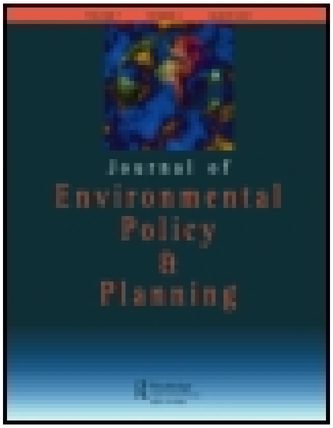

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Using ‘Mobility Environments' in Practice: Lessons from a Metropolitan Transit Corridor in Spain

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ABSTRACT *The last few years have seen a growing interest in furthering our understanding of the complex relationships between land use and transport. Nevertheless, putting that knowledge into practice in urban transport planning has been adversely affected by the lack of broad consensus on the main concepts and methods used in this field. To address that issue, this paper proposes a new approach based on the concept of 'mobility environments' as a new instrument for mobility planning. To illustrate and assess the 'mobility environments' approach, an application has been developed for a metropolitan transport corridor in the city of Granada (Spain), where local institutions are funding the implementation of a new light rail system. This paper highlights a number of important findings related to what exactly 'mobility environments' are and how they can be used in planning practice.*

KEY WORDS: sustainable mobility, land use, public transport, metropolitan, environment

1. Introduction

As in many other fields, a reduction of negative environmental impact in transport planning (air pollution, energy consumption, etc.) is thought to be decisive in promoting sustainable development outcomes (Banister, 2005; Hysing, 2009; Holden, 2014; Litman, 2009). Nevertheless, evidence shows that this objective is hardly ever achieved in practice (Hull, 2008) and the urban transport sector continues to be the largest source of noise and pollution in cities, as well as a major user of carbon-based fuel (Banister, Anderton, Bonilla, Givoni, & Schwanen, 2011). According to a wide number of academics, the answer seems to be related to

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finding ways to: (i) plan more to travel less and more efficiently; and (ii) break away from the sectionalized mobility planning approach, enabling co-operation between the main professional disciplines involved.

Academia has come to realize that integrating land use and transport planning at city level can deliver a significant contribution in terms of planning more to travel less (Banister, 2008; Silva & Pinho, 2011; Switzer, Bertolini, & Grin, 2013). This is based on the belief that if the land use and transport system are reciprocally supportive, then major mobility benefits can be generated, that is, access to activities, jobs and so on, while negative impacts could be reduced, that is, pollution, congestion, noise and so on. This also reflects a long-standing body of theory on the relationship between land use and transport (Cervero & Kockelman, 1997; Ewing & Cervero, 2010; Mattioli, 2013; Wegener & Fürst, 2004). However, despite successful experiences, such as the practice of Transit-Oriented Development (TOD—Curtis, Renne, & Bertolini, 2009; Ratner & Goetz, 2013), implementation in daily practice is lagging behind. Certain reasons seem to be responsible for this situation: the emphasis on accommodating automobiles and other motor vehicles took precedence over other factors in land use planning, thus relegating some city areas to be car-only 'mobility environments', as well as the lack of spatial perspective focused on planning practice. Furthermore, as indicated by Bertolini (2012, p. 16), urban planning still seems to see mobility as just one among many particular concerns, rather than as a central, structuring perspective on the development of cities.

Together with the above-mentioned issues, the context of transport planning has also seen dramatic changes in recent decades, in particular, the growing interaction between different professional disciplines and stakeholders in decision-making (Bertolini, Clercq, & Straatemeier, 2008; Te Brömmelstroet & Bertolini, 2008). As a result, more stakeholders are involved in the transport-planning process, which limits the suitability of technical-rational instruments and fosters the need to develop new concepts and methodological approaches to trigger dialogue and discussion mechanisms between the stakeholders involved.

This paper aims to gain more insight into this discussion by revisiting the concept of 'mobility environments' that has been previously introduced by Bertolini and Dijst (2003). To do this, this paper will explore the following central research questions: (i) what exactly are 'mobility environments'? and (ii) how can they be used in practice? To offer an in-depth knowledge about such issues, 'mobility environments' were used to implement a new light rail system ('LRT') in the metropolitan area of Granada ('MAG'), Spain. First, this paper will answer the question (i) by developing a specific method to identify 'mobility environments' in the MAG through the interaction between land use and transport indicators. Thereafter, it will answer the research question (ii) by using the identified 'mobility environments' in making a better implementation of LRT in the MAG through the interaction of the different stakeholders involved.

Section 2 reviews the concept of 'mobility environments' and discusses its potential role in planning practice. Section 3 proposes a research methodology to identify 'mobility environments' in the context of the MAG. Section 4 presents the five identified 'mobility environments' in the context of the MAG, which are: (i) local-oriented; (ii) local- and circulation-oriented; (iii) metropolitan node-oriented; (iv) motorized traffic-oriented; and (v) intermodal station-oriented, as well as different planning strategies to implement LRT within them. Finally, Section 5 concludes with some concluding remarks and future research issues.

2. Towards a Comprehensive Planning Concept: 'Mobility Environments'

2.1 *Definition*

The first question this article seeks to answer is: what exactly are 'mobility environments'? This question will be answered in what we call 'an integrative vision between land use and transport'.

Modern lifestyles and business processes are inextricably linked to mobility (Bertolini, 2012). The configuration of our cities, that is, the location of activities and businesses is increasingly influenced by progress in transport and communication technologies (Castell, 2002). People have to travel every day and mobility has become the essence of cities. In this regard, many authors explore the potentially most relevant factors affecting the relationship between land use and transport (Frank, Bradley, Kavage, Chapman, & Lawton, 2008; Mokhtarian & Cao, 2008; Næss & Jensen, 2002; Silva, 2013; Soltani & Allan, 2006), the main environmental impacts of travel patterns in cities (Mindali, Raveh, & Salomon, 2004), and how mobility could play a central role in urban planning (Curtis & Sheurer, 2010; Glesson, Darbas, & Lawson, 2004; Vigar, 2004). Despite a proliferation of studies which seek to shed light on these questions, many problems have been identified when theory has been put into practice, and mobility planning still appears to be seen as just one of many particular concerns.

'Mobility environments' were introduced by Bertolini and Dijst (2003) as a comprehensive planning concept rooted in an integrative approach between accessibility and land use. It particularly responds to the importance of transportation nodes and their capacity to influence the location of activities by developing a view of the city as an open system of connected open sub-systems in which human interaction can take place through mobility. The authors (2003, p. 28) indicate that 'mobility environments' are defined as the combination of accessibility and proximity features. In other words, a specific 'mobility environment' is conceived (Bertolini, 2006, p. 320) as a place jointly identified by the interrelated characteristics of the available transport modes (how people travel from one place to another) and land-use characteristics (how urban form factors influence travel patterns). This interaction between land use and transport would shape a specific social framework based on human interaction (characterized by aspects such as duration, intensity and diversity) which could be understood as the identity of 'mobility environments' (Figure 1).

Despite its origin focused on the new urban dimension of transportation nodes as successfully applied in Amsterdam (The Netherlands), evidence shows that the concept of 'mobility environments' represents a better conceptualization of urban planning and design in connection with the diversification of mobility in contemporary lifestyles. Zanvliedt, Bertolini, and Dijst (2008) identify 'mobility environments' in The Netherlands by combining mobile population and land use characteristics. Such 'mobility environments' were used to determine the 'performance of places' in The Netherlands. Soria-Lara (2012) also defines 'mobility environments' by using transport and land use indicators in Spain to map transit corridors in cities in order to facilitate the implementation of new public transport systems.

The accessibility approach is believed to provide a useful framework to support the design of integrated land use and transport policies by specifically identifying the geographical units which are equivalent to potential 'mobility environments'. Some useful examples can be seen in Singh et al. (2014) in which accessibility by train in Arnhem Nijmegen region (Netherlands) is used

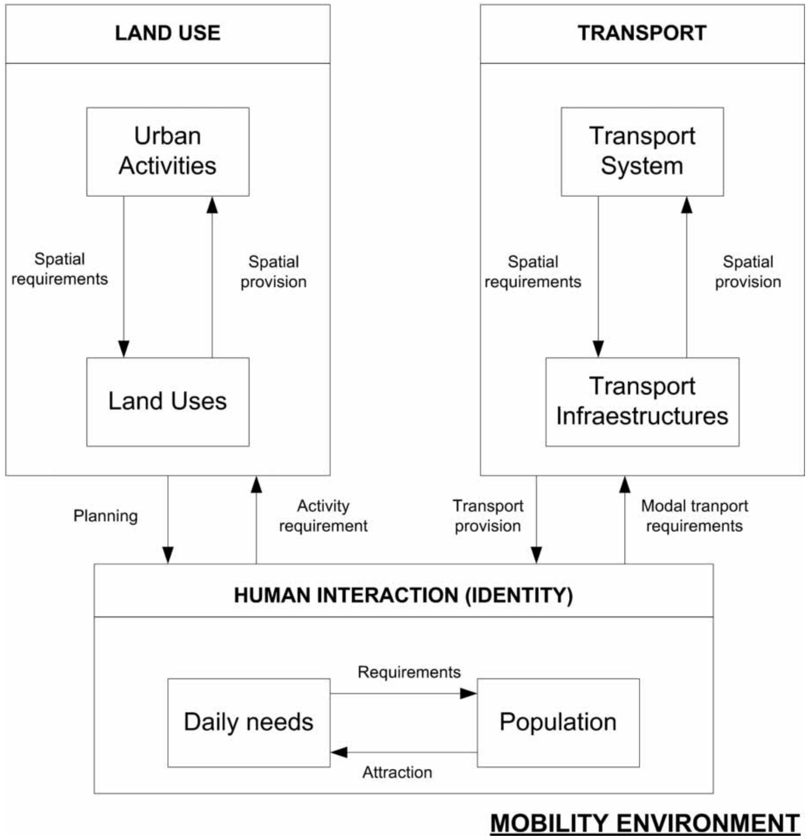

Figure 1. Theoretical conceptualization of 'Mobility environments'.

to measure potential TOD implementation. This makes it possible to define geographical mobility units according to density (residential, employment and commercial intensity), land-use diversity, private investment in the area and so on. Another important example in defining the 'mobility environments' through the use of accessibility measures is given by Silva (2013). The author combines accessibility indicators and urban form factors (residential density, employment, facilities, etc.) to identify the mobility units in Greater Porto (Portugal) associated with different transport modes (private cars, public systems, etc.). Further to this point, Rodríguez, Brisson, and Estupiñán (2009) also identify 'pedestrian mobility environments' based on the accessibility level around Bogota's BRT stations (Colombia). Similarly, Lee, Yi, and Hong (2013) analyse the relationship between the use of the Seoul Metropolitan Subway and the land-use pattern of its station areas, thereby establishing an urban structural hierarchy according to diversity and land-use diversity factors.

Based on the previous examples, the concept of 'mobility environments' is built on the inextricable relationship between land use and transport. These interrelations are not only complex, but they also have many possible dimensions (Cervero & Kockelman, 1997; Ewing & Cervero, 2001; 2010; Naess, 2009; Pitombo, Kawamoto, & Sousa, 2010). The reflections made by Banister (2005, p. 97) identify six groups of factors which interconnect land use and transport: settlement size, density, diversity, design, spatial location, local accessibility and parking provision.

Studies show that settlement size (in terms of population or housing) is directly related to travel patterns. Evidence from recent years suggests that the larger the settlement, the greater the decline in intercity travel. Naess and Sandberg (1996) demonstrated this point through the comparison of mobility energy consumption in different settlements. Banister, Hickman, and Stead (2008) had similar findings by relating the size of settlements and CO2 mobility emissions. In addition, Cervero and Kockelman (1997) believe that density, diversity and design are the three core elements in understanding the relationship between land use and transport. Density—commonly measured by population, housing and employment—is, for many authors, the most representative example of the interaction between land use and transport (Handy, 2002). This was made clearer through evidence adduced / presented by Newman and Kenworthy (1999). Other authors who have shown such signals are Mindali et al. (2004) or Oakes, Forsyth, & Schmitz (2007). Diversity is another determining parameter. This is defined as the level of different urban activities and services in one specific place. There is a significant evidence that higher levels of diversity are associated with lower levels of motorized mobility and vice versa (Pitombo et al., 2010; Song, & Knaap, 2004). Finally, design, understood to be the relationship between built-up spaces and streets, appears to be an important issue in the promotion of some travel patterns (Jones, Boujenko, & Laidet, 2008; Roger Evans Associated, 2007).

