Accessibility Planning tools for sustainable and integrated Land Use/Transport (LUT) development: an application to Rome

Coppola, P. and Papa, E.

SIDT Scientific Seminar 2012

Accessibility Planning tools for sustainable and integrated Land Use/Transport (LUT) development: an application to Rome

Pierluigi Coppola[a], Enrica Papa[a],*

[a]Dept. of Enterprise Engineering University of Rome "Tor Vergata", Via del Politecnico 1, Roma 00133, Italy

Abstract

The paper fits into the themes of sustainable accessibility planning in urban areas, that can be defined as the integration of transport and land use planning to achieve sustainable development. In particular the study proposes a tool to support the choices of activities location, which is based on a new aggregate (zone-specific) indicator: the 'Marginal Activity Access Cost', providing estimation in monetary terms of the impacts on mobility and on the environment of locating one new activity in a specific zone of the urban area. The proposed indicator is validated through an application to the urban area of Rome.

1. Introduction

There is a growing consensus regarding the crucial role of integrated Land-Use and Transport (LUT) policies for more sustainable planning outcomes (Banister, 2008; te Brommelstroet & Bertolini, 2010). Within the LUT approach some studies recognize a paradigm shift from mobility planning to accessibility planning (Bertolini, le Clercq & Kapoen, 2005), where accessibility planning can be defined as the process of "re-orienting the existing urban structure by focusing development at places with high accessibility in order to support an effective public and private transport system" (Curtis, 2008). In fact, many authors agree that accessibility planning is a key strategy to maximize the environmental sustainability and the quality of life in urban areas and at the same time to make the public and private transport systems more efficient (te Brömmelstroet & Bertolini, 2011).

While the (traditional) mobility planning approach is mainly focused at improving transport networks performance, accessibility planning is oriented at maximizing access to opportunities (e.g. workplaces, services, entertainment, …) which are spatially distributed within a given study area. Accessibility planning includes

---

* Corresponding author. Tel.: +39-06-72597059; fax: +39-06-72597053
E-mail address: enpapa@unina.it

mobility planning as "access" depends on the qualities of the transport system (e.g. travel speed, travel distances), but it is more focused on the ultimate goal of movements, i.e. the opportunity to be accessed. In other words, the focus shift can be seen from the "means" (i.e. transport networks and mobility) to the "ends" (i.e. working, shopping …). Accessibility planning, as a strategy for integrated LUT solutions including systems engineering, transport and urban planning, is a main concern not only in the scientific debate but also in the operative field. Despite an extensive literature on the land use-transport interaction has been produced, Straatemeier (2008) suggests that the theory is not well applied in practice. Tools for LUT integrated planning based on accessibility concepts that could support the choices of location of new activities are not widely applied. The gap between the clear theoretical assumptions and the infrequent application of accessibility tools in planning practice shows the need to maximize the usability of accessibility instruments and measures (Hull *et al.* 2012).

Starting from the above considerations, the goal of this work is to develop a tool to support the choices of activities location, which is based on accessibility and transport costs concepts. Assuming that integrated LUT planning entails minimizing the generalized transportation costs (Nuzzolo & Coppola, 2010), in compliance with the objectives of environmental sustainability and quality of life, the tool computes the "marginal access cost" of locating new activities in a particular zone of the urban area, providing an estimation in monetary terms of the impacts on mobility and on the environment.

The paper is structured into three parts. The first part offers an overview of the literature on accessibility planning, while the second part describes the accessibility planning method proposed, based on marginal access cost of activities. In the third part an application of the proposed methodology to the metropolitan area of Rome is discussed and some conclusions are drawn.

2. Accessibility planning: approaches and experiences in Europe

Since the 1990s, urban transportation planning has attempted to enlarge the sphere of its goal from transport network performances to broader environmental and social dimensions (Banister, 2002; Carmona & Sieh, 2008; Hall, 1997). The adoption of such new goals has generated the need of new planning approaches and of new performance measures to monitor progress towards their achievement. In particular they necessitate a highlighting on accessibility rather than the traditional emphasis on increasing personal mobility. The first explicit mentioning of the term "accessibility planning" is given by Cervero (1996), who describes it as an approach that complements the traditional focus of transport planning on mobility, suggesting that a key difference between planning for mobility as opposed to planning for accessibility is between "planning for cars versus planning for people and places".

Some international experiences show interesting example of accessibility as part of planning guidelines and regulations. The pioneering Netherlands approach to transport planning, for instance, embraces different policies and plans aimed at increasing accessibility by public transport and at matching, mobility requirements with accessibility standards of different location typologies. One of the main goals of the new Dutch White Paper on transport and planning (I&M, 2012) is to improve accessibility and one of latest project based on this principle, i.e.s the "StedenbaanPlus" (Geurs *et al.* 2012), pursue the goal of densifing urbanization around more than 30 railway stations and improving station accessibility to increase rail ridership.

In UK, Accessibility Planning is framed in the context of social exclusion within transport planning, focusing on the ability of people to participate in society. According to UK Accessibility Planning Guidance, approved in 2004 (DfT, 2004), a primary focus of Local Transport Plans is to "improve access to jobs and services". Furthermore, it is recommended to local authorities to use a methodology comprising five stages: strategic accessibility assessment, local accessibility assessment, option appraisal, accessibility plan preparation and monitoring. The DfT defines a variety of core accessibility indicators at different scales: from a small geographic

scale to the whole country. It recommends the additional calculation of local accessibility indicators to be used for assessment and monitoring purposes.

