities".

In *Develop* section, readers can get information about the development stage of the SUMP. This stage includes professional help and advice from a team of experts appointed to meet the authorities' specific needs and requirements. *Raise* section inform about the opportunity to visit the best-performing towns and cities (the 'BUMP Pioneers') where the BUMP approach has been fully implemented and put into practice, leading to remarkable results in terms of sustainable urban mobility plans and realizations. In this section, people who is interested in can insert their contact to keep themselves updated.

In addition, BUMP home page contains a clear and effective summary that lists the reasons why to adopt a Sustainable Urban Mobility Plan. Another way to navigate the BUMP website is to select one of the sections listed in the upper web bar. *About BUMP* section includes short information about objectives, methodology and partners. In *Resources* section users will find all the useful documents being produced during the project. They will also find the best selection of relevant external links that can help them go deeper in detail on freshly updated contents related to urban mobility and available on the net. They are Eltis portal, SUMP Portal, CIVITAS, CH4LLENGE, ETC. This section is constantly enriched and updated. In the end, *News* section contains the latest news about the project.

BUMP website represents an important reference to support local authorities in the development of Sustainable Urban Mobility Plans for cities with a population ranging from 40.000 to 350.000 inhabitants. The project targets senior officers and directors within local authorities, allowing them to acquire the necessary skills to develop their SUMPs. The results of the project show that 36 new SUMPs have been produced during the project's lifetime (and another 60 by 2020); 180 directors/high-ranking officers and technicians from 90 cities in the 40-350.000 inhabitants range have been trained during the project' s lifetime (and another 200 trained by 2020); 50 new cities have joint the CIVITAS Forum Network during the project's lifetime; 2.000 municipalities in the 40-350.000 inhabitants range have been informed about project activities during the project's lifetime.

ELTIS - THE URBAN MOBILITY OBSERVATORY
http: // www.eltis.org/

Eltis facilitates the exchange of information, knowledge and experiences in the field of sustainable urban mobility in Europe. It is aimed at individuals working in transport as well as in related disciplines, including urban and regional development, health, energy and environmental sciences. Created more than 10 years ago, Eltis is now Europe's main observatory on urban mobility. It is financed by the European Union under the Intelligent Energy - Europe (IEE) programme. Eltis homepage lets readers choose among key themes: *DISCOVER*, *RESOURCES* and *PARTICIPATE*. Through them Eltis provides the information, good practices, tools and communication channels needed to help you turn your cities into models of sustainable urban mobility. The dedicated *MOBILITY PLANS* section offers a hub of information on how to develop and implement Sustainable Urban Mobility Plans (SUMPs) as the need for more sustainable and integrated planning processes in Europe grows. Within DISCOVER section: *News* offers a regular round-up of local, regional and European news related to sustainable urban mobility; *Case studies* presents and analyses successful local examples of sustainable urban mobility initiatives and strategies; *Facts & figures* provides a range of statistical data on sustainable urban mobility topics; *Topics* outlines the key sustainable urban mobility related subjects covered on Eltis; *EU legislation & policies* contains important legislation and policy developments on sustainable urban mobility. The section RESOURCES supports users to act and promote sustainable forms of mobility in their region or city. It consists of six subsections: *Tools* contains guides, handbooks and reports to support and inform urban mobility professionals in their work; *Photos* hosts a gallery of images you can use to promote urban mobility; *Videos* features outstanding examples of sustainable urban mobility approaches; *Training materials* presents training and educational materials produced in the sustainable urban mobility fields; *EU funding* brings together the current EU funding streams and programmes that are accessible for local governments; *Press & promo* contains Eltis and Mobility Plans platform promotional materials (such as logos, templates) as well as materials from events and seminars.

Moreover, Eltis website, in *PARTICIPATE* section, allows readers to share examples of best practice and discuss new and innovative ideas on sustainable urban mobility. As a registered *Friend of Eltis* you can submit content and comment on your colleagues' ideas and initiatives and read more about the benefits of becoming a member; *Events* presents a calendar of important conferences, meetings, workshops and networking sessions; *Job* offers is a noticeboard of current sustainable urban mobility related employment opportunities; on the *Forum*, users can discuss all matters related to sustainable urban mobility.

Eltis website is very engaging and informative.

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Orchi, S., & Valentini, M. P. (2014). Il ruolo strategico dei Piani Urbani della Mobilità Sostenibile in Europa e in Italia. *Energia, Ambiente e Innovazione*, 2-3/2014. doi: 10.12910/EAI2014-60.

IMAGE SOURCES

The images are from: http://www.greenstart.it/; http://www.transport-research.info/; http: // www.bump-mobility.eu/; http: // www.eltis.org/

02

CITIES, ENERGY AND MOBILITY

REVIEW PAGES: BOOKS

GERARDO CARPENTIERI

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In this number
FROM SMART CITY
TO SMART MOBILITY

Urbanization is accelerating at pace, placing new, intense pressures on city resources and infrastructure. Urban Mobility will be one of the toughest challenges for cities around the globe. In many cities, existing mobility systems are already inadequate, yet urbanization and increasing populations will increase demand still further. Cities have traditionally sought to solve such challenges by adding new capacity to match demand. However, a capacity-building approach alone is neither efficient nor sustainable.

Mobility underpins everything we do as individuals, as communities, as regional, national and international economies. People need to move around to secure basic human needs, but mobility is also a luxury, contributing to quality of life by enabling exploration, leisure and recreation. In the city, high quality mobility is a necessity for the success of other urban sectors and the creation of jobs, and plays a key role in cultivating an attractive environment for residents and business. The demand for mobility is growing around the world. People expect safer, easier, healthier and more pleasant solutions. These demands are especially strong in cities, where demographic pressure is causing the main economic, social and environmental challenges of the future to converge.

In a rapidly changing world, mobility is key to sustainable development. Increasing economic, ecological and social aspirations of citizens worldwide, changing consumption and production patterns, and limited natural resources are driving innovation in the transport sector. Transport services and infrastructure are no longer seen as simple means of moving people and goods, but mobility and logistics are increasingly perceived as key agents of change.

Technology has been fundamental to transport throughout human history, but recent rapid advances in information technology promise to transform transport management in ways that would have been inconceivable until recently. Just as information and communication technologies are crucial for sustainable development, so can their use accelerate the "greening" of transportation.

According to these short considerations, this section proposes three documents that help to better understand the issue of this number: The policy brochure Smart and Sustainable Logistics for a Competitive Europe; Urban Mobility in the Smart City Age; 50 BIG IDEAS - Shaping the Future of Electric Mobility.

Title: Smart and Sustainable Logistics for a Competitive Europe
Author/editor: European Commission
Publisher: European Union
Download: http://www.transport-research.info
Publication year: 2015
ISBN code: 978-92-79-43913-1

This policy brochure presents an overview of current and future policy on smart and sustainable logistics and EU-funded research to support development and implementation of this policy. Additional information on transport research programmes and related projects is available on the transport research and innovation portal website at http://www.transport-research.info.

Logistics is central to the EU economy, contributing to economic growth and playing a key role in international competitiveness. With the predicted growth in freight transport, the challenge is to raise the efficiency and competitiveness of the logistics sector and to reduce the sector's environmental impacts. Europe is currently a leader in logistics, with six EU Member States in the global top 10 in logistics performance in 2014 (World Bank, 2014). With the steady growth in freight volumes throughout Europe, the long-term forecast is 80% growth in freight transport by 2050.

In the last two decades, transport-related greenhouse gas emissions have increased substantially, one third of these emissions is attributed to freight transport. With increasing growth in freight transport, EU policy is to improve freight logistics while simultaneously minimising the negative impacts of this growth. The policy focus is to reduce the heavy dependence on fossil fuels (EC, 2011). Constant high levels of CO_2 emissions threaten the EU target of 60% reduction in greenhouse gas emissions in the transport sector by 2050 with respect to the 1990 level (EC, 2012). Currently, 74% of Europe's population lives in urban areas, and the percentage is expected to increase (UN World Urbanization Prospects, 2011). As a result, high density urban areas are increasingly confronted with the impacts of freight logistics in the form of congestion, noise hindrance and air pollution. The urban environment also presents a special challenge for logistics companies. The last mile of the logistic chain, which accounts for a large proportion of shipment costs and complexity of operations, is o en the most inefficient. Thus, distribution and logistics from production sites to distribution warehouses and to customers in urban areas need to be improved. Logistics in urban areas can be improved by implementing new organisational concepts in combination with innovative vehicles. For example, electric vehicles that are particularly quiet are highly suitable for night deliveries to reduce road congestion during rush hours.A priority goal in EU transport policy is to improve the efficiency and to reduce the environmental impact of freight logistics. In support of this policy, research priorities include development and launch of smart logistics concepts especially in urban areas, using advanced information and communication technologies, and promoting eco-innovation in freight transport. Goods delivery accounts for a significant proportion of traffic in urban areas and contributes disproportionately to congestion, air pollution, and carbon emissions. EU policy and research are dedicated to developing efficient freight delivery concepts to reduce congestion and to lower emissions. Research focuses on the introduction of clean freight vehicles and innovative logistics concepts for urban areas.

EU-funded research has developed new approaches to urban freight logistics that contribute to strategies to safeguard the 'liveability' of cities. These approaches include improving vehicle load capacity, raising the efficiency of transhipment operations, and integrating delivery operations in city traffic management. These solutions have been validated in business cases and pilot studies with stakeholders including large and small companies, city authorities and transport authorities. The EU is providing implementation support through research projects and the CIVITAS initiative, which tests and evaluates measures to stimulate efficiency in urban transport logistics.
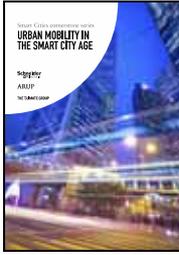
Title: Urban Mobility in the Smart City Age
Author/editor: Arup, The Climate Group and Schneider Electric
Publisher: CHENGDU 2014 GLOBAL SUMMIT
Download: http://digital.arup.com/wp-content/uploads/2014/06/Urban-Mobility.pdf
Publication year: 2014
ISBN code: n.d.

This publication explores how we will move from a reactive approach to mobility services, to a proactive model that anticipates future change and takes advantage of new opportunities. The aim is to provide city and mobility decision-makers with reflections and guidance on developing and adopting sustainable strategies that meet current and evolving challenges.

This publication is articulate in six different chapters: The challenge of Urban Mobility; The promise of Smart Mobility; The structure of Smart Mobility; Smart Mobility and the Role of Data; Bringing the value chain to Life; Mobility: A corners tone of the Smart, Sustainable City.

This chapter establishes the challenge of urban mobility in today's cities. It sets out why mobility is such an important element of the urban sphere, and identifies the drivers which de ne the need for a new approach to mobility.

The first chapter explores the potential for smart mobility to meet the actually challenges. It explains how smart mobility can lead to more efficiently use of transport infrastructure, and alter the way people use transport services by offering them with more and better information.

The second chapter describes some of the services that arise from a smart mobility system, and the advantages that these products can create for travelers, transport operators, urban planners and city governments. Also, this chapter considers the toolkit for building a smart mobility system, which enables the creation of smart services.

The third chapter describes the technology foundations of smart mobility solutions, and introduced the concept of data as the raw material for new mobility services. This chapter describes how smart mobility services are made, focusing on the role of data and how data is used and services are created through an information value chain that brings together stakeholders from across different sectors and verticals. This will help city government, transport operators and industry understand how they need to start thinking about data and operational technologies when commissioning new services-either infrastructure like control centers, or transport modes such as new bus contracts to allow additional economic and social value to be created.

The fourth chapter defines how the new mobility services, building on operational technology and data, are starting to address problems related to peak hour travel demand, while also offering the potential to make cities more livable and successful. Delivering the benefits of these services to a wide range of actors requires multiple data streams from multiple data sources and technologies. This requires an ecosystem approach, in which commercial, organizational, social and technical components are aligned.

This paper show the potential benefits for the mobility sector. But cities are made up of a complex web of overlapping systems, of which Mobility is just one. Energy, Water, Public Services, Buildings & Homes, and Information and Communication Technologies to name but a few are all part of the essential fabric of cities.

This report has considered the opportunities available for cities to improve the operational efficiency and traveller experience of their mobility systems, while generating new economic value. Smart technologies offer incredible potential for sustainable mobility. However, the key messages of this report can also be applied to the other urban sectors.

Title: *50 BIG IDEAS - Shaping the Future of Electric Mobility*
Author/editor: Urban Foresight
Publisher: Urban Foresight
Download: http://www.cleanenergyministerial.org/Portals/2/pdfs/EVI_2014_EV-City-Casebook.pdf
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Cities, businesses, and governments around the world have recognized electric vehicles as an essential part of a smarter and more sustainable future. The multiple environmental, economic, and energy system benefits offered by electric vehicles and hybrid have shaped a broad consensus on why this transformation is essential. The goal of this casebook is twofold to demonstrate the significance of what has been achieved to date and to show how innovative solutions can create new opportunities for electric mobility in the future. Experience suggests that it is unlikely that a single breakthrough or policy intervention will bring about this transformation, but rather a combination of different measures.

This is the second edition of the electric vehicle city casebook explores these future-facing questions. It pro les 50 examples of transformative policies, projects, technologies, and business models that have been implemented in 23 countries across six continents. The 50 Big Ideas presented in this casebook are by no means an exhaustive list of factors that will contribute to this change. However, they do highlight areas of considerable promise for the future of electric mobility.

The impact of each of the Big Ideas has been evaluated against six dimensions to explain its expected contribution to advancing Electric Vehicle adoption and realizing the associated benefits that this will bring:

— RELATIVE ADVANTAGE - Does it give electric vehicle's a distinct advantage over internal combustion engine (ICE) vehicles?

— EASE OF USE - Does it make electric vehicle's more convenient and enjoyable to use?

— VEHICLE PERFORMANCE - Does it enhance the design, construction, and performance of electric vehicles?

— AWARENESS - Does it help people to better understand electric vehicle's?