Spatial location is another significant factor. On one hand, the work of Winter and Farthing (1997) shows that the provision of local facilities and services clearly reduces the need to travel distances in urban spaces. On the other hand, spatial location factors may influence accessibility to public transport as demonstrated by Cervero, Sarmiento, Jacoby, Gomez, and Neiman (2009), whose research in Bogota (Columbia) shows a high correlation between local accessibility to public transport and the level of use of such modes. Lastly, the provision of parking appears to be another important factor in the interactions between land use and transport, mainly in the choice of the mode of transport (Banister, 2002). Research by Albert and Mahalel (2006) shows that when there is a rise in parking charges, there tends to be a change in travel patterns in favour of public transport.

We can now answer at a theoretical level for the question posed at the beginning of this section: what exactly are 'mobility environments'? They should be understood as a comprehensive planning concept based on the interaction between land use and transport factors. At an operational level for planning, 'mobility environments' would be geographical units with homogeneous mobility characteristics (in terms of density, diversity, accessibility, car transit, etc.) based directly on the idea that mobility planning should play a central role in urban planning. In addition, the theoretical background that is set above increasingly facilitates the adoption of particular methodologies to identify and use 'mobility environments' from different countries and planning contexts. This will be the case of this paper that develops a specific method to identify 'mobility environments' in the MAG (Sections 3 and 4) from this theoretical discussion.

2.2 *'Mobility Environments' in Practice*

The context described gives rise to a second question for this paper: How could 'mobility environments' be used? The question will be answered at a theoretical level based on 'the doctrine of planning'.

Academic literature suggests that there are two main approaches in planning theory which explicitly address the substantive purpose of planning. The first, taking a rationalistic approach, considers planning as the way to produce material things, mainly based on the expertise of planners. Project plans are its main tool. Here, planning is conceived as a technical exercise where plans give prescriptions for action in substantive fields such as economic development, environmental planning, transport and so on (Alexander, 2006, 2009). The other approach understands planning from a communicative perspective as a framework to lead mutual discussions between stakeholders during decision-making. Strategic plans are its main tool. In this approach, planning is conceived as a learning process in which plans are related to situations requiring the coordination of various stakeholders (Faludi, 2000; Mastop & Faludi, 1997).

Despite new methods, processes and instruments have emerged during recent decades which focus on the transport planning process moving towards more communicative or collaborative approaches (Khisty & Arslan, 2005; Loukopoulos & Scholz, 2004; Soria-Lara, Bertolini, & te Brommelstroet, 2015; Walter & Scholz, 2007; Zegras, Sussman, & Conklin, 2004). Transport planning is traditionally conceived from the viewpoint of instrumental rationality. It is frequently based on scientific knowledge where analytical data are often presented as 'findings' rather than a form of discourse.

From this rational approach, and according to Willson (2001), transport planning usually follows a sequence of discrete steps. The identification of ends occurs first (goals phase). Next comes the selection of means (policies, programmes, plans or projects), which involves the generation of alternatives, analysis and evaluation (technocratic phase). Finally, decision-makers consider possible actions assisted by transport-planners (decision phase). In this context, 'mobility environments' can play an important role in different stages of this rational transport planning process, especially as an assessment instrument for project alternatives from social or environmental viewpoints. For example, Curtis and Sheurer (2010) demonstrated that how the identification of 'mobility environments' during the definition of objectives and alternatives design made it possible to develop efficient integrative assessment tools for the next stages of the planning process. Another relevant example is the work conducted by Talavera-García, Soria-Lara, and Valenzuela-Montes (2014) where the definition of 'mobility environments' was the basis for the assessment of pedestrian quality in the city of Granada (Spain). Finally, the optimization of public transport solutions was also improved through the identification of 'mobility environments' as demonstrated by Soria-Lara and Valenzuela-Montes (2014a).

In addition, 'mobility environments' can be useful in promoting transitions towards a more communicative transport planning process in which all stakeholders are invited to take part in decision-making through learning processes. Innovative experiences can be found in Soria-Lara and Valenzuela-Montes (2014b) in which 'mobility environments' were used to integrate the 'tacit' and 'explicit' knowledge of different focus groups (environmental assessment developers and transport planners) presented in decision-making. Zanvliedt et al. (2008) also showed the usefulness of 'mobility environments' in assessing the performance of places as a leading discourse for planning practice.

To end the section, we should state that in this paper 'mobility environments' were used for strategy-making (see Section 4) by promoting a better implementation of LRT in the MAG and guiding decision-makers during the process.

3. Research Methodology

3.1. *Case Study: An LRT in the MAG*

The MAG is an excellent case study to address the main goal of this paper. Most of the previously discussed issues are present in this region. The MAG is composed of 32 municipalities and 600,000 inhabitants. Over the last 40 years, relations between municipalities have increasingly improved and mobility flows have also increased, especially through the use of private cars (Aguilera, 2008). This unsustainable situation was combated by local authorities in 2003 through the creation of the Metropolitan Transport Consortium. However, problems such as growth in car use and congestion, as well as a lower standard of air quality, noise and so on, were not completely eliminated. In addition, land use and transport policies have not been sufficiently coordinated, and there were also communication problems between the professional groups involved, thereby impeding a more integrative approach between land use and transport (Valenzuela-Montes, Soria-Lara, & Talavera-García, 2009).

In this context, local authorities decided to construct a LRT in the main corridor of the region (Table 1) to use as a tool in the promotion of sustainable mobility patterns. The corridor is made up of four municipalities: Albolote, Armilla, Granada and Maracena (Figure 2).

This action required a large number of urban and transport transformations in the corridor, demanding not only a better integration of land use and transport issues, but also new concepts and tools based on the interaction between involved stakeholders (specifically transport and land use planners.) In this context, the University of Granada was asked to lead strategies and policies aimed towards linking the land use and transport in the corridor by taking into consideration the new public transport system, LRT. In response to this request, the identification and definition of 'mobility environments' in this transport corridor were considered as the most convenient way of addressing the aforementioned goal. Each identified 'mobility environment' would be used as a model framework to develop the guidelines linking the land use and transport in leading discussion processes between involved stakeholders.

3.2. *A Method for Identifying 'Mobility Environments'*

The method was developed in 2010 and conducted in the case study in early 2011. Three methodological work packages were identified: (i) definition of indicators (for the two fields: land use and transport) and mobility dynamics (to characterize the potential human interactions through mobility in the MAG corridor), (ii) identification of 'mobility environments', and (iii) recommendations to implement LRT in the MAG by linking the land use and transport in the corridor (Figure 3).

The first work package was used to select and distinguish indicators and mobility dynamics as a preliminary step to define 'mobility environments'.

Table 1. Main features of light rail train project in the MAG

Light rail train system in MAG	Lines	Length (m)	Stations	Passengers/year (mill/year)	Covered population	Full time travel
	1	15.923	26	12.9	138.248	45′

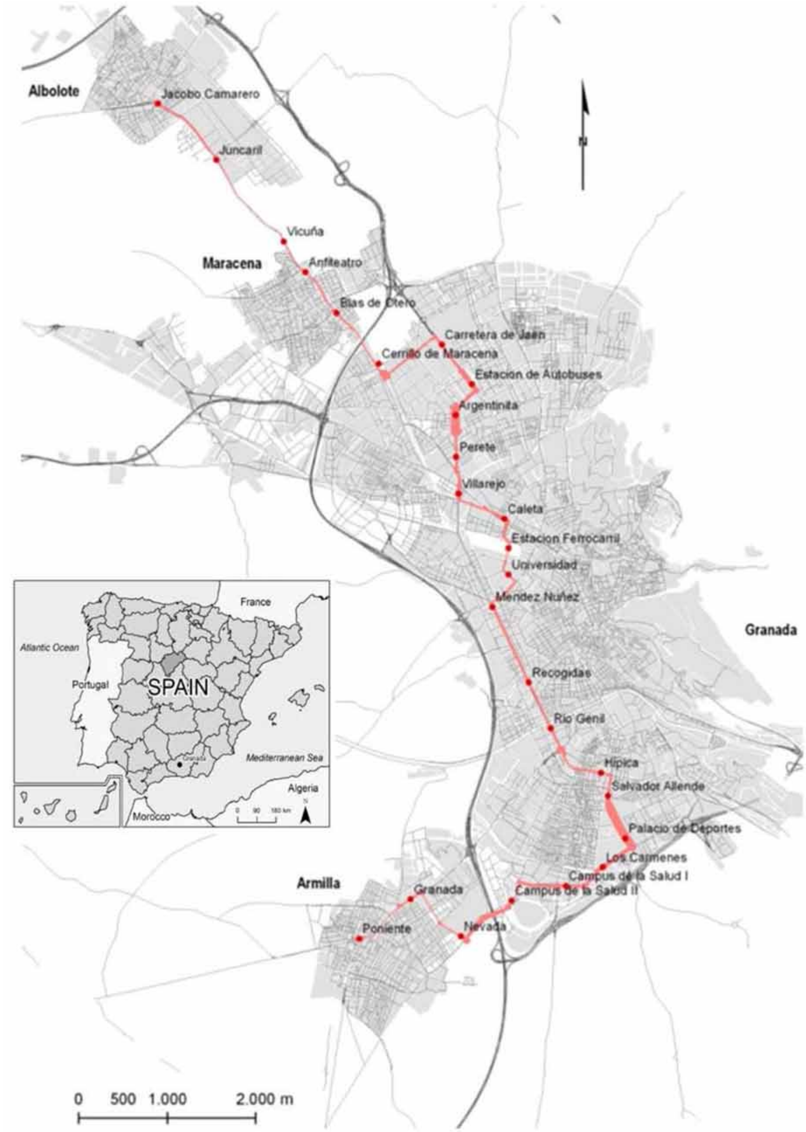

Figure 2. Case study: an LRT in MAG, Spain.

First, lessons from the academic literature and planning practice experiences were used to select eight indicators which could show differences between land use and transport characteristics along the MAG corridor. Literature suggested using land use indicators based mainly on density and diversity issues (see Cervero & Kockelman, 1997; Cervero et al., 2009; Ewing & Cervero, 2001 and many others), as well as indicators that directly combine transport modes, transit and land use characteristics (see Rodriguez et al., 2009). Table 2 gives the selected indicators and their main characteristics. Official statistics from local authorities and other public institutions were the sources used to implement these indicators in the case study. Such indicators were applied to an area of 500 m around the corridor according to the distance decay effect of LRT in urban contexts recommended by several

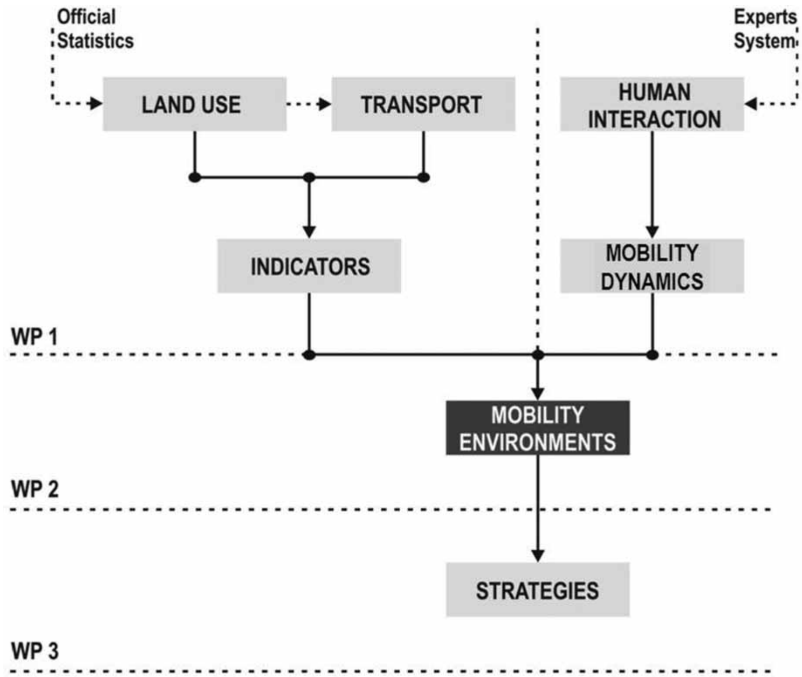

Figure 3. Research methodology.

authors (Hass-Klau & Crampton, 2005; Vuchic, 2005). Furthermore, the corridor was divided into 25 sections which matched the existing space between two adjacent LRT stops. This made it easier to identify the spatial distribution of 'mobility environments' along the corridor.

An expert system was also used to identify certain mobility dynamics along the corridor. Such mobility dynamics aim at shedding light on human interactions which occur along the corridor as a consequence of the characteristics of its mobility such as intensity, duration and diversity. The expert system was created by using a web-based survey directed at 50 stakeholders from the region. Twenty-five statements related to the characteristics of mobility comprised the survey (related to: what were the main areas for commuters, how long do people stay in places around the corridor, etc.). Respondents had to indicate their agreement level from 1 to 5 with each statement (a detailed description of the process can be consulted in Valenzuela-Montes, 2011). A total of 43 people replied and fully completed the survey (13 were academics, 8 were public servants and decision-makers in transport-planning institutions, 16 were practitioners working for companies in the sector and 10 were members of the general public). This made it possible to distinguish the following three mobility dynamics in the case study: (i) long-stay dynamics from those places along the corridor where people stay for a long time during the day and especially at weekends (duration), performing many different activities (diversity), and where the majority of trips are completed by walking, thereby facilitating a high interaction between people (intensity), (ii) specialization dynamics from those places along the corridor where people stay for a few hours during the day (duration), focusing their activity on a specific subject such as work, leisure, study and so on (diversity)

Table 2. Description of land use and transport indicators

Land use
1. Density *Dwellings density*: dwellings per developed Hectare DD = Dwellings/Hectare
2. Diversity *Urban activities intensity*, measured as per 1000 dwellings including public facilities (schools, sports, university, institutional); commercial (convenience stores, retail services, supermarkets, eateries); industrial $UA = \sum \text{activity} * \text{Num} \cdot \text{buildings}/1000\,\text{dwellings}$ *Urban activities dominance*, measured as percentage per developed hectare rates of: public facilities (schools, sports, university, institutional); commercial (convenience stores, retail services, supermarkets, eateries); industrial
3. Daily urban activities *Temporal coverage of urban activities*, number of urban activities measured per daily time slots (6–9 h; 9–14.30 h; 14.30–18 h; 18–21.30 h; 21.30–3 h)
Transport system
1. Motorized transit *Car transit intensities per day*, measured as per urban activities rates including public facilities; commercial; industrial $CT = \text{Number cars}/\sum \text{activity} * \text{Num. buildings}$ *Public transport intensities*, measured as per urban activities rates including public facilities; commercial; industrial in a day $CT = \text{Public transport vehicles}/\sum \text{activity} * \text{Num buildings}$
2. Transverse streets *Non-motorized transit routes*, measured as land use hectares including commercial activities (supermarkets, eateries) and open spaces (public parks) per kilometres developed transversal street *Motorized transit influence*, measured as percentage of vehicles (public and private) which are entering and leaving the corridor through transverse streets

and where access to these places is fundamentally orientated towards motorized modes, thereby reducing interaction between people (intensity), and (iii) transit dynamics from those places along the corridor where people never stay and only travel through them during the day (duration), where people do nothing but travel (diversity) and where there is no possible interaction between people (intensity).

The second work package was aimed at identifying 'mobility environments' along the corridor through a qualitative combination of mobility dynamics identified by stakeholders and the results obtained from land use and transport indicators. In this way, results showed the spatial location of identified mobility dynamics along the corridor by experts. Quantitative methods were not used for this, just the previous practical experience and the on-site perceptions.

Finally, the third work package was based on developing the strategies to link land use and transport based on promoting a better implementation of the LRT system in the MAG. Certain action-based principles and solutions were created for each 'mobility environment'. A short description of them can be found at the end of the article in Section 4.

4. Results

4.1. *'Mobility Environments' in the MAG*

After applying the described research methodology, five 'mobility environments' were identified along the metropolitan transit corridor: (i) local-oriented, (ii) local and circulation-oriented, (iii) metropolitan node-oriented, (iv) motorized traffic-oriented, and (v) intermodal station-oriented.

The first type of 'mobility environment' we identified was a local-oriented environment not visited by many people from other sections along the corridor. It was located in section 1 (municipality of Albolote), 3, 4, 5 (municipality of Maracena), 18, 19 (municipality of Granada) and 25 (municipality of Armilla) (Figure 4). The local-oriented environment was strongly characterized by long-stay dynamics previously described by stakeholders in the expert system. In this regard, land use and transport indicators clearly reinforced the point. The obtained results (Table 3) showed that they were the places with high or very high dwelling density (≥95 dwellings/Ha). The non-residential activity in these sections was medium to high. Commercial activity seemed to be predominant. There were low levels of motorized traffic with an average of 46.02 vehicles/urban activity and 4.30 bus/urban activity. They were places along the corridor that were well-structured from an urban viewpoint, where residents could cover the majority of their daily needs (working, shopping, leisure, etc.). Cars and other motorized transport were not essential and walking was a recurrent activity. There were open spaces and a low level of air pollution in these areas, which was why children and old people frequently used this 'mobility environment' as space for leisure and socializing.

The second type of 'mobility environment' was called a local and circulation-oriented environment. It was located in sections 11, 14, 15, 16 and 17; all of them in the city of Granada. The local and circulation-oriented environment had mobility dynamics between long-stay and transit dynamics previously distinguished by stakeholders. This was also shown by land use and transport indicators. They (Table 3) showed high or very high residential density (≥86 dwellings/Ha). The non-residential intensity was high in all cases exceeding 120 urban activities/1000 dwellings with a strong commercial activity, as well as having a wide spectrum of urban activities at all times of day. There were spaces with levels of motorized urban traffic of around 36.34 vehicles/activity and 4.04 bus/urban activity, respectively. In connection with the previous 'mobility environment', they were also places that were well-structured from an urban viewpoint, where residents could cover the majority of their daily needs. However, cars and other motorized transport had a strong presence. Many people only used these areas for transit. For this reason, walking activity and motorized transport coexisted in this 'mobility environment'. This coexistence frequently generated conflictive situations because of people wanting to use or actually tending to use these areas for socializing, although motorized transport levels made this difficult.