Despite some exceptions, and the diffusion of the accessibility planning approach, in most countries there is still concern on how accessibility concepts have to be interpreted and translated into practice. While there is a large body of literature focusing on the theoretical definitions and measurements of accessibility (Handy & Niemeier, 1997; Geurs & van Eck, 2001), the extent to which such measures are useful in assessing the most appropriate interventions is less clear (Geurs & van Wee, 2004; Curl et al., 2011).

The accessibility tools comparison proposed by Hull et al. (2012) shows the variety of accessibility planning goals, tools characteristics and performance, focusing on the usability of the instruments and measures. With different approaches and in different stages of the decision making process, accessibility instruments and measures are used not only to evaluate transportation plans or to monitor their implementation, but also to assess the spatial impacts of transportation projects or new activities locations.

With a view at supporting the decision making process related to the location of new activities and solve the optimal activities location problem, the most used accessibility measures is the "passive or place accessibility", that can be defined such as the ease of an activity to be reached by any potential users, e.g. clients, workers, providers, etc. (Ben-Akiva & Lerman, 1979). In other words, passive accessibility of activities located in the generic zone d is the ease of being reached by all possible users wherever located in the study area. It depends on two factors: an "attractive factor" measuring the total number of potential users located in different zones o and an "impedance factor" representing the travel cost to overcome the spatial separation between the zone o and the zone d.

Place accessibility is in general defined from the individual perspective (i.e. residents or activities), in that it includes individual travel times and costs but does not cope with environmental issues such as the impacts of mobility on environment, e.g. in terms of pollutant emissions. Moreover, accessibility measures are typically a-dimensional: they correspond to an index varying in a numeric scale that does not have any empirical unit of measure, and therefore, can be difficult understood.

To overcome such difficulties a new measure of sustainable accessibility, i.e. the "Marginal Activity Access Cost" (MAAC) has been proposed by Nuzzolo et al. (2013), estimating in monetary terms the impacts on mobility and on environment of locating one new activities in a specific zone of the urban area.

3. The Marginal Activity Access Cost (MAAC)

It is well established that travel demand (i.e. the aggregation of individual trips) is derived from the needs (e.g. working, shopping, …) travelers have to carry out in different locations (Cascetta, 2009) and that it is strictly related to the spatial distribution of the activities (i.e. workplaces, shops, …) among the zones of a given study area. Locating new activities in a zone can modify the potential the zone has to satisfy travelers' needs (i.e. the attractiveness of the zone), and thus can not only alter flows to and from the zone itself, but can also modify the mobility patterns in the whole study area.

Travel demand consists of trips people make to reach their workplace (i.e. commuting trips), and trips people make for several other purposes, e.g. shopping trips. The costs of these trips (i.e. the mobility cost) are related to the costs people perceive from travelling (i.e. internal costs) and the cost they generate on the environment (i.e. external costs). The latter is mainly due to trips by car which produce noises and air pollution.

The "Marginal Activities Access Cost" (MAAC) is an aggregate (zone-specific) indicator aiming at estimating such costs. It is defined as the incremental cost (expressed in monetary terms) on the mobility induced by the location of one single new activity in a specific zone d of the study area. Activities are here expressed in terms of people employed; "one single new activity in the specific zone o", thus, means an increment of n employees in zone d, n being the number of employees of the activity itself.

The MAAC is here computed as the difference of access cost to the zone d, with and without the new activity, under the assumption that the Origin-to-Destination (OD) generalized travel costs are constant; in other terms, the additional mobility induced by the activity has no impacts on network links congestion and on the spatial distribution of other activities in the study area. To keep this assumption be valid, the number of employees of the new activity should be small enough, e.g. be equal to one.

The access cost to zone d includes two components: the first component represents the internal cost, i.e. the generalized travel cost (times and cost on auto and public transport) both of people employed in the new activity (i.e. commuting costs) and of people "attracted" by that activity for other purposes (e.g. shopping); the second component represents the external cost, e.g. the pollutant emissions related to the additional trips those people make by car. Therefore, MAAC can be computed as:

$$MAAC(d) = IMC(d) + ETC(d)$$

where the first component ,"Induced Mobility Costs" (IMC), measures the incremental mobility costs due to trips generated by the activity (i.e. for commuting and other purposes), and the second component, "External Transport Costs" (ETC), measures the impacts that such induced trips generate on the environment, e.g. in terms of air pollution and noise.

3.1. Induced Mobility Costs (IMC)

The induced mobility costs (IMC) component is measured as the incremental generalized travel cost induced by the location of one single new employee in a given zone d, keeping constant the distribution of other activities and the transport network performances (link travel times). It consists of two terms:

- commuting mobility cost, related to the home-to-work trips of the new employee in the activities of zone d;
- other purposes mobility costs, related to the flows of users attracted by the zone for other purposes (e.g. for shopping and leisure).

Thus, the IMC component can be expressed as:

$$IMC(d) = \sum_O \Delta d_{Od} \cdot C_{Od} \tag{1}$$

where:

- Δd_{Od} is the sum of the commuting trips and those trips made for other purposes, induced by the location of the new employee in zone d;
- C_{Od} is the average travel cost from O to d using the available transport modes (e.g. auto and public transport).

The induced demand, Δd_{Od} , can be computed as follows:

$$\Delta d_{Od} = p_{loc}(O \mid d) + \sum_s \left[E_s(O) \cdot \Delta p_{other}(d \mid O) \right] \tag{2}$$

where:

- $p_{loc}(O|d)$ is the probability of residing in zone O of the new employee in zone d ; this can be estimated using residential location models conditional to workplace (Coppola & Nuzzolo, 2011);
- $E_s(O)$ is the number of trips generated from zone O for purpose s, s being several purposes but commuting; this estimated by trip frequency models;
- $\Delta p_{other}(d|O)$ is the variation in the probability of choosing zone d as destination for several purpose but "work", conditional to living in zone O; this can be estimated by trip distribution models.