— ENVIRONMENTAL - Does it provide direct environmental benefits?

— ENERGY SYSTEM - Does it enhance the management and operation of energy systems?

For each Big idea is indicated the degree to which will has a direct impact on each of the six dimensions.

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03

CITIES, ENERGY AND MOBILITY

REVIEW PAGES: LAWS

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In this issue
REGULATORY FRAMEWORK TOWARDS
A MORE SUSTAINABLE URBAN MOBILITY

Urban areas face today the challenge of developing more sustainable transport systems in order to support both their economic competitiveness and environmental health. Indeed, the shift towards a more ecological mobility may considerably reduce greenhouse gas emissions as well as pollution and congestion, having positive consequences to address the issues related to climate change.

By sustainable mobility we mean the mobility model that enables movement with minimal environmental impact while at the same time addressing social interests, in other words, a model whose means of transport consume the least energy and produce less pollution as well as respond to health problems, foster social cohesion and consider a priority the needs of *wick people* (Tiboni, Rossetti, 2012).

In the last decade a great number of measures have been promoted all over the world to improve the sustainability of mobility systems and, in particular, the European Union has played a significant role at international level coming up with various initiatives to make urban transport throughout Europe more efficient and effective. Specifically, this issue analyzes:

- the European Action Plan on Urban Mobility, adopted by the European Commission in 2009;
- the 2010/40/EU Directive on the framework for the development of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport, adopted by the European Commission in 2010.

The Action Plan proposes several actions to help local, regional and national authorities in addressing specific issues related to urban mobility in a coordinated way; it promotes the exchange of best practices amongst the member states and provides funding in order to support the implementations of innovative policies.

On the other hand, the 2010/40/EU Directive aims at accelerating the coordinated deployment and use of Intelligent Transport Systems in road transport across Europe, identifying four priority areas in which work should be further pursued and six priority actions to be promoted.

In order to have a wider framework of the commitments towards the development of a more sustainable mobility system at international level, the last document described in this issue is the new Mexico City's Mobility Law, adopted in 2014 with the goal of promoting public transport, cycling and walking in one of the largest cities in the world. The three documents provide a diverse perspective of the various measures developed to catalyze sustainable transport worldwide.

COM (2009) 490: EUROPEAN ACTION PLAN ON URBAN MOBILITY

The growth of cities and the irreversible consequences of climate change make it necessary to ensure an efficient transport network among European cities as well as within urban areas, where most transport starts and ends. Improvement in transport systems may indeed lead to a significant reduction in congestion, which means less greenhouse gas emissions, pollution and noise and, at the same time, may foster territorial competitiveness ensuring higher level of economic development.

In this framework, and based on the consultations following the presentation of the Green Paper in 2008, one year later the European Parliament drawn the Action Plan of urban mobility up. This Plan "sets out a coherent framework for EU initiatives in the area of urban mobility while respecting the principle of subsidiarity". The aim of the document is give support to policy makers and local administrators both financially and operatively, by providing funding and examples of short and medium term practical actions to be activated within the different geographic contexts.

The plan proposes twenty actions structured in the following six themes:

− *promoting integrated policies* – integrated planning affords insights into the interconnections between the various transport, environmental, urban and industrial sectors, ensuring a wider approach which is more suitable for the complexity of the urban space;

− *focusing on citizens* – the efficiency and attractiveness of urban transport system depend on its reliability, accessibility and safety and for this reason UE wants to improve travel information, accessibility for passengers with reduce mobility and support the spread of a new ecological culture for urban mobility, through different communication tools such as awareness-raising campaign;

− *greening urban transport* – the promotion of environmentally friendly strategies focused on the diffusion of lower and zero emission vehicles represents a key factor for the success of the Action Plan, which confirms the EU financial support for research and demonstration projects related to "green" technologies, vehicles and infrastructures;

− *strengthening funding* – the Commission is aware of the grower need for investments in order to improve urban mobility and for this reason it strengths EU existing funding sources like the Structural and Cohesion Funds, the sub-program STEER and the CIVITAS initiative;

− *sharing experience and knowledge* – exchange of information is fundamental for achieving the ambitious goals of sustainable urban mobility strategies, so the UE encourages the national and international share of best practices and projects developed by virtuous cities. Moreover, the Commission is committed to improving data collection in order to address the lack of statistics about transport and mobility;

− *optimizing urban mobility* – the optimization of urban mobility involves various aspects, for example improving modal shift towards more sustainable modes of transport, facilitating urban freight transport, or encouraging the application of Intelligent Transport Systems (ITS) within the European context.

Each theme represents a specific line of strategy the UE wants to develop for the promotion of a more environmental friendly urban mobility throughout the Continent and up to now several initiatives have been implemented to achieve the previously mentioned goal. The contribution of the UE is of particular importance because authorities and policy makers need support, both economically and operationally, for the development of efficient and innovative solutions.