The third 'mobility environment' was the motorized traffic-oriented environment, which refers to those sections along the corridor where mobility was characterized by very high traffic flows. The traffic-oriented environment was strongly characterized by the transit dynamics previously described by stakeholders on the expert panel. The indicators strongly reflected this issue used. The obtained results (Table 3) showed that they were usually the places with low or very low residential density (<30 dwellings/Ha). The non-residential activity was low or

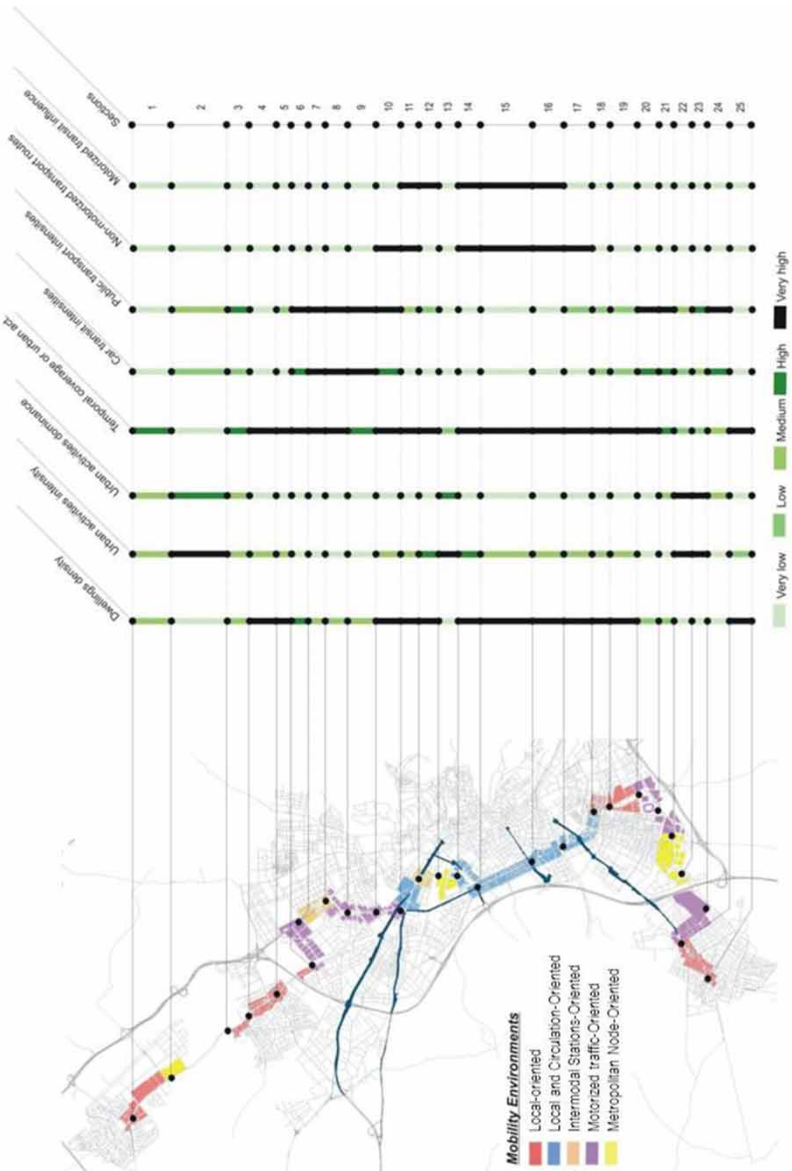

Figure 4. Indicators and 'mobility environments' along the MAG corridor.

very low with an average of 53.56 urban activity/1000 dwellings. They were spaces with high or very high levels of motorized traffic with an average of 384.27 vehicles/urban activity and 23.68 buses/urban activity. Mobility by proximity was irrelevant for this 'mobility environment'. They were solely residential places where people could cover their daily needs with difficulty. This could have been the reason for the high traffic volume. The absence of open spaces, the poor air quality, as well as the high level of noise, made it difficult to use these areas for leisure.

The fourth type of 'mobility environment' was labelled a metropolitan-oriented environment, which received large flows of workers from other parts

Table 3. Results for each 'Mobility environment'

		Land use										Transport system			
				I.3			I.4								
Mobility environments	Corridor (sections)	I.1	I.2	Commercial	Public facilities	Industrial	6–9 h	9–14.30 h	14.30 h–18 h	18–21.30 h	21.30–3 h	I.5	I.6	I.7	I.8
Local-oriented	1	26.56	149.70	77.78	6.94	15.28	21.33	84.00	37.33	76.00	17.33	9.66	1.28	–	–
	3	22.86	130.84	76.92	15.38	7.69	21.43	100.00	14.29	71.43	0.00	111.71	10.29	–	–
	4	131.82	139.05	97.92	2.08	0.00	2.05	89.04	23.97	96.58	10.96	10.08	1.05	–	–
	5	97.46	142.50	96.43	3.57	0.00	3.51	85.96	19.30	94.74	14.04	20.55	4.79	–	–
	18	255.71	109.86	96.80	3.20	0.00	0.79	80.31	30.71	97.64	19.69	62.72	4.44	–	–
	19	103.53	138.94	97.37	2.63	0.00	2.47	67.90	34.57	91.36	32.10	90.99	6.84	–	–
	25	94.96	115.69	90.00	5.00	5.00	8.22	88.36	21.23	87.67	10.27	16.38	1.48	–	–
	Average	104.70	132.37	90.46	5.54	4.00	8.54	85.08	25.91	87.92	14.91	46.01	4.31	–	–
Local and circulation-oriented	11	97.97	188.70	94.05	5.95	0.00	5.88	91.98	15.51	89.84	9.63	39.88	8.64	14.85	24.15
	14	86.63	238.66	95.90	4.10	0.00	3.50	73.50	36.00	97.00	26.50	54.49	2.74	21.57	41.45
	15	342.94	164.85	99.14	0.86	0.00	0.58	81.44	24.32	99.28	18.56	19.75	1.01	18.91	31.02
	16	238.95	145.39	97.32	2.68	0.00	1.98	92.74	13.53	97.69	7.92	33.81	2.31	21.57	52.55
	17	205.54	122.14	97.41	2.22	0.37	2.21	87.13	19.85	97.43	13.24	33.80	5.54	19.33	–
	Average	194.406	171.948	96.764	3.162	0.074	2.83	85.358	21.842	96.248	15.17	36.346	4.048	19.246	37.2925
Motorized traffic-oriented	6	52.43	24.39	93.75	6.25	0.00	5.26	100.00	0.00	78.95	0.00	238.32	22.18	–	–
	8	46.71	18.62	100.00	0.00	0.00	0.00	100.00	0.00	85.71	0.00	621.71	27.43	–	–
	9	34.43	61.61	80.00	20.00	0.00	15.38	100.00	7.69	61.54	0.00	906.42	14.77	–	–
	10	133.28	120.09	100.00	0.00	0.00	0.00	94.23	13.46	100.00	5.77	229.54	19.38	12.73	
	20	29.25	67.51	87.50	12.50	0.00	6.25	93.75	18.75	93.75	6.25	186.13	28.91	–	–
	21	38.83	63.35	64.29	14.29	21.43	35.71	100.00	35.71	78.57	7.14	205.43	26.18	–	–
	24	17.50	19.37	50.00	12.50	37.50	50.00	100.00	37.50	50.00	0.00	302.36	26.93	–	–
	Average	50.35	53.56	82.22	9.36	8.42	16.09	98.28	16.16	78.36	2.74	384.27	23.68	1.81	

