Case Study

Planning for Pedestrians with a Participatory Multicriteria Approach

Hannia Gonzalez-Urango[1]; Giuseppe Inturri, Ph.D.[2]; Michela Le Pira, Ph.D.[3]; and Mónica García-Melón, Ph.D.[4]

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

Abstract: The design of accessible walking routes needs to take into account the different stakeholders' preferences and factors affecting walking. It is a complex issue which policy-makers should deal with to foster sustainable mobility. A participatory multicriteria decision analysis approach is presented to help the planning and designing of pedestrian routes, based on a sound analysis of factors affecting walking behavior and the attributes of the roads, and a stakeholder-driven evaluation of the same. A group of different stakeholders has been involved to select the criteria for designing pedestrian routes in the city center of Cartagena (Colombia). Some of them have been selected based on the results of a social network analysis (SNA) to be involved as key stakeholders for the evaluation of the selected criteria through an analytic network process (ANP). An index to measure the importance of each criterion in designing pedestrian routes has been obtained. Results provide valuable inputs to understand how to redesign and reconfigure streets for pedestrians in a city so as to improve walkability and foster a shift toward active and sustainable transport modes. **DOI: 10.1061/(ASCE)UP.1943-5444.0000585**. © *2020 American Society of Civil Engineers*.

Author keywords: Analytic network process; Stakeholder analysis; Pedestrian route design; Pedestrian mobility; Pedestrian accessibility; Urban walkability.

Introduction

Cities are continuously growing in population, raising several challenges related to their resource use, and pointing to the need for them to adapt to emerging trends and new dynamics of urbanization "in an evolving landscape of change" (Hickman and Banister 2014). Urban transport systems need to be adapted to satisfy the needs of citizens, while reducing their negative externalities, the most severe being environmental and road damage, accidents, congestion, and oil dependence (Santos et al. 2010). Promoting a shift toward sustainable transport modes in cities should be considered as a priority by local administration for limiting the increase in motorization and transport energy dependence, acknowledging its important contribution to total energy consumption (Ignaccolo et al. 2016; Fichera et al. 2018). In this respect, walking is among the most sustainable transport modes, providing social, environmental, and economic benefits (Caprì et al. 2016; Moura et al. 2017; Southworth 2005).

It is also a good way to attract visitors and tourists to cities, following the concept of "transport as tourism," where the transport mode is the containing context for travel and a basis for the tourist experience, as opposed to the utilitarian theory of "transport for tourism" (Page 2009).

In general, pedestrian-oriented policies should aim at increasing walkability, defined as "the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network" (Southworth 2005). Thus, the design of pedestrian routes and areas involves consideration of different technical, economic, environmental, and social factors (Sayyadi and Awasthi 2013).

Location planning and design of pedestrian zones has multifaceted aspects (Sayyadi and Awasthi 2013) that involve different stakeholders and multiple criteria, resulting in a multistakeholder multicriteria problem. In addition, barriers to the implementation of pedestrian-oriented policies can arise, for example, in terms of opposition from residents and motorists, and local merchants (Parajuli and Pojani 2018). Understanding the factors that influence walkability and pedestrians' perceptions enables planners to build more walkable and liveable cities (Jabbari et al. 2017). Research in urban environments and among different social groups is needed to understand which design factors are most effective in promoting walking (Southworth 2005).

This work intends to prove that a procedure based on a multicriteria decision analysis (MCDA) technique, that is, analytic network process (ANP), is appropriate to elicit stakeholder preferences and obtain a stakeholder-driven evaluation of the important issues for pedestrian routes in the city center of Cartagena de Indias (Colombia). The problem is quite relevant, since it has been demonstrated that pedestrian facilities and policies, such as pedestrian malls, have met limited success outside of Europe (Parajuli and Pojani 2018).

[1]Ph.D. Candidate, Ingenio (CSIC-UPV), Universitat Politècnica de València, Ciudad Politécnica de la Innovación, Edif 8E 4°, Camino de Vera s/n, Valencia 46022, Spain; Universidad Simón Bolívar, Facultad de Ingenierías, Barranquilla, Colombia. (corresponding author). ORCID: https://orcid.org/0000-0001-8300-7774. Email: hangonur@doctor.upv.es; gonzalezurango@gmail.com

[2]Associate Professor, Dept. of Electric, Electronic and Computer Engineering, Univ. of Catania, Via Santa Sofia 64, Catania 95125, Italy. Email: ginturri@dica.unict.it

[3]Lecturer/Research Fellow, Dept. of Civil Engineering and Architecture, Univ. of Catania, Via Santa Sofia 64, Catania 95125, Italy. ORCID: https://orcid.org/0000-0002-5963-0854. Email: mlepira@dica.unict.it

[4]Full Professor, Ingenio (CSIC-UPV), Universitat Politècnica de València, Ciudad Politécnica de la Innovación, Edif 8E 4°, Camino de Vera s/n, Valencia 46022, Spain. Email: mgarciam@dpi.upv.es

Note. This manuscript was submitted on January 23, 2019; approved on December 17, 2019; published online on May 18, 2020. Discussion period open until October 18, 2020; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Urban Planning and Development***, © ASCE, ISSN 0733-9488.

Cartagena de Indias is a case in point, being a well-known international touristic destination with a vibrant historic center with different characteristics that make it a vital point for the city. This area combines different formal and informal activities, such as commercial, educational, and touristic. In terms of mobility, it is one of the most vulnerable areas. Pedestrians, vehicles, and formal and informal commerce interact in the same spaces daily.

The methodology proposed is therefore intended to support the local administration of the city in the design of walkable routes to improve pedestrian accessibility in the city center, involving stakeholders in the definition of the important elements and characteristics of pedestrian routes. The paper adopts a case study strategy based on a participatory multicriteria technique. It combines two recognized techniques, social network analysis (SNA) and ANP, which allow decision-makers to get more transparent and traceable results. The SNA–ANP approach has been previously applied on issues related to the evaluation of projects and the definition of indicators (Gonzalez-Urango and García-Melón 2018). However, to the best of the authors' knowledge, it is the first time that this approach is considered for issues related to the planning of pedestrian routes or mobility. Unlike previous applications, this case is novel in the way the model is developed. Owing to the potential of the proposed approach, the development and results of this study provide valuable inputs for planning and implementing plans aiming to promote pedestrian mobility and spatial analysis involving stakeholders.

Conceptual Framework

Pedestrian Mobility and Pedestrian Route Design

Planning and designing walking facilities is crucial for promoting a healthy public life, creating sustainable areas, and enhancing social life and economy (Singh 2016). A literature review completed by Tong et al. (2016) discusses the importance of walkability focusing on new urban development. In terms of research content, most of the studies consider different dimensions and approaches.

Several works were found in terms of walkability and how to assess it, but few of them in relation to the parameters of design for pedestrian routes. The main research methods include subjective perception (self-reporting and questionnaires), objective assessment [accelerometers, mathematical model, spatial analysis, and geographic information system (GIS)], and some composite assessment tools (Tong et al. 2016).

Jan Gehl's work (Gehl 2010) presents details on how to design good cities for walking. However, in most cities, instead of designing new ones, spaces have to be redesigned to improve walkability. Several actions will be necessary in order to improve walkability. According to (Southworth 2005), some of these are related to: the assessment of current walkability conditions; