

WestminsterResearch

<http://www.westminster.ac.uk/westminsterresearch>

Testing a gravity-based accessibility instrument to engage stakeholders into integrated LUT planning

Papa, E., Coppola, P., Angiello, G. and Carpentieri, G.

This is an electronic version of a paper presented at the *Joint Conference CITTA 7th Annual Conference COST TU1002 Final Conference*, Oporto, 2014 .

The WestminsterResearch online digital archive at the University of Westminster aims to make the research output of the University available to a wider audience. Copyright and Moral Rights remain with the authors and/or copyright owners.

Whilst further distribution of specific materials from within this archive is forbidden, you may freely distribute the URL of WestminsterResearch: (<http://westminsterresearch.wmin.ac.uk/>).

In case of abuse or copyright appearing without permission e-mail repository@westminster.ac.uk

*BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS*

X I intend to have this conference paper considered for the selection of best papers to be submitted to the special issues.

Testing a gravity-based accessibility instrument to engage stakeholders into integrated LUT planning

Enrica Papa 1, Pierluigi Coppola 2, Gennaro Angiello 3, Gerardo Carpentieri 4

1 Department of Civil Engineering - Center for Mobility and Spatial Planning AMRP
University of Ghent, enrica.papa@ugent.be
Phone: +32 09 3313256

2 Department of Enterprise Engineering
University of Rome Tor Vergata, coppola@ing.uniroma2.it
Phone: +39 06 72597059

3 Department of Civil, Architectural and Environmental DICEA
University of Naples Federico II, gennaro.angiello@unina.it
Phone: +39 081 7685978

4 Department of Civil, Architectural and Environmental DICEA
University of Naples Federico II, gerardo.carpentieri@unina.it
Phone: +39 081 7685978

Abstract

The paper starts from the concern that while there is a large body of literature focusing on the theoretical definitions and measurements of accessibility, the extent to which such measures are used in planning practice is less clear. Previous reviews of accessibility instruments have in fact identified a gap between the clear theoretical assumptions and the infrequent applications of accessibility instruments in spatial and transport planning.

In this paper we present the results of a structured-workshop involving private and public stakeholders to test usability of gravity-based accessibility measures (GraBaM) to assess integrated land-use and transport policies. The research is part of the COST Action TU1002 "Accessibility Instruments for Planning Practice" during which different accessibility instruments were tested for different case studies. Here we report on the empirical case study of Rome.

Keywords: Accessibility tool; structured workshops; integrated land-use and transport planning

1 Introduction

The lack of common languages and shared tools that can support transport and spatial planners in developing strategies, and the absence of implementation into practice of the Land-Use and Transport integrated planning support tools, e.g. Accessibility Instruments (AI), are considered in literature as the main barriers to integrated spatial and mobility planning (te Brömmelstroet & Bertolini, 2008).

Starting from the above concern, this research aims at understanding whether, how, and to what extent, barriers to integration can be overcome through a learning process, that involve practitioners and researchers working in different fields.

According to the experiential learning theory ELT, self-directed learning processes are powerful and effective methods for facilitating and inspiring individuals and groups and for organizational learning and development (Kolb & Kolb, 2012). These principles are based on the iterative sequence of interlinked knowledge and experience, reflection and action, with one nurturing the other. This relationship was a core concern of American pragmatism, according to which human practices are based on more dimensions of 'knowing' than the merely cognitive sort of knowledge experts typically contributes (Straatemeier et al., 2010). This key pragmatist notion has been further articulated and made operational in the field of education by Kolb and Fry (1975): the observation and reflection on concrete experience leads to the forming of abstract concepts, which are then tested in new situations, eventually resulting in the adaptation of existing practices (i.e. concrete experience). The process is based on a learning cycle driven by the resolution of the dual dialectics of action/reflection and experience/abstraction (Figure 1).

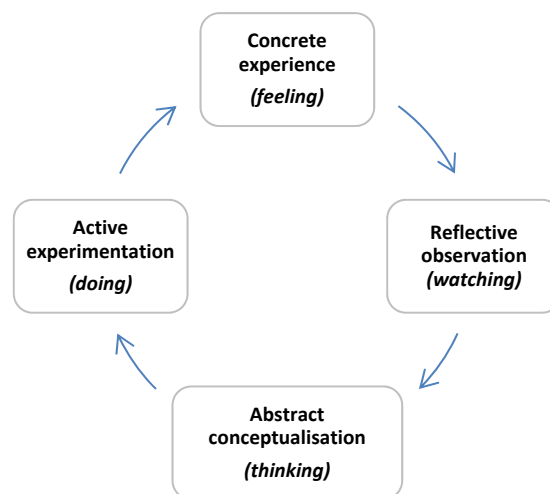


Figure 1. Experiential learning cycle (Kolb, 1984)

These general principles of experiential learning were applied during the COST Action TU1002 to create insights on accessibility concept and implementation into practice of Accessibility instruments (AIs). In fact, the whole COST Action had two main objectives.

*BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS*

The first objective was to reduce the distance between land use and transport planners, by means of using a shared language based on accessibility concepts. In fact, substantive differences exist between land use and transport planning domains (de Brömmelstroet & Bertolini, 2008): scientific instrumental rationality still seems the predominant paradigm in the field of transport planning (Wilson, 2001): transport planners focus more on general theories and models, to set optimal system variables, dealing with uncertainty in the future by means of demand forecasting methods. On the other hand, land use planners tend to use more qualitative information, mapping places and functions, and try to work in a more communicative settings, based (at least theoretically) on deliberative rationality in which multiple stakeholders are involved (Healey, 1997).

The second objective was to involve directly stakeholders and practitioners in the planning process by means of the use of accessibility tools. In this respect, there is a wide consensus in the international debate, that planning support tools should be an integral part of the decision process and must meet context and user requirements (Vonk, 2006).

To achieve the above objectives, a process framework was applied to facilitate a constructive and structured dialogue between on the one hand transport and land-use planners, and, on the other hand, among researchers, model developers and practitioners.

This paper presents the results of the learning process that took place within a structured-workshop involving private and public stakeholders to test usability of gravity-based accessibility measures (GraBaM) to assess integrated land-use and transport policies. The research is part of the COST Action TU1002 "Accessibility Instruments for Planning Practice" during which different accessibility instruments were tested for different case studies. Here we report on the empirical case study of Rome

The article is organized as follows. In Section 2 of the paper, the research methodology is described. In Section 3 the Rome experience is reported, by first describing the accessibility measure adopted and the GraBaM tool (Papa and Coppola, 2012), then the workshop protocol and the workshop evaluation. Finally some conclusions on the experiment are reported in Section 4.

3 Research methodology

The research process is described in Figure 2 and consists into a system of actions: a sequence of activities made by the accessibility instrument developers involving local actors and a monitoring procedure before and after the workshop. The activities run by the AI developers are the AI setup, its application in local workshop and eventually the AI modification. The monitoring process consisted of two surveys: the pre workshop survey and the post workshop survey. The pre-workshop survey had the aim of gaining insights into the current state of practice in the use and understanding of accessibility concepts. After the workshop the participants were asked also to fill in a post workshop survey in order to understand how the participants experienced the process and to interpret if there was any significant increase in understanding.

In the process, the local contexts influenced the process because of the presence of local context barriers and in some cases the local context was modified after the running of local workshops.

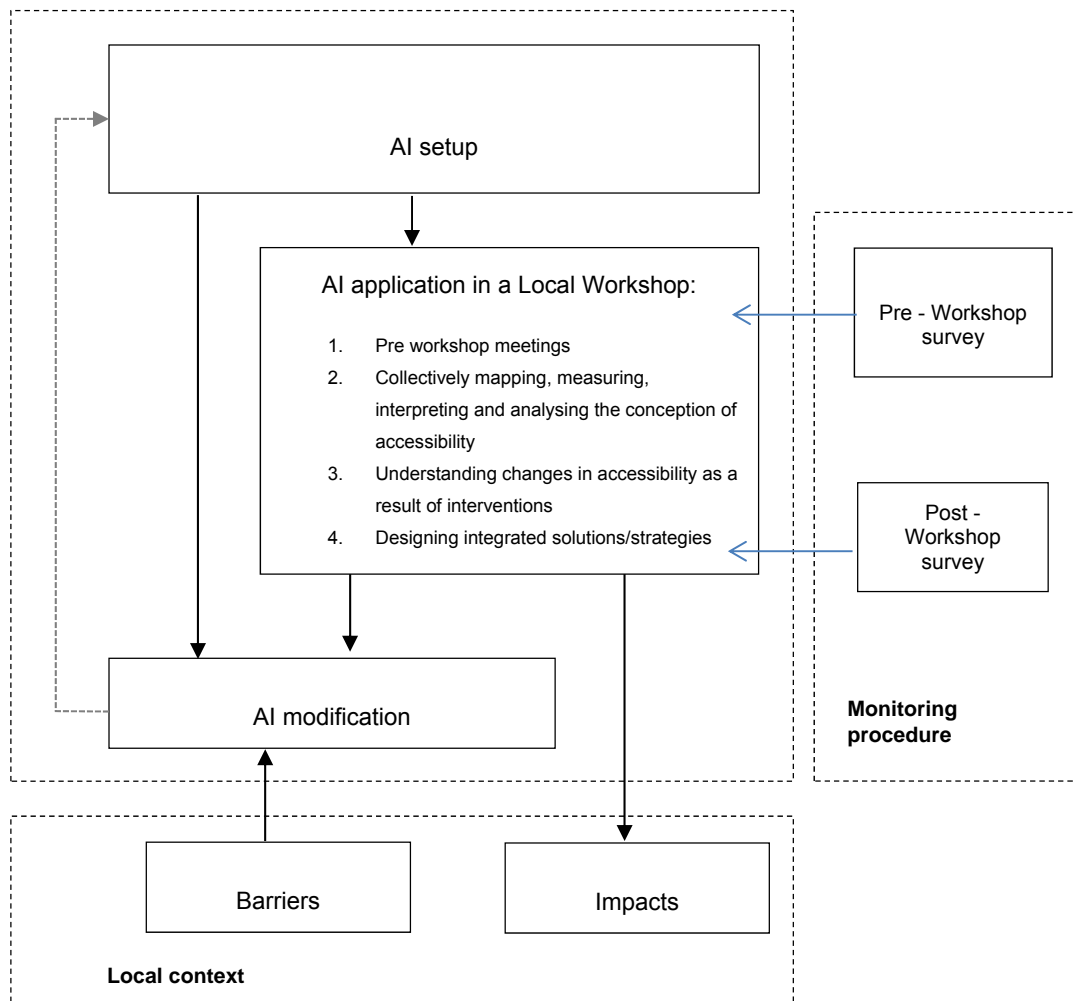


Figure 2. The methodological steps of the research

4 The Rome experience

3.2 The used Gravity based accessibility measures and the GraBAM tool

The accessibility measures used in the experience of Rome are defined in literature as “gravity-based”, since it can be derived from “gravity-type” trip distribution model (Hansen, 1959). In particular two types of accessibility have been considered, referred to as “active” and “passive” accessibility (Cascetta, 2009). The active accessibility of a given zone i is a proxy of the ease of reaching the activities/opportunities located in different zones j of the study area for a given purpose (e.g. workplace, shopping) moving from i . On the other hand, the passive accessibility is a proxy of the opportunity of an activity located in a given zone i to be reached from the potential “consumers” coming from all the other zones j of the study area for a given purpose. Such definitions do consider the accessibility of a given zone as a sum of the generalized travel costs between zones itself and the other zones of the study area, weighted by an attraction term representing either the

*BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS*

opportunities to be reached in the other zones (in the case of the active accessibility) or the potential “consumers” of the opportunity located in the given zone (in the case of the passive accessibility).

$$A_{(act,i)} = \sum_j E(j)^{\alpha_1} \cdot \exp[-\alpha_2 \cdot C(i,j)] \quad (1)$$

where: $E(j)$ is the number of jobs in the zone j ; $C(i,j)$ is the generalized travel cost given by the weighed sum of the travel time and travel costs on different modes of transport, between zone i and zone j ; α_1 and α_2 are estimated parameters (Coppola and Nuzzolo, 2011).

The passive accessibility of a zone i is a proxy of the opportunity of an activity located in a given zone i to be reached from the potential “consumers” coming from all the other zones j of the study area for a given purpose. Here we considered the passive accessibility of services and commerce with respect to the residents in the study area:

$$A_{(pas,i)} = \sum_j Res(j)^{\gamma_1} \cdot \exp[-\gamma_2 \cdot C(j,i)] \quad (2)$$

where: $Res(j)$ is the number of people residing in zone j (i.e. the potential “consumers” of the economic activities in i); $C(j,i)$ is the above generalized travel cost; γ_1 and γ_2 are estimated parameters (Coppola and Nuzzolo, 2011).

The tool integrates the calculus of these accessibility measures with the production of accessibility maps, allowing easily changing parameters and visualizing the outputs, with the use of GIS, which provides easily spatial data entry, management, retrieval, analysis and visualization. In particular the accessibility maps represent for each traffic zone in which the study area is divided, the accessibility measure, also allowing overlapping it with other geographical data.

The GraBAM tool can be integrated in comprehensive Land Use Transport Interaction (LUTI) modelling architecture, simulating the impacts of changing accessibility on the spatial distribution of residential and economic activity as well as on dwelling prices (Coppola and Nuzzolo, 2011). In doing so it can also assist urban planners in identifying optimal locations for new development areas and can support the analysis of the real estate market dynamics due to changing land-use and transport variables.

The feature that makes GraBAM usable for planning practice is first of all the flexibility of the tool: accessibility can be calculated for private transport and/or for public transportation system, for different trip purposes (home to work and home other purposes), and for different aggregation of Traffic Analysis Zones (TAZ). Another characteristic of this measure is that it can be easily represented using thematic maps in a GIS environment (see Figure 3).

The tool can be used in a variety of operational planning and public involvement activities of transportation agencies. Trying to answer to the basic question “who reaps the benefits from investments in the transport system and where these are located”, GraBAM is suitable to identify

the interrelations between new transport infrastructures (i.e. changing zonal accessibility) and the changes of population and economic activities location. Moreover, it can also support the analysis of the real estate market dynamics. In fact, GraBAM is integrated in a comprehensive Land-Use Transport Interaction (LUTI) modeling architecture simulating the impacts of changing accessibility on the residential and economic activity spatial distribution, as well as on dwelling prices (Nuzzolo and Coppola, 2011).

The tool has been already applied in several applications in transport planning processes, in feasibility studies for transport infrastructures assessment, and for the evaluation of Master Plans at different scales (urban, provincial and regional). One of the latest applications regards the assessment of Transport Plans of Rome (Nuzzolo and Coppola, 2008).

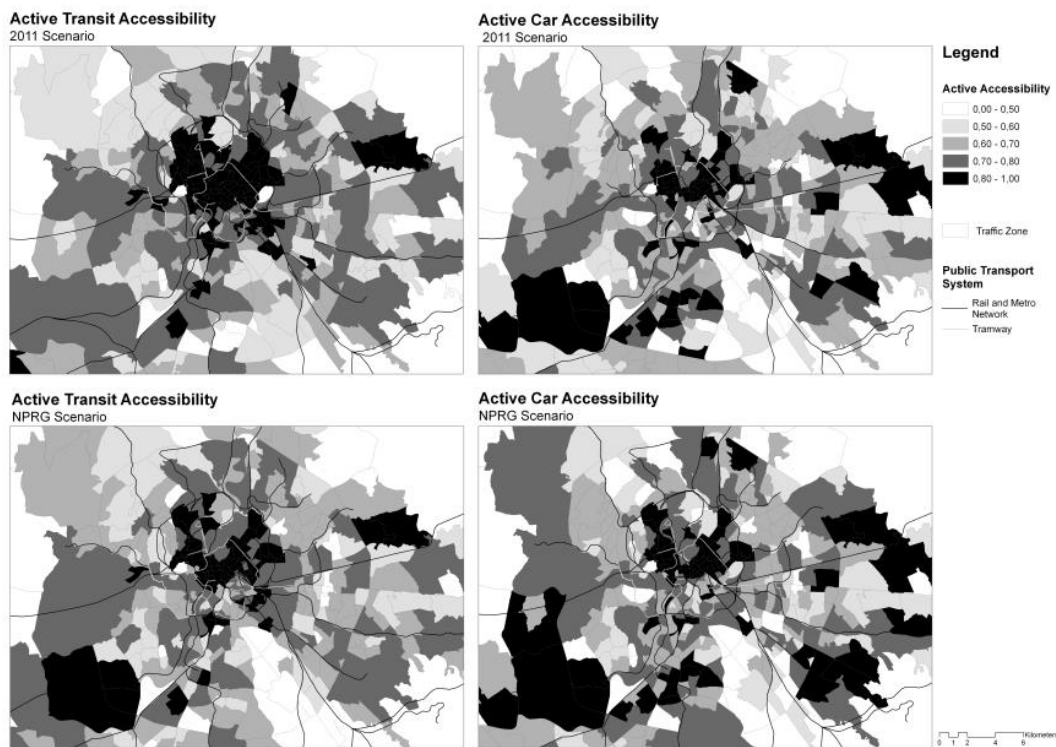


Figure 3. GraBAM outputs: comparing car and transit active accessibility in different scenario: 2011 scenario vs. NPRG scenario (i.e. the Master Plan of Rome).

3.3 The Rome Local workshop protocol

The described tool has been tested within a structured workshop involving public and private stakeholders, according to a four-step protocol (te Brömmelstroet et al, 2014) defined within the COST Action. The main goal was to evaluate usability and applicability of the tool in the current practice of the practitioners involved in the experiment, and, at the same, time to generate an experiential learning-cycle process within the group of people (researchers and practitioners) involved.

*BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS*

The experiment was set in Rome, and involved a panel of experts in the fields of Land Use and Transport planning. Different backgrounds guaranteed different perspectives on the usability of the instrument, both transport and urban planners from the private sector (consulting), public sector (municipal planning offices) and academia were involved. The heterogeneity of the group was a key factor for the success of the workshop. Nevertheless, this required a more complex preliminary activity to organize 'customized' pre-workshops with selected groups of participants. The local workshop carried on by the Work Unit "IT01" involved a panel of experts in Land Use and Transport planning in order to evaluate LUTI policies for the sustainable development of the urban area of Rome and to test the usability of the tool GraBAM (Papa and Coppola, 2012), playing with the instrument in a next-to-real exercise.

The workshop took place in Rome on May 2013 and involved twelve participants: eight practitioners from different backgrounds and from different cities (Naples and Rome), plus four members of the Local Unit: two of them as observers and two chairing the discussion. Practitioners of the same age (from thirty to forty-five) and of the same professional position were engaged. Some of them already knew each other (or had worked together). This led to a more informal and comfortable atmosphere and did facilitate the discussion.

To guarantee different views on usability of the instrument, both transport and urban planners from private sector (consulting), public sector (Municipalities Planning Office) and academia were involved. The heterogeneity of the group was a key factor for the success of the workshop. Nevertheless this required a more complex preliminary activity to organize three "customized" pre-workshops with selected groups of participants in Rome and Naples. In fact, participants had dissimilar backgrounds and experiences in using accessibility indicators in their daily practice. Most of them were not familiar at all with the use of accessibility measures in technical assessment, and only few had used basic accessibility measures such as isochrones, contour measures and spatial separation measures.

The "four-step" protocol took place in two main stages: the phase of the customized pre-workshops and the workshop itself.