(*Continued*)

Table 3. Continued

		Land use										Transport system			
				I.3			I.4								
Mobility environments	Corridor (sections)	I.1	I.2	Commercial	Public facilities	Industrial	6–9 h	9–14.30 h	14.30 h–18 h	18–21.30 h	21.30–3 h	I.5	I.6	I.7	I.8
Metropolitan node-oriented	2	1.57	300.00	23.08	0.00	76.92	76.92	92.31	84.62	23.08	7.69	89.06	7.38	–	–
	13	8.37	300.00	26.32	73.68	0.00	57.89	94.74	68.42	100.00	5.26	0.00	0.00	–	–
	22	6.42	300.00	14.71	26.47	58.82	80.56	97.22	83.33	38.89	2.78	104.58	8.00	–	–
	23	0.74	300.00	7.14	21.43	71.43	81.25	100.00	81.25	25.00	0.00	176.80	12.32	–	–
	Average	4.275	300	17.8125	30.395	51.7925	74.155	96.0675	79.405	46.7425	3.9325	92.61	6.925	–	–
Intermodal stations-oriented	7	42.62	52.81	93.33	6.67	0.00	6.25	93.75	12.50	93.75	12.50	471.81	46.56	–	–
	12	164.17	240.45	98.05	1.95	0.00	1.55	89.53	19.38	98.45	10.85	20.61	5.88	–	18.9
	Average	103.395	146.63	95.69	4.31	0	3.9	91.64	15.94	96.1	11.675	246.21	26.22	–	9.45

Indicators:

I.1. Dwellings density (dwellings/Ha)
I.2. Urban activities intensities (urban activities/1000 dwellings)
I.3. Urban activities dominance (% urban activities/Ha)
I.4. Temporal coverage of urban activities (% urban activities per daily time slots)
I.5. Car transit intensities (cars/urban activity)
I.6. Public transport intensities (bus/urban activity)
I.7. Non-motorized transit routes (Ha land use/Km)
I.8. Motorized transit influence (% cars and buses)

of the corridor, including a relatively large share of people who had their homes in other places around the corridor. It is located in sections 2 (municipality of Albolote), 13, 22 and 23 (city of Granada). Industrial and technological areas and the main university campus comprise this 'mobility environment'. The metropolitan-oriented environment was wholly characterized by specialization dynamics distinguished by stakeholders in the expert system. Land use and transport indicators also identified such characteristics (Table 3). They showed that they were the places with practically no residential activity. In all cases, non-residential activity exceeded 300 urban activities/1000 dwellings with strong industrial-technological and public facilities predominance. They were areas with high levels of motorized traffic with an average of 123.48 vehicles/urban activity and 9.23 bus/urban activity. The presence of this work-oriented type of 'mobility environments' (also including other metropolitan facilities such as the university or research campus) was mainly related to the de-concentration of economic land uses (jobs) from the city centre to locations readily accessible by car.

Lastly, the final 'mobility environment' was called the inter-modal station-oriented environment. This refers to a particular type of metropolitan node-oriented environment. This particular distinction of inter-modal station-oriented environment was due mainly to the stakeholders who participated in the expert system stressing the importance of inter-modal stations on the transport corridor, but not at the same level as the three described mobility dynamics. The basic distinction with respect to metropolitan node-oriented environment lies in the fact that this environment was defined by the location of the main public transport stations on the corridor such as the bus station in the north of Granada and the train station (future High Speed Station (AVE)) in the central section of the corridor. This 'mobility environment' was located in sections 7 and 12, both in the municipality of Granada. Residential density was high in the case of section 12 (164,187 dwellings/Ha) and lowest in the case of section 7 (42.62 dwellings/Ha). The intensity of non-residential activities also varied in each section, being high in section 12 (240 act/1000 homes) and low in section 7 (52.81 activities/1000 dwellings). It should be noted that section 7 presented high motorized traffic for non-residential activities of 471.81 and 46.56 vehicles/urban activity. These statistics were much lower in section 12 due to its high intensity of non-residential activity with 20.61 and 5.88 buses/urban activity.

4.2. *'Mobility Environments' and Strategy-Making*

Having identified 'mobility environments' along the corridor, this section focuses on how they could be used in practice (Figure 5). As in many other planning contexts, Spanish practice is embedded in a rationalistic perspective. In this context, planning and decision-making could be considered to be different phases of the process. This means that the application of 'mobility environments' theory to the context of the MAG will be considered as a tool for delivering expert knowledge. In this context, the final objective of this research was aimed at providing decision-makers with ideas and/or solutions in order to link land use and transport by improving the implementation of LRT into the metropolitan corridor. The latest part of the final report presented to institutions described possible strategies for each 'mobility environment'. In the remainder of this section, we briefly describe the characteristics of these types of strategies (only some relevant examples of them).

In the case of local-oriented environment, several strategies were designed. The most relevant was labelled 'reinforcing social dimensions'. As described, in this 'mobility environment' proximity became very relevant and motorized transport was not essential. Therefore, these places were considered to be an excellent framework for socializing spaces. The strategy encouraged investment in open-space quality, by promoting new facilities and commercial activities in these areas such as small shops, bars, spaces for children and so on. The idea was to reinforce activities covered by walking and to limit flows of visitors from other parts along the corridor. The access to LRT would be also limited to pedestrians and car parking charges would be higher than in other parts of the corridor.