The OD travel cost, C_{Od} , is expressed in monetary term, and can be estimated as follow:

$$C_{Od} = \%auto_{Od} \cdot (tt_{Auto,Od} \cdot VOT_{Auto} + mc_{Auto,Od}) + \%PT_{Od} \cdot (tt_{PT,Od} \cdot VOT_{PT} + mc_{PT,Od}) \tag{3}$$

where:

- $\%auto_{Od}$, $\%PT_{Od}$ are the modal shares of auto and public transport modes on the OD pair *Od*;
- VOT_{Auto}, VOT_{PT} are the values of times for travelers using auto and public transport modes respectively (in Euro/hour);
- $tt_{Auto, Od}$ is the travel times (in hour) by auto on the OD pair *Od*;
- $tt_{PT,Od}$ is the travel times (in hour) by public transport on the OD pair *Od*, including on-board time, waiting time and access-egress time;
- $mc_{Auto, Od}$ $mc_{PT,Od}$ the monetary costs using auto and public transport modes respectively, on the OD pair *Od*.

3.2. External Transport Costs (ETC)

   External transport costs (ETC) component, usually referred to as "externalities", measures wider impacts on economy, environment and public health: pollution, noise, climate change, vibration, severance, visual intrusion, loss of important sites, resource consumption, impairment of landscape, soil and water pollution. European-wide reviews of external costs of transportation are provided in several studies including IMPACT (Mailbach et al., 2008) and HEATCO (Odgaard et al., 2005).

   In this study, the external transport costs component is measured as the incremental external cost due to additional distances travelled by car, induced by the location of one new employee in a given zone d. It includes climate change, air pollution, noise, road safety and congestion. The induced mobility cost IMC component can be expressed as:

$$ETC(d) = \sum_O \sum_i \Delta veich_{Od} \cdot dist_{Od} \cdot \alpha^i \tag{4}$$

where:

- $\Delta veich_{Od}$ is the sum of the induced trips by car (converted into vehicles), including commuting trips and those for other purposes, induced by the location of the new employee in zone d;
- $dist_{Od}$ is the distance on the road network between zone O and zone d;
- α^i is the unitary external cost (expressed in Euro/Vehicle-Km); this values have been adapted to the case study based on the literature, see Table 1.

Table 1. Unitary external costs for passenger trips by car

	Climate change	Air pollution	Noise	Accidents.	Congestion.
Passenger trips [cent €/vehicle-km]	4.50	18.62	10.08	20.92	16.85

3.3 Some remarks

As we have seen, MAAC measures the impacts on mobility costs (internal and external) of locating an activity in a given zone. The induced trips by the activity may depend on the typology of such activity, i.e. one employee in commerce, education, services may attract a different number of trips. Therefore, several types of MAAC indicators can be defined according to activity sector.

Moreover, since such impacts vary from zone to zone, the proposed indicator gives an estimation of the differentiated impacts of locating activities in different zones of the urban area, and could be useful to assess land-use and transport development policies in compliance with the goal of reducing the overall transport cost. In fact, it does not measure the "opportunities" of an activity to be reached but the cost of location of a new activity for the whole community due to induced mobility.

To perform the computation of the MAAC, spatial Land-Use Transport Interaction (LUTI) models, particularly residential location models, trip generation-attraction and modal split models, are needed. In the application presented in the next paragraph, the LUTI model STIT (Nuzzolo & Coppola, 2005) is adopted. This allows to estimate the spatial distribution of the residents conditional to workplace and the origin-destination matrices by mode and purpose, using random utility models.

Finally, the MAAC has a clear and easy communicable unit of measure (i.e. Euro). This constitutes a great advantaged for the stakeholders' engagement and in general in the communication phase, as it can be easily understood.

4. The application to the urban area of Rome

The proposed indicator has been validated through an application to the urban area of Rome, which is the Italian most populated urban area, with 2.8 million residents in 1,285.3 sqkm and 1.1 millions of employees, contributing to about 600,000 trips in the morning peak hour..

The structure of Rome Municipality is strongly mono-centric. It can be split into circular rings with increasing densities approaching the city center. The "Grande Raccordo Anulare" GRA, i.e. the circular freeway of approximately 68 km of length, delimits the most dense and populated area, with an average density of population of about 70 inhabitants/ha and an average density of employees of about 75 employees/ha. Inside the GRA area population and activities are mainly placed along radial roads to/from the city center (i.e. the access roads to the ancient roman town). The transit system consists of two (as well radial) metro lines with a total length of about 36 km, with only an interchange node in the "Stazione Termini" central rail station. Seven regional rail lines connect the surrounding urban areas to the city center. Rome has a very high level of automobile ownerships (more than 700 for 1,000 persons) and the road network is highly congested. In large part of the historical center, access by car is allowed only to the residents and public transport vehicles.

The application has been implemented into two steps, related to two separate objectives: to validate MAAC indicator and to use it to assess some location choices made by the new Urban Development Master Plan, i.e. "Piano Regolatore Generale" (for a synthetic description of the plan see also Nuzzolo & Coppola, 2008).