The first step "Conceptualizing accessibility in the light of wider economic, social and spatial goals" was implemented in the pre-workshops, using the case study of Rome to create a shared understanding of accessibility concepts and a common language to define and identify sustainable planning strategies. The land use and transport (LUT) system was presented with the aid of thematic maps describing current and future socioeconomic scenarios and displaying planned interventions of the Master Plan. We identified and discussed with the participants the main threats and opportunities (i.e. high concentration of jobs in the city centers, unsustainable auto-oriented transportation system, urban sprawl, and so on) and asked them to suggest strategies to tackle these problems leading to more sustainable urban development (Figure 4). Furthermore, during the pre-workshops "active" and "passive" accessibility definition was proposed, stimulating discussion on the meaning of accessibility compared to mobility. One of the goals of the pre-workshops was, in fact, to understand participant's background in using (or just understanding) accessibility indicators

and to translate individual thinking on the planning question into a shared accessibility language. During the pre-workshops, GraBAM was also displayed, focusing the attention on the potential usability to evaluate LUT plans.

The pre-workshops ended with the submission of the pre-workshop questionnaires. Assisting participants in filling in the survey was very useful to get people more involved, to tackle new issues which did not emerge previously and to clarify further questions.

The second step of the local workshop protocol “Collectively mapping, measuring, interpreting and analysing the conception of accessibility”, was held partly by tool developers on their own, and partly during the workshop. In fact, after the pre-workshops, based on the participant’s proposals, several strategies were identified: most of them dealing with integrated LUT policies, only few, mainly proposed by transport planners, focusing on transport network interventions. In the time between the pre-workshops and the workshop, the tool developers produced the desired accessibility output, using LUTI models and GIS. Scenario setting and simulations runs were carried out in advance (i.e. before the workshop), since GraBAM requires computation times that are not compatible with real-time simulation to be held during the workshop.

A crucial issue in this phase was how to present the results of the simulations to end users and how to make accessibility representation sufficiently simplistic without sacrificing the necessary qualities of the model. Due to a number of outputs resulting from the simulation and many ways of representing them, we ended up with more than 30 thematic maps. Such an amount of information might lead to misunderstanding and confusion. For this reason, only a limited number of maps were presented to start up the debate at the workshop; then, from time to time, those specifically requested were showed “on demand” to participants.



Figure 4. Development strategies for the urban area of Rome, proposed by the workshop participants.

**BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS**

The step 3 “Understanding changes in accessibility as a result of interventions” took place during the workshop, which started with a brief presentation of the scenarios simulated, resulting from the different strategies proposed during the pre-workshops. The accessibility maps showed how the levels of accessibility were affected by the intervention on transport and land-use system.

To provide a better understanding of the outcomes, accessibility maps were compared to thematic maps of more familiar indicators, such as travel times and distances, commonly used by practitioners. What participants clearly understood from this comparison was that while mobility indicators focus only on the ease of movement over the network, accessibility indicators take into account both the transport network performances and the spatial distribution of activities. This concept emerged when accessibility and mobility levels of peripheral areas interested by new developments were compared.

The step 4 “Designing integrated solutions/strategies” was held in a plenary session, during which the group of planners agreed upon a set of interventions for Rome urban development, based on the simulation results and the maps presented. This phase was characterized by a stimulating discussion on the possibility to apply the instruments in planning practices. Many participants found that the tool might offer new insights to their daily practice. Furthermore, some participants identified specific projects they worked on for which the instrument would be useful to evaluate alternative scenarios.



Figure 5. Measuring, interpreting, analysing the conception of accessibility and designing integrated solutions during the workshop.

3.4 The workshop evaluation

The workshop evaluation by means of the pre-workshop survey and post workshop surveys allowed a better understanding of the learning process both by the instrument developers and by the practitioners participating at the experiment.

The most interesting results from the pre-workshop survey regard the different interpretation and definition of accessibility and mobility terms that planning practitioners have. In fact despite accessibility was acknowledged as a key concept in describing the relationships between land use and transports systems, different disciplines have dissimilar perception of accessibility and mobility concepts. In our analysis we found that the most frequently proposed definition of accessibility was 'the ease of getting to a place'; however, the fact that a very wide range of definitions was suggested indicates that there is still a need for the development of a shared language.

From the post workshop survey came out an evaluation on the experience itself and on the usability and usefulness of Grabam. In the figure 6 a synthesis of the Rome workshop evaluation form the post workshop survey is reported, derived from the average value of the answer given by the participants.