DIRECTIVE 2010/40/EU ON THE FRAMEWORK FOR THE DEPLOYMENT OF INTELLIGENT TRANSPORT SYSTEMS IN THE FIELD OF ROAD TRANSPORT AND FOR INTERFACES WITH OTHER MODES OF TRANSPORT

In 2008 the European Commission adopted the Action Plan for the Deployment of Intelligent Transport Systems (ITS) in Europe in order to accelerate the implementation of ITS in road transport. In presenting the ITS Action Plan, the Commission also proposed a Directive, which has been formally adopted in 2010.

The 2010/40 EU Directive establishes a framework for the promotion of the coordinated and coherent deployment and use of Intelligent Transport Systems within the European Union.

Specifically, "Intelligent Support Systems means systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport (art. 4). The application of these innovative technologies to the road transport sector represents a crucial step towards energy saving, better environmental performance and the reduction of congestion of road infrastructure.

The main goal of this Directive is to ensure a coordinated implementation of these tools within Europe as a whole, giving priority to the following four main areas of ITS deployment (art. 2):

- optimal use of road, traffic and travel data;
- continuity of traffic and freight management ITS services;
- ITS road safety and security applications;
- linking the vehicle with the transport infrastructure.

For each priority areas, the Directive identifies a number of priority actions (art. 3):

- the provision of EU-wide multimodal travel information services;
- the provision of EU-wide real-time traffic information services;
- data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users;
- the harmonized provision for an interoperable EU-wide eCall;
- the provision of information services for safe and secure parking places for trucks and commercial vehicles;
- the provision of reservation services for safe and secure parking places for trucks and commercial vehicles.

Since the adoption of the ITS Action Plan first and of the 2010/40 Directive later, most member states show active engagement at some level, as described in the Report on the implementation of Directive 2010/40/EU released by the European Commission in 2014, which offers an overview of the twenty-seven national reports provided by the member states in 2011, as requested by art. 17(1) of Directive 2010/40.

The report highlights that numerous initiatives have been developed by the member states in order to promote the application of ITS, responding both to end users' needs as well as operator tasks. Most member states have focused their investments into the first priority area of ITS deployment – the optimal use of road, traffic and travel data – while very little attention has been devoted to the fourth priority areas by now. However, overall, European states are demonstrating a strong interest to promote ITS application throughout Europe.

MEXICO CITY'S MOBILITY LAW –
LEY DE MOVILIDAD

Mexico City, with an estimated population of nine millions in 2014, is part of the most populous metropolitan area in the Western Hemisphere, with over twenty million people. When we think of virtuous examples of sustainable transport in cities, we immediately think of European cities such as Amsterdam and Copenhagen, or highly dense realities such as Singapore or Hong Kong. Nevertheless, this list should also include the capital of Mexico, which has made significant efforts in improving the sustainability of its mobility in the last decade by developing new metro lines and limiting the use of private vehicles. Various measures have been implemented to shift focus towards citizens instead of cars: the Metrobus rapid transit system (BRT) has been created, together with the ECOBICI public bike-sharing system and several downtown areas have been pedestrianized. In addition to these considerable strides, the new Mobility Law has made greater improvement in promoting walking, bicycling and public transport with the ambitious goal of turning Mexico City into an example of sustainable mobility.

Among the most important innovations introduced by the new Mobility Law are (OECD, 2015):

− the introduction of mobility as a right – "Mobility is the right of each individual and of society to move freely and access goods through the different modes recognized in this law";

− the prioritization of road space and financial resources according to a new user hierarchy, which places pedestrians at the top, followed by cyclists;

− the enactment of explicit sustainability principles to guide policy.

Furthermore, the new Mobility Law aims at the creation of a "regulatory body" for transportation operators, so to eliminate the existent fragmentation of the system; this new body would also be responsible for the promotion of a more efficient, safer and inclusive public transport service.

Resilience represents an additional aspect considered by the Mobility Law that, indeed, emphasizes the importance for the city's mobility system to be able to quickly adapt to extreme weather events that are becoming more and more widespread.

Mexico City's commitment for the development of a more sustainable mobility system proves that also enormous urban conurbations can reduce their contribution to climate change and become positive examples of sustainability.

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Fig. 1: https://eu-smartcities.eu
Fig. 2: https://en.wikipedia.org/wiki/Environmental_impact_of_transport
Fig. 3: https://en.wikipedia.org/wiki/Intelligent_transportation_system
Fig. 4: https://en.wikipedia.org/wiki/Trolleybuses_in_Mexico_City

04

REVIEW PAGES: URBAN PRACTICES

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In this number
SUSTAINABLE CITY LOGISTICS: TWO CASE-STUDIES

According to the United Nations Population Fund, in 2009 the proportion of the global population living in urban settings exceeded 50% for the first time in history, with an estimated 3.4 billion people living in urban areas, more than the entire global population in 1960. This trend is expected to continue, with urban areas absorbing all of the expected population growth over the next four decades (UNFPA, 2014).