In the first phase, four different clusters of zones (the zoning consisting of 463 zones covering the whole study area) have been defined within the study area, according to two indicators: proximity to city center and accessibility to public transport within the zone. Accordingly, four different clusters have been identified (see Figures 1 and 2):
- cluster A: made by traffic zones close to the city center, with low accessibility to Public Transport (PT);
- cluster B: made by traffic zones close to the city center, with high accessibility to PT;
- cluster C: made by traffic zones far from the city center, with high accessibility to PT;
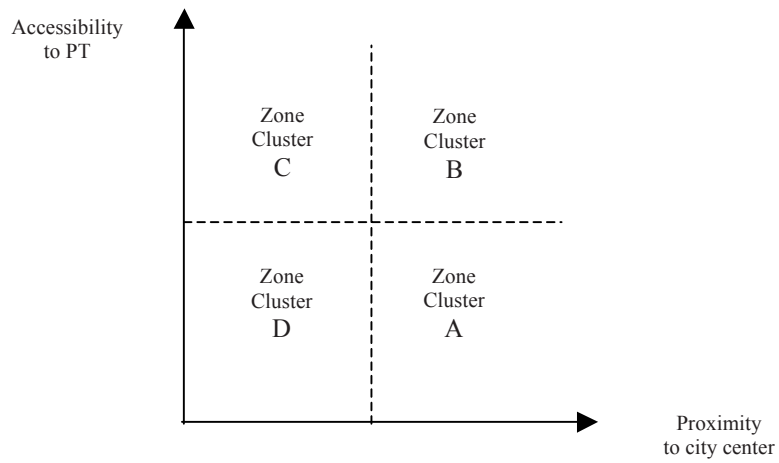- cluster D: made by traffic zones far from the city center, with low accessibility to PT.

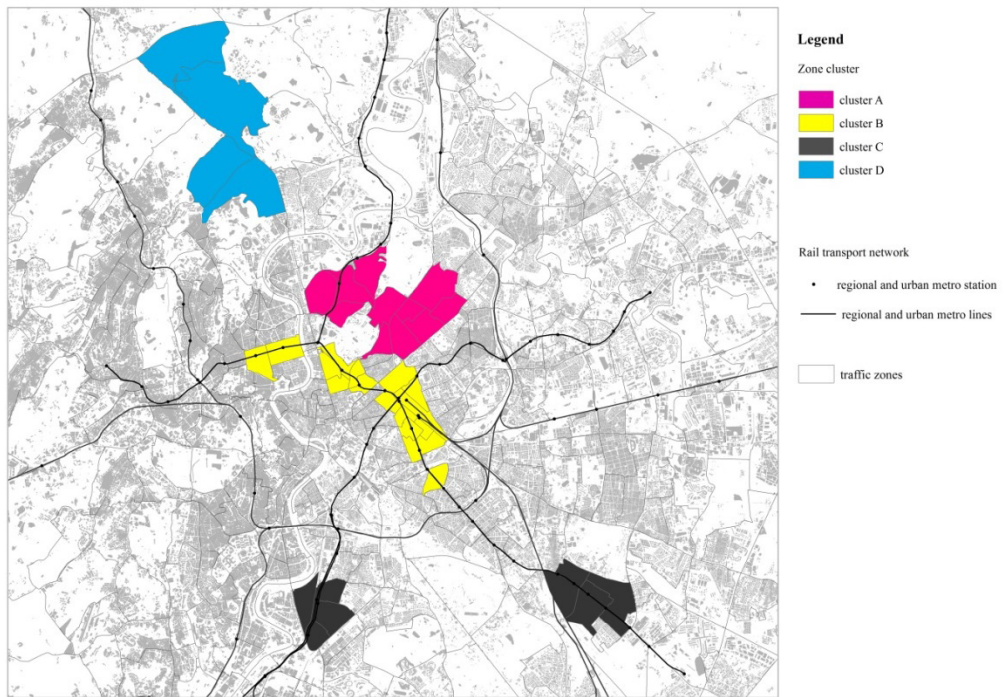Fig. 1. Criteria for zones clustering

Fig. 2. Selected zones clusters

For each area the MAAC has been calculated, differentiating the IMC component, which is linked to the cost of individual mobility (travel time, fuel consumption and parking fees), and the ETC component, which is related to pollutant emissions and other externalities of vehicles trips. The scatterplot of MACC values for the traffic zones belonging to the clusters with respect to the accessibility to public transport within the zone does confirm the validity of the clustering criteria adopted. Indeed, areas belonging to the same group are bounded in a specific area of the graph. The same occurs for the other criterion identified for zones clustering, i.e. proximity to city center (Figure 3).
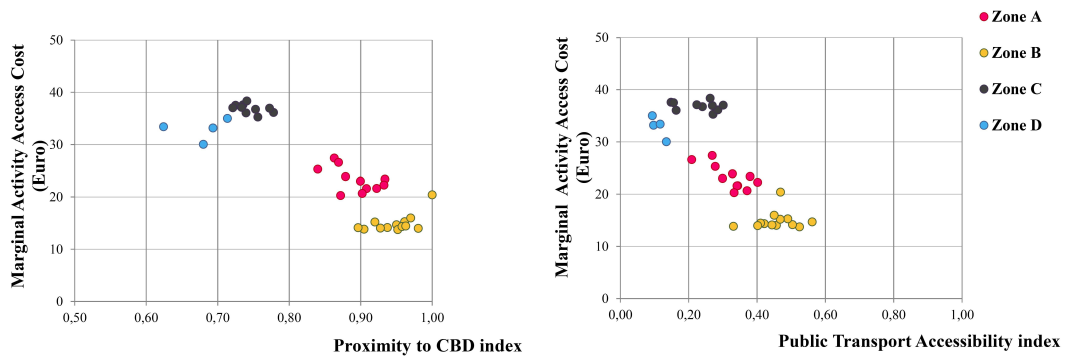

Fig. 3. MAAC scatterplots w.r.t. proximity to city center and Public Transport accessibility

From the analysis of the mean values of the MAAC measured in the different zones clusters, as summarized in Table 2, some conclusions can be drawn.