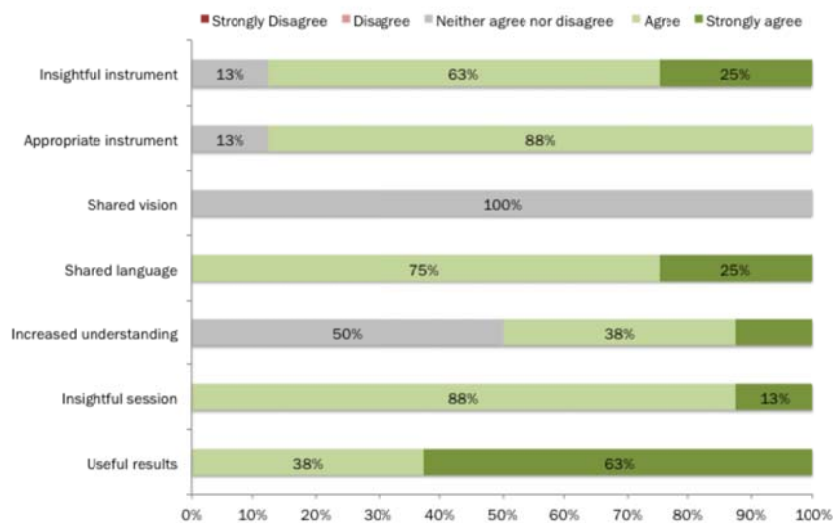


Figure 6. Synthesis of the Rome workshop evaluation form the post workshop survey (Source: te Brömmelstroet et al, 2014)

The participants had, in general, a very positive reaction to the process, for example, mentioning that the workshop gave useful results; satisfactory sessions; correct assumptions and group solution; useful insights with regard to the processes. Nevertheless, though people were satisfied with the workshop because of the high degree of interactions with other participants, in some particular moment of the workshop, transport and urban planners seemed to speak a different language: for example the first were more interested in issues such as “modal split”, the second in the “relation between green areas and urban structures”.

The perception of communication and cohesion was generally high among the participants. This is likely related to the positive responses about the perception of consensus in terms of reaching a

*BRIDGING THE IMPLEMENTATION GAP
OF ACCESSIBILITY INSTRUMENTS AND PLANNING SUPPORT SYSTEMS*

shared vision on the problems and the goals. A general agreement on the potential of the instrument emerged from the workshop. However, there was still some uncertainty about its use in the current practice. Transport planners, for instance, defined accessibility “ambiguous” to be used for evaluating plans while land-use planners found it “difficult to be measured”.

As regards the different attitudes during the workshop of the participants, belonging to different disciplines (urban or transport planning), transport planners showed a better theoretical background on accessibility measures, asking very detailed and technical questions such as “the influence of the zoning on the measure”. On the other hand, land use planners were more interested in using the instrument in planning practices. In this regards transport planners perceive accessibility measures as complementary to other usual assessment indicators, while urban planners see the use of these measures as a new way for tackling recurring planning problems, and in particular for activity location choice.

As regard the perceived usability of GraBam, the participants had in general very positive views regarding the usability of the instruments for real-life planning problems; the relevance of the instruments to their profession; and the insights that the instruments offered into planning problems (but not so much into the land use–transportation relationship). In fact GraBAM during the workshop demonstrate a good degree of usability, but with a low real-time capability. This can constitute an important limitation in these kinds of workshop settings. To improve the usability of the tool it would be necessary to increase the level of real time interactivity towards end users. This could be possible by developing a user interface for viewing, interacting and playing with the tool in real-time. In any case, a common response was that participants found the visual map-based media to be a very useful tool for communicating accessibility and for laying a basis for discussion.

As regards the potential barriers to the potential use of the instruments in planning practice, two groups of barriers were identified concerning the technical and resources barrier, the political barrier. The participants expressed significant concerns about the low familiarity of their organizations with accessibility instruments and, therefore, felt that the instruments presented in the workshops would not be used.