Due to their large populations and extensive commercial and industrial establishments, urban areas required large amounts of goods and service for commercial and domestic use. The growing importance of urban freight transport is related to increase in urban population and continued economic growth in urban areas. This results in increasing level of demand for freight transport services. Urban freight transport and logistics covers all activities involved in the transport of goods in a city. It involves the delivery and collection of goods and provision of services in town and cities. It also includes activities such as good storages and inventory management, waste handling, office and households removals and home delivery services (Nuzzolo et al., 2013).

Freight transport constitutes a major enabling factor for most economic and social activities taking place in urban areas. In particular, an efficient freight transport system plays a significant role in the competitiveness of an urban areas and represents an important element for the local economy regarding the employment and income that it generates (Russo & Comi, 2010). However, it is a major contributor to environmental impacts, particular to local air pollution, congestion and noise and, as a result, it has an important impact on public health and quality of life. Indeed, as confirmed by several empirical studies, urban freight vehicles account for 6–18% of total urban travel (Figliozzi, 2010), for 19% of energy use and 21% of CO_2 emissions (Schoemaker et al., 2006). As a result, environmental sustainability has become a critical issue in the context of urban freight in the last two decades and many cities around the world have implemented measures to mitigate the negative effects of freight transportation.

In the next sections, two relevant case studies of sustainable city logistic solutions are illustrated:

− The Cityporto of Padova (Italy);
− The Elcidis Urban Consolidation Center of La Rochelle (France);

The analysis presented in the next sections illustrate how an integrated approach to urban logistics can help solve complicated and difficult problems and pave the way to a more sustainable urban freight transport by combining modern technology factors within conventional urban planning tools.

PADOVA

Padova is an Italian medium city (about 250,000 inhabitants) that has a historical city centre recently classified as Human Patrimony by the UNESCO. The main urban transport problems in Padova are traffic congestion and noise, low air quality and large commercial road traffic into the city centre. Like other medium Italian cities, the municipality has defined a restricted access zone (ZTL) to deal with this congestion. For most freight transport vehicles, the access hours to the ZTL are from 10:00 to 12:00 only in working days. Out of these periods, only the residents and authorised categories of vehicles are allowed to enter. An electronic tag identification system has been adopted to increase the access control at the gates of the zone.

In 2004, Cityporto, an innovative city logistics system, was established in Padova's periphery. The Cityporto, proposed by Interporto di Padova S.p.A., the real state and management company related to the intermodal platform, aims to enhance the delivery flows of goods as well as to improve the quality of the city life (Gonzalez-Feliu & Morana, 2010). The project is the result of more than 18 months of an experience that involved the Municipality of Padova, the Interporto di Padova S.P.A., the Province, the local Chamber of Commerce and the transport operators.

The model, laying on the basis of an urban consolidation centre, is extremely simple: logistics operators, above all carriers, deliver their goods to the logistics platform where eco-friendly low impact methane and electric vehicles are loaded. Then these vehicles distribute the goods to the city centre, the so-called "last mile" in the transport chain. The low impact vehicles used to distribute the goods to the city centre have free access to the restricted traffic zone, preferential lanes and are able to park inside the limited traffic zones at any time of the day. The service is dedicated to the subcontracted and direct goods hauliers who work in the city, and will be extended shortly to perishable goods delivery. The tariffs of the service are contracted with each customer, in base of the quantity of freight to be delivered.

A key element of this project is the use of ITC. Indeed, as a support to tactical and operational planning, a strong information system has been developed. The system allows to track in real time the vehicle fleet position, using automatic vehicle location (AVL) web-based tracking system. This allows management to meet customer needs more efficiently. Vehicle location information can also be used to verify that legal requirements are being met.

The logistic platform aims to reduce the negative effects of goods distributions by improving the efficiency of the supply chain. A study of the CLAS Group for the Italian Ministry of Environment pointed out a reduction of the length of the delivery trips and of the total amount of kilometres covered by freight vehicles and related emission. In particular, over a 24 months period, the study has pointed out a reduction of 561,400 km (1,216 km/day on average), a reduction of 58,200 litres of gas consumption (due to less freight transport vehicles circulating) and a reduction of pollutants (51.4 Kg of PM10). Furthermore, in the period 2003 - 2009 (i.e. before and after the opening of the Cityporto) there was a reduction of approximately 67 % of greenhouse gas emissions.