Table 2. Average values of MAAC for the 4 identified clusters

	IMC (a)	ETC (b)	MAAC (a+b)
	[€]	[€]	[€]
Cluster A: close to city center and low accessibility to public transport	12.4	10.9	23.3
Cluster B: close to city center and high accessibility to public transport	9.7	5.0	14.8
Cluster C: far from city center and high accessibility to public transport	18.4	18.5	36.9
Cluster D: far from city center and low accessibility to public transport	15.7	19.7	35.4
Mean value	14.0	13.5	27.6

First, proximity to city center (i.e., in the case of Rome, proximity to more densely urbanized districts) is a key factor in determining the marginal activities access cost. In fact, the areas close to city center, i.e. clusters A and B characterized by higher population and activities density, present values of both IMC and ECT lower than the zones far from the city center with low density of settlement, i.e. clusters C and D (Figures 4 and 5). This depends on the fact that central zones are located in barycentric position with respect to residents and other activities, and, therefore, the average trips length, and consequentially the (internal and external) travel costs to access these zones are lower than for trips to access peripheral zones.

Second, high accessibility to public transport present ETC values lower than those characterized by low accessibility, due to less volume of vehicles directed towards these zones: fewer trips by car means lower emissions and therefore smaller external costs. This phenomenon is much less marked in peripheral areas where the road network is less congested, and the modal shares of public transport tend to decrease.
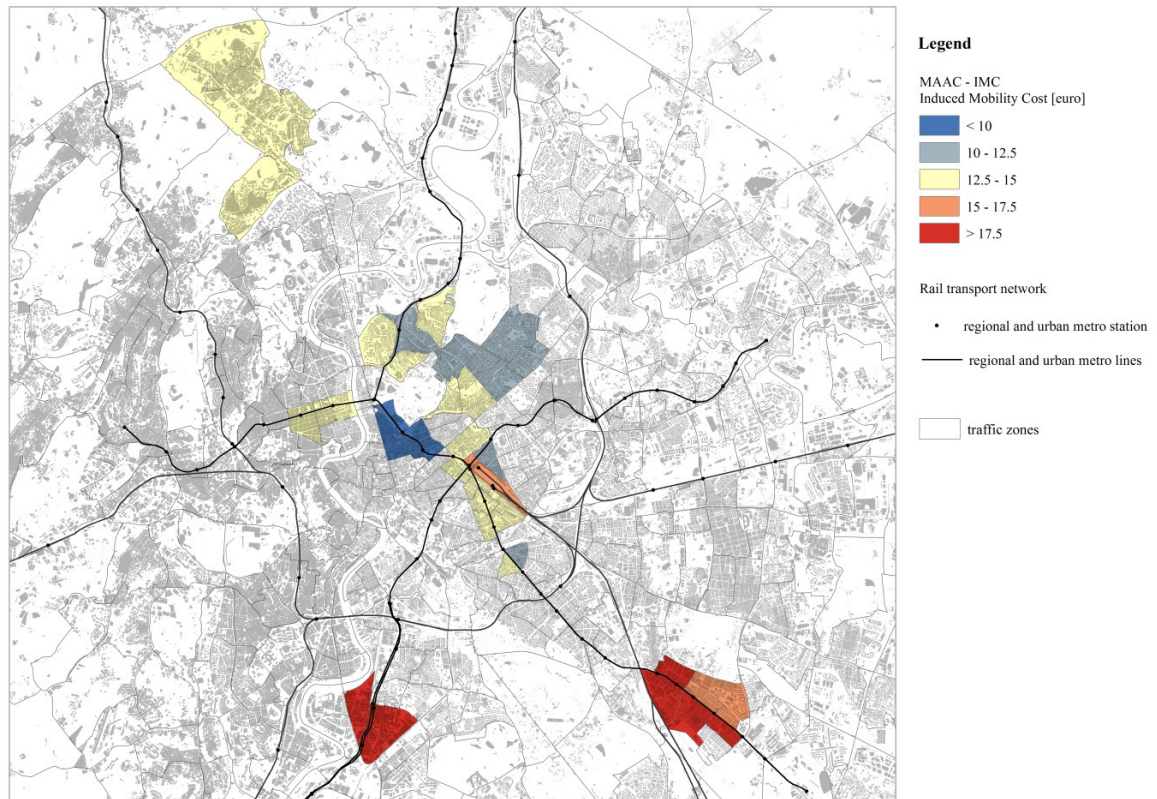
Fig. 4. Induced Mobility Costs (IMC) component for the selected zones