5 Conclusions

The experience of applying an accessibility instrument in the Rome context clearly showed that transport and land use planning integration requires collaboration and communication between the two profession groups—transport planners and urban planners. From the empirical experiment, it emerged that each specialization has its own unique professional training, skill set and ideology and these dissimilarity can be seen in their use (or lack of use) of transport models and accessibility instruments as well as in their diverse definitions of accessibility. By the means of the proposed accessibility instrument these differences and barriers emerged clearly and in part were overcome, thanks to the use of a common and shared tool, and in particular with the accessibility maps. The tool played in fact a central role in the interaction and communication between the participants, to the point that it will be applied by the participants working at the Rome Municipality for the next Transport Plan of the metropolitan area.

The feedback from the Rome case demonstrates a clear need for developing interactive ways to enable planning practitioners to engage with visualized accessibility indicators.

This research conducted under this COST Action clearly is just the start of the efforts to bridge the gap between the broad range of accessibility instruments and their potential users. Further step of this research will consist in observing and interviewing the participant at the workshop individual in a longer time period to understanding if the use of the tool had the impact expected and how accessibility enhanced their planning experiences.

References

- Cascetta E. (2009) *Transportation System Analysis Models and Applications*. Springer.
- Coppola P. and Nuzzolo A. (2011) Changing accessibility, dwelling price and the spatial distribution of socioeconomic activities. *Research in Transportation Economics*, Vol. 31, 63-71.
- Nuzzolo A., Coppola P. (2008). Infrastrutture di trasporto e assetto territoriale nell'area metropolitana di Roma. In: Marescotti and Mussone (Eds) *Grandi infrastrutture per la mobilità di trasporto e sistemi metropolitani: Milano, Roma e Napoli* MILANO: Libreria Clup, 29-53.
- Hansen W.G., 1959. How Accessibility shapes land use. *Journal of American Institute of Planners*, Vol. 16.
- Healey, P. (1997) *Collaborative Planning; Shaping Places in Fragmented Societies*: Palgrave, Hampshire/New York.
- Kolb, D. A., Fry, R. (1975) *Toward an applied theory of experiential learning*. Theories of Group Process: C. Cooper (John Wiley).
- Kolb, A. Y., and Kolb, D. A. (2012) *Experiential learning theory*. In *Encyclopedia of the Sciences of Learning*, pp. 1215-1219: Springer US.
- Nuzzolo A. and Coppola P. (2005). S.T.I.T.: a system of mathematical models for the simulation of land-use and transport interactions. In: *Proceedings of the European Transportation Conference Strasbourg (France)*. AET associates.
- Papa E., Coppola P. (2012), Gravity-Based Accessibility measures for Integrated Transport-land Use Planning (GraBAM), in Angela Hull, Cecília Silva and Luca Bertolini (Eds.) *Accessibility Instruments for Planning Practice*. COST Office, 117-124.
- Straatemeier, T., Bertolini, L., te Brömmelstroet, M., and Hoetjes, P. (2010) An experiential approach to research in planning. *Environment and Planning B* 37(4), pp. 578–591.
- te Brömmelstroet M. Curtis C. Milakis D. Mellor R. (2014) *Methodological Consideration*, In te Brömmelstroet M. Silva C. Bertolini L. (eds) *Assessing Usability of Accessibility Instrument*, Report II, COST Action TU1002 "Accessibility Instrument for Planning Practice in Europe". BRUSSELS - LUXEMBOURG: COST Office
- te Brömmelstroet, M. and Bertolini, L. (2008) Developing land use and transport PSS: Meaningful information through a dialogue between modelers and planners. *Transport Policy*, 15(4), pp. 251-259.
- Vonk, G., (2006) *Improving Planning Support; The Use of Planning Support Systems for Spatial Planning*. *Nederlandse Geografische Studies*, Utrecht.
- Willson, R., (2001) Assessing communicative rationality as a transportation planning paradigm. *Transportation* 28, pp. 1–31.

Acknowledgements

The authors would like to acknowledge the valuable contribution of all the members of the COST Action TU1002 to the work presented in this paper, as well as the COST Office for funding Action TU1002.