Cityporto of Padova is one of the few experiences of this kind successfully operating in Italy. The model has been taken as an example by many other Italian towns (e.g. Modena, Albano Terme and Como), and every year it is studied by numerous foreign delegations. The Cityporto plan provides a robust economic argument for timely and preventative measures for energy and C02 emission saving in urban good distribution.

LA ROCHELLE

La Rochelle is a medium city (about 80,014 inhabitants) and one of the most important French seaport. It has been the first European city which organized an electric car-sharing system in the city centre and the first French city which organized a public bike rental system. Despite a strong political support for an environmentally approach to transport planning, the city has experienced an increase in traffic congestion and noise over the last twenty yeas (SUGAR, 2011).

In 2001, the Communauté d'Agglomeration de La Rochelle initiated an urban consolidation centre (UCC) in La Rochelle. The objective of the project was to optimise goods distribution in the city's historical centre with an environmentally friendly approach. In particular, the project aims to improve economic and environmental performance of the goods distribution by reducing the number of trips and by maximizing the loading rates of vehicles and the usage of low-pollution urban freight transportation vehicles.

As for the case of the Cityporto, the project lays on the basis of a simple scheme: the transport operators or the self-transporting stakeholders deliver their goods to the urban consolidation centre, located by the train station and next to the historic centre, where they are temporary stored. From this site, low-emission vehicles depart for the distribution of goods in the city centre. In particular, deliveries from the urban consolidation centre are made using nine electric vehicles of which two are equipped with dedicated temperature control for the delivery of perishables. Beside this service, the UCC also offers other auxiliary services with electric vehicles. The manager, Transports Genty, is a private company founded by a competitive tender.

The project is the result of a long process of participation that involved important stakeholders in the process at a very early stage. The success of the La Rochelle UCC is in the first place due to the shared sense of urgency of all stakeholders involved in the process. The good participation is presumably also due to the funds provided by the municipality. Indeed, subsidies are provided by the local government for the infrastructure and a fixed amount per package.

The platform was designed not only to promote delivery using electric vehicles, but also to relieve traffic congestion in the centre by reorganising deliveries. To that end, a new traffic regulation was passed. According to this regulation, heavy freight-delivery vehicles (i.e. GVW exceeding 3,5t) are allowed to deliver within the perimeter only between 6:00 and 7:30 a.m. The time-window management of the municipality encourages transport companies to drop of their goods at the urban consolidation centre.

Today the UCC of La Rochelle serves 1300 businesses and around 30% of the deliveries to the city centre are handled by the urban consolidation centre. This is approximately 450 parcels/day and between 5 and 10 pallets per day. Delivery from the urban consolidation centre to the inner city costs 3.75 euro/parcel. According to a report from the SUGAR project (SUGAR, 2011) the Elcidis Urban Consolidation Centre has brought significant environmental benefits. In particular, the use of electric vehicles has brought a huge benefits regarding exhaust gas emissions, noise emissions and C02 emissions (61% saving). The UCC is successful according to most stakeholders and there are 61% less vehicle kilometres with conventional trucks in the city centre (Patier, 2006). Carriers can avoid wasting time in delivering in the city centre and retailers and residents appreciate better traffic and parking conditions and noticed the general improvement of their local environment (SUGAR, 2011).

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IMAGE SOURCES

The image shown in the first page is from http://logiseconomy.tistory.com; the images shown in the second page is from http://wikipedia.org; the image in the third page is from http://www.linternaute.com.

05

CITIES, ENERGY AND MOBILITY

REVIEW PAGES: NEWS AND EVENTS

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In this number
TRANSPORT ENERGY CONSUMPTION:
A DISCUSSION FOR A WIDER MOBILITY VISION

Nowadays energy consumption is one of the main themes of transport policy. A number of strategies have been designed over the last decades in order to reduce current energy consumption trends in the transport sector. They include fuel taxes, more efficient technologies and changing travel behavior through demand regulation. Indeed, technology progress alone is not able to improve effectively the energy efficiency of the transport system (Lopez et al., 2012); this is mainly due to the structure of the current mobility system, designed for the use of private transport; it is confirmed by the analysis conducted by the European Commission on energy consumption in 2010 in the old continent, according to which the majority (82 %) of the energy is consumed by road transport, and about 2/3 of the total consumption are due to passengers transport. This approach is no longer sustainable: In a simulation made with the *business as usual* method the dependence on oil is expected to remain slightly below 90% and CO_2 emissions remain higher than a third compared to their 1990 level. Next to these numerical data on environmental cost the research finds other interesting data: the cost of congestion would increase by 50%, the gap in accessibility between central and peripheral areas would increase, and the social costs of accidents and noise would continue to grow. Therefore, the challenge is to decouple the transport system from oil dependence without sacrificing its efficiency; it calls into question the whole system and the classical view of efficiency of movements linked exclusively to a non-integrated management of road infrastructure, seeking alternative approaches to optimize the use of all modes of transport and to organize a better complementarity (co-modality) of different transport modes both public and private. Rules that help the transport mode that needs less energy should be implemented. Several studies consider as central point of the question the analysis of the interaction of urban pattern characteristics – such as population density, settlement size, distance from urban centers and transport networks, jobs and housing balance, local neighborhood design, public transport accessibility – and socio-economic characteristics – such as income and car ownership, house tenure and attitude to travel – in relation to the impact on energy consumption of the transport system. In a nutshell it is essential to address the issue of sustainable mobility considering the transport system inextricably linked to all the other main elements of the wider urban system (Gargiulo et al, 2012).

For this reason, in the international conferences selected, the issue of mobility is the core point for the development of broader strategies for sustainable and energy efficient development on a urban and regional scale.

6TH EUROPEAN TRANSPORT RESEARCH CONFERENCE. MOVING FORWARD INNOVATIVE SOLUTIONS FOR TOMORROW'S MOBILITY

Where: Warsaw, Poland
When: 18-21 April 2016

The TRA conference represent one of the most important transport research event in Europe, gathering every 2 years the main stakeholders among the researchers, experts, and policy-makers. Its scope covers all modes of surface transport: road, rail and waterborne, as well as co-modality, in urban, inter-urban and long-distance settings. One of the main assumption of the conference is that the transport represent an important factor for the global competitiveness of Europe. For that reason the organizing committee will give priority to researches and implementation challenges that take into account the following goals:

- The development of common schemes and standards for the interoperability of European transport systems;

- The development of cooperation and competitiveness mechanisms between transport systems in Europe and in the world, to address the evolving needs in the education system to better tackle future industrial and societal needs;

- Ensuring, through a wider vision of transport system, the mobility of people and goods, and thus freedom in the political and economic sense;

- Enabling a better spatial planning so that transport systems provide mobility for people and goods at the highest level of energy efficiency, reliability, and safety.

21ST INTERNATIONAL TRANSPORT AND AIR POLLUTION CONFERENCE (TAP 2016)

Where: Lyon, France
When: 24-26 May 2016

Reduction of fossil energy and the increasing demand for mobility are the central topics of this conference born with the aim of bringing together public authorities and state or local government agencies with jurisdiction over transport or air quality, community groups, operators, commercial carriers, nonprofit and other business entities to share their contributions on the current scientific knowledge of air pollution due to emissions from transport system. The conference goal address the main challenges in transport with respect to energy, environment and economy issues and aims to explore the most advanced research works and innovations, the latest technological and industrial developments and implementations, and innovative policies, in Europe and worldwide, with an emphasis on the following topics:

- Exhaust and non-exhaust emissions from transport modes: measurements and modeling;

- Emission control and Technologies;

- Transport, energy consumption and greenhouse gas emissions;

- Urban and suburban air quality;

- Transport policies and mobility challenges towards cleaner cities.

22ND INTERNATIONAL CONFERENCE ON URBAN TRANSPORT AND THE ENVIRONMENT
Where: Crete, Greece
When: 21-23 June 2016

The complex interactions between urban transport and the environment is the starting point of the conference which aims to provide opportunities for establishing practical action strategies for resolving urban transportation problems.

Clearly the issue of providing effective and efficient transport systems in the urban settings remains an acute challenge with financial, political and environmental constraints limiting the ability of transport system planners and operators to deliver the high quality outcomes expected by the public. Therefore the interaction between academic and practical perspectives is emphasized: theories and ideas are debated and their practical applications rigorously tested. The range of subjects proposed in this conference is really wide covering classical topics of the mobility world as transport security and efficiency as well as more actual one connected with the most pressing challenge of the modern society as climate change, land use reduction and energy efficiency.

INTERNATIONAL CONFERENCE ON TRANSPORTATION & DEVELOPMENT 2016
Where: Houston, Texas, USA
When: 26-29 June 2016

The conference will focus on projects and best practices around the topic of smart transportation that contribute to the development of innovative tools for competitiveness and prosperity. Presentations and panel are called to illustrate how the researches are improving performance to meet the critical mobility and development challenges of a changing operational and competitive environment. It will cover transportation and development planning, financing, functional design, construction, operation, and management.

2016 ACT INTERNATIONAL CONFERENCE
Where: Portland, USA
When: 31 July-3 August 2016

The conference theme is "Mobilizing our Communities"; The ACT International Conference aims to be a collaborative learning community composed by practitioners, government officials, students, researchers, and educators called to develop the next generation of transportation demand and mobility management leadership, technologies, analytics and strategies. The main topics of the conference are:

− Mitigating congestion;

− Enhancing mobility;

− Economic benefits of TDM;

− Energy conservation;

− The future of transportation funding sources;

− Commuter and employee safety.

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