The second identified 'mobility environment' was a local and circulation-oriented environment. Here, the most relevant strategy was called 'redirecting cars'. These places had a huge potential for human interactions and they also had high levels of motorized transit. 'Redirecting cars' meant redesigning the traffic network along the corridor. LRT could play an important role in this context. Among LRT project alternatives, some of them included the implementation of boulevards in the main avenues. Our final report encouraged decision-makers to opt for this alternative. They could reduce car space ('redirecting cars') in the avenues and at the same time this space would be enjoyed by people as socializing and leisure spaces.

In relation to the motorized traffic-oriented environment, a strategy called 'modal shift' was developed. These were places with very high levels of car

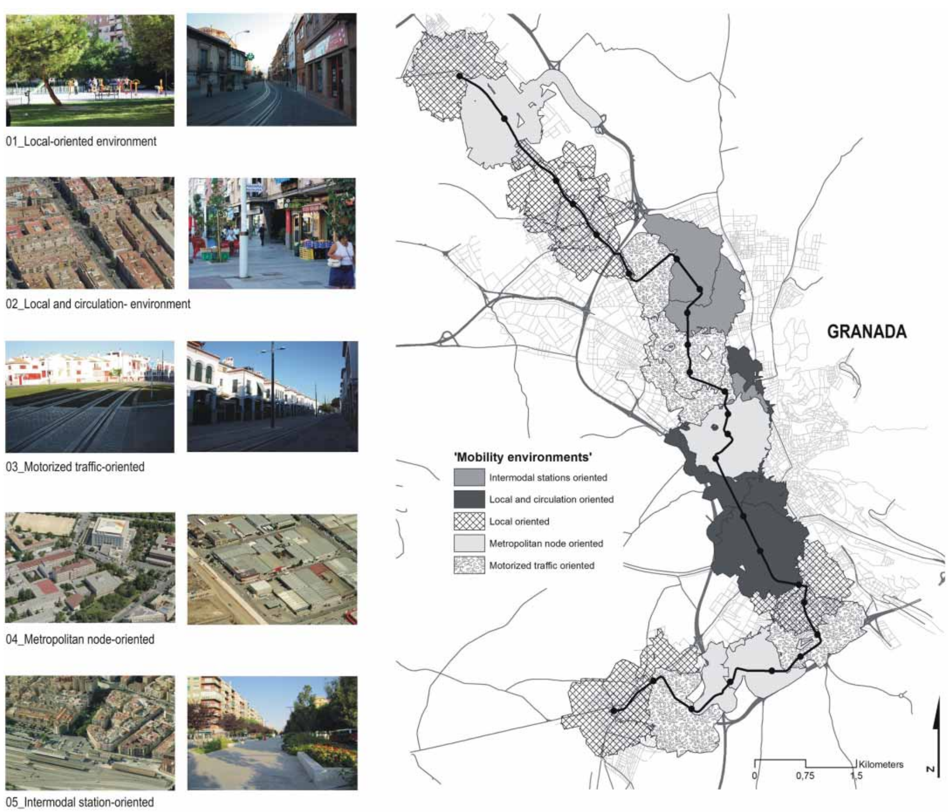

Figure 5. Mapping 'mobility environments' and strategies along the MAG corridor.

transit where proximity became irrelevant. The idea was to keep these areas as spaces focused on motorized traffic, but encouraging a 'modal shift'. A 'park and ride' system was proposed in these places connecting them with the LRT system. Economic advantages for park and ride users were proposed, as well as other regulatory and tax measures (circulation and parking charges, etc.).

Finally, it should be noted that a common strategy was proposed in the cases of intermodal station-oriented and metropolitan node-oriented environments. This was labelled 'Metropolitan landmarks'. The idea of the strategy was not only to reinforce the metropolitan role of these places, but was also to avoid the decentralization of metropolitan facilities along the corridor. Using this strategy, decision-makers were encouraged to locate metropolitan activities such as new university buildings, technological and logistic activities and so on. Promoting agreement between major companies and the Transport Consortium was another recommendation included in the 'metropolitan landmarks strategy'.

This section has only included a brief description of designed strategies from 'mobility environments' theory in the corridor of the MAG. A detailed description of strategies can be consulted in Soria-Lara (2012).

5. Conclusions

In this paper, we have discussed both what exactly 'mobility environments' are and how they can be used in practice. According to Bertolini and Dijst (2003), three main aspects were identified when 'mobility environments' were being defined: (i) land use, (ii) transport and (iii) human interaction. The use of 'mobility environments' in practice is defined by the planning system where they are embedded. This paper showed how 'mobility environments' could provide decision-makers with arguments and reasons to guide actions from more rationalistic perspectives, and how they could move the transport-planning process towards more communicative approaches where all stakeholders take part from the earliest phases.

These theoretical assumptions were used in the particular case of a transport corridor located in the MAG, Spain. Institutions had decided to implement a new LRT in the corridor and their priority was based on linking land use and transport as an effective way of promoting new sustainable mobility patterns in the region. The University of Granada was required to design strategies oriented towards this main goal. From academia 'mobility environments' was the selected method for this cause. Despite the development of different practical applications based on 'mobility environments' as can be seen in Bertolini (2006), Soria-Lara (2012) or Talavera et al. (2014), there are no strict guidelines on how 'mobility environments' can be defined, identified and mapped. In this context, this paper took this opportunity to shed light on the subject and an ad hoc method was designed to identify 'mobility environments' along the corridor. The method was strongly encouraged by stakeholders due to the fact that the definition of 'mobility environments' considered both official statistics from institutions (designing land use and transport indicators) and the opinion of experts about the type of mobility along the corridor. In this way, the proposed method was simultaneously recognized as realistic and sophisticated method.

The method was developed during 2010 and conducted in the corridor during 2011. Five 'mobility environments' were identified: (i) local-oriented, (ii) local and circulation-oriented, (iii) metropolitan node-oriented, (iv) motorized traffic-oriented, and (iv) intermodal station-oriented. Once 'mobility environments' were described and analysed, a set of strategies were proposed with the aim of effectively linking land use and transport. The majority of the proposed strategies were not in the end adopted by decision-makers. Problems with the final budget and the urgency of implementing the LRT were the main causes. Nevertheless, the research was considered useful for both the academic and the professional world. From academia, we have had the opportunity to reflect on the definition and identification of 'mobility environments' and there was support for these from the professional world during the decision-making process.

New topics are opening up based on this research, aimed particularly at testing the use of the concept of 'mobility environment' in practice. Researching in the interface between academia and the professional world is considered to be an excellent way to establish new findings in the field.

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