The combination of the above two effects yields that among the zones close to city center (i.e. high density), those with prevailing accessibility to public transport have a lower MAAC (cluster B) than areas with low accessibility (cluster A). On the other hand, among the zones far from the city center, since access travel time by public transport is less "competitive" than access travel time by car, zones with higher accessibility to public transport (cluster C) present MAAC greater than zones with low accessibility (cluster D). In fact, the IMC is greater for these zone (low PT accessibility), and the ETC is almost the same as for zones with high PT accessibility. Therefore, the reduction of vehicle emission due to less volume of car accessing peripheral zone, areas with high accessibility to public transport do not compensate the greater access travel times and cost of travelling by public transport with respect to those using the car.
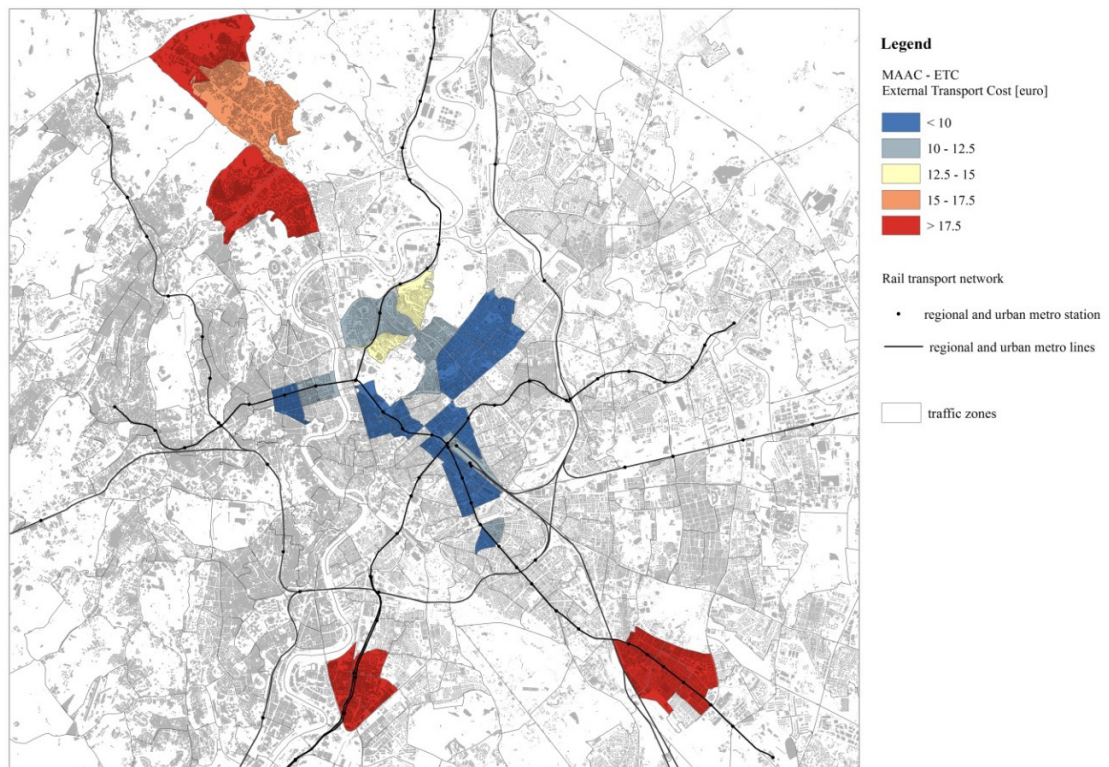
Fig. 5. External Transport Cost (ETC) component for the selected zones

Finally, Table 3 reports the ICM components related to commuting trips and those for other purposes. It can be observed, first that commuting marginal access costs are lower than those for other purposes, due to a lower average travel distance from home to work than for moving for other purpose (e.g. leisure).

Table 3. Induced mobility costs IMC for trip purpose (home to work and other purposes) for zone clusters

Clusters	IMC home to work (a) [€]	IMC other purposes (b) [€]	IMC (a+b) [€]
Cluster A: near the city center and low accessibility to public transport	4,2	8,2	12,4
Cluster B: near the city center and high accessibility to public transport	3,8	6,0	9,7
Cluster C: far from the city center and high accessibility to public transport	4,0	14,4	18,4
Cluster D: far from the city center and low accessibility to public transport	5,6	10,1	15,7
Mean value	4,4	9,7	14,0

Moreover, while the "commuting" MAAC components have a limited range of variation among the clusters, the "other-purposes" ones are much lower (about 40% less) for zones close to the city center than for the peripheral ones. The explanation arises from the consideration that the distance of the residence from the workplace zone does not vary with the distance from the city center; in other terms wherever the workplace is located, either in the city center or in the suburbs, the average distance home-to-work (and thus the average commuting access cost) is almost invariant. This is not true for other purpose trip where the average access distance is greater for peripheral zones (clusters C and D) than for more barycentric zones of clusters A and B.

In a second step the proposed method was applied to test the new development proposed by the new Urban Master Plan. In particular, we calculated the marginal activity access cost to the "new centralities" defined by the plan, i.e. new urban developments along the rail network axis, in which the plan locates new settlements with about 120,000 new employees in various sectors (Figure 6).
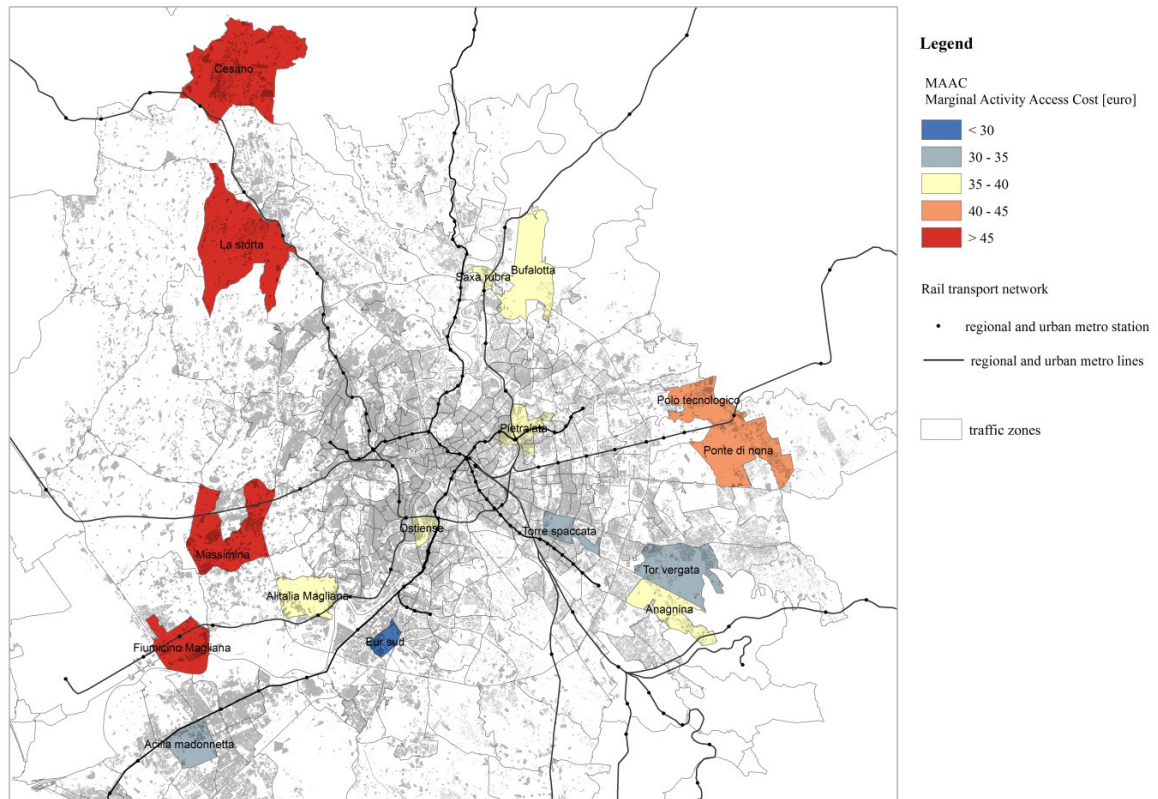

Fig. 6. Average values of MAAC for the new "centralities" defined by the Master Plan of the Municipality of Rome

The MAAC values for such "centralities" allow to validate the location choices proposed by the Master Plan, from the perspective of the impacts on transport cost and related externalities. As can be seen from Table 4, the "Tor Vergata" and "Eur Sud" centralities proposed in the Master Plan present lower MAAC values than other peripheral centralities. Among the latter, Fiumicino-Magliana, Cesano and La Storta, are so far from urbanized area as to have very high MAAC, especially for the external transport costs (ETC) component. These seem to be not sustainable locations for new settlements.

Table 4. Average values of MAAC (induced mobility costs IMC plus external transport costs ETC) for new Master Plan Centralities

Master Plan new centralities	IMC component (a) [€]	ETC component (b) [€]	MAAC (a+b) [€]
Fiumicino Magliana	21.8	31.9	53.7
Cesano	18.6	34.0	52.6
Massimina	20.5	31.5	51.9
La storta	17.6	29.8	47.4
Polo Tecnologico	16.5	24.1	40.6
Ponte di Nona	16.0	24.1	40.1
Bufalotta	16.1	23.5	39.6
Alitalia Magliana	16.8	21.8	38.6
Saxa Rubra	15.4	21.8	37.2
Anagnina	14.8	21.6	36.4
Pietralata	17.5	18.2	35.7
Ostiense	18.4	16.8	35.2
Torre Spaccata	15.4	17.6	33.1
Acilia Madonnetta	14.0	17.7	31.7
Tor Vergata	13.7	17.8	31.4
Eur sud	14.0	15.9	29.8
Mean value	16.7	23.0	39.7

5. **Conclusions**

This paper proposes an aggregate (zone-specific) indicator, the Marginal Activities Access Cost (MAAC), to measure the impacts of locating new activities on transport system and related externalities. In line with the goals of accessibility planning, aiming at sustainable and integrated Land-Use and Transport (LUT) development, this indicator is an useful tool to assess the location choices of new activities and it does represent an important step towards a more comprehensive approach to measuring and presenting accessibility changes for policy makers. Unlike the existing aggregated accessibility measures, the MAAC takes into account not only individual travel time and costs (IMC) but also external costs (ETC) and has a clear and communicable unit measure (Euro). At the same time it has a strong theoretical base, as it is based on widely consolidated Land Use and Transport Interactions models.

Two applications to the urban area of Rome have been presented: the first aiming at validating the proposed tool for zones clusters identified by accessibility to Public Transport and proximity to city center; the second application aiming at assessing the strategies of the new Master Plan of the Municipality of Rome in term of mobility costs and related externalities.

It resulted that proximity to city center (i.e. in the mono-centric case study of Rome, proximity to more densely urbanized districts) is a key factor in determining the marginal activities access cost: the areas close to city center present values of both IMC and ECT lower than the zones far from the city center with low density of settlements.

Moreover, zones with high accessibility to public transport present external cost component (ETC) lower than those characterized by prevailing accessibility by car, due to less volume of vehicles directed towards these zones: fewer trips by car mean lower emissions and therefore smaller external costs. This phenomenon is much

less marked in peripheral areas where the road network is less congested, and the modal shares of public transport tend to decrease.

Finally, the MAAC has allowed to assess the new location choices proposed by the Master Plan of the municipality of Rome, identifying critical issues related to those "centralities", i.e. Fiumicino-Magliana, Cesano and La Storta, which have so high MAAC to seem not sustainable for new settlements.

Further research and improvements will regard: adding an energy cost component in the external transport costs ETC; applying the indicator to other metropolitan areas that have a polycentric urban structure in order to verify usability and transferability of the proposed tool to different urban contexts (mono-centric vs. polycentric urban areas).

References

Ben-Akiva, M., & Lerman, S. (1979). Disaggregate travel and mobility-choice models and measures of accessibility. In D. A. Hensher & P. R. Storper (Eds.), *Behavioral Travel Modelling* (pp. 654-679). London: Croom-Helm.

Banister, D. (2002). Transport Planning. Spon Press, New York.

Banister, D. (2008). The sustainable mobility paradigm, *Transport Policy, 15 (2),* 73-80.

Bertolini, L., le Clercq, F., & Kapoen, L. (2005). Sustainable accessibility: a conceptual framework to integrate transport and land use plan making. Two test applications in the Netherlands and reflection on the way forward. *Transport Policy, 12 (3),* 207-220.

Carmona, M., & Sieh, L. (2008). Performance measurement in planning towards a holistic view. *Environment & Planning C, 26*, 428-454.

Cervero, R. (1996). Paradigm shift: From automobility to accessibility planning (Working Paper No. 677, Institute of Urban and Regional Development). Berkeley, CA: University of California.

Cascetta E. (2009). *Transportation Systems Analysis: Models and Applications*. Springer Ed.

Coppola, P., & Nuzzolo, A. (2011). Changing accessibility, dwelling price and the spatial distribution of socio-economic activities. *Research in Transportation Economics*, *31(1),* 63-71.

Curl A., Nelson, J. D., & Anable, J. (2011). Does Accessibility Planning address what matters? A review of current practice and practitioner perspectives. *Research in Transportation Business & Management, 2*, 3-11.

Curtis C. (2008). Planning for sustainable accessibility: the implementation challenge. *Transport Policy, 15*, 104-112.

DfT (2004). Accessibility Planning: Full Guidance. UK Department for Transport (http://www.dft.gov.uk/).

Geurs, K. Maat, K. Rietveld, P. & de Visser, G. (2012). Transit Oriented Development in the Randstad South Wing: goals, issues and research. Paper for the conference 'Building the Urban Future and Transit Oriented Development', Paris, France.

Geurs K.T., & van Eck J.R. (2001). Accessibility Measures: Review and Applications. Rijksinstituut voor Volksgezondheid en Milieu (National Institute of Public Health and the Environment, RIVM) and Urban Research Centre, Utrecht University. Bilthoven/Utrecht, Netherlands.

Geurs K.T., & van Wee B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport Geography, 12*, 127-140.

Hall, P. (1997). The future of the metropolis and its form. *Regional Studies*, 31(3), 211-220.

Handy, S. L., & Niemeier, D. A. (1997). Measuring accessibility: An exploration of issues and alternatives. *Environment and Planning A, 29*, 1175-1194.

Hull A., Papa E., Silva C., & Joutsiniemi A. (2012). Discussion on accessibility instruments. In Hull A., Silva C., Bertolini L. (Eds.), *Accessibility Instruments for Planning Practice* © COST Office.

I&M (2012). Structuurvisie Infrastructuur en Ruimte (white paper on transport and planning). Ministerie van Infrastructuur & Milieu, Den Haag.

Maibach, M., Schreyer, C., Sutter, D., Van Essen, H. P., Boon, B. H., Smokers, R., & Bak, M. (2008). *Handbook on estimation of external costs in the transport sector. Internalisation Measures and Policies for All external Cost of Transport (IMPACT)*. CE Delft.

Nuzzolo A., & Coppola P. (2005). S.T.I.T.: a system of mathematical models for the simulation of land-use and transport interactions. Proceeding of the European Transport Conference, Strasbourg, France. © AET and contributors 2005.

Nuzzolo A., & Coppola P. (2008). Infrastrutture di trasporto e assetto territoriale nell'area metropolitana di Roma. In: Marescotti L. E Mussone L. *Grandi infrastrutture per la mobilità di trasporto e sistemi metropolitani*: Milano, Roma e Napoli, (pp. 29-53). MILANO: Libreria Clup.

Nuzzolo A, & Coppola P. (2010). Pianificazione dei Trasporti (Transportation Planning). Paper written for the Italian Encyclopedia of the New Millennium: Istituto della Enciclopedia Italiana Treccani. XXI secolo - L'Universo fisico. (pp. 545-556) © Treccani, Roma.

Nuzzolo A., Coppola P., & Papa E. (2013). An indicator of accessibility and mobility costs. Proceeding of the Euro Working Group on Transportation (EWGT), Porto, Portugal (forthcoming).

Odgaard, T., Charlotte K. & James L. (2005). Current Practice in Project Appraisal in Europe, HEATCO - Developing Harmonized European Approaches for Transport Costing and Project Assessment, Deliverable 3; prepared for the European Commission.

te Brömmelstroet, M., & Bertolini L. (2010). Integrating land use and transport knowledge in strategy-making. *Transportation*, *37*, 85-104.

te Brömmelstroet M., & Bertolini L. (2011). A transition towards sustainable strategy making: integrating land use and transport knowledge types. In J.A.E.E. van Nunen, P. Huijbregts & P. Rietveld (Eds.), *Transitions towards sustainable mobility: new solutions and approaches for sustainable transport systems*, 19-40. Berlin: Springer.

Straatemeier, T. (2008). How to plan for regional accessibility. *Transport Policy, 15(2),* 127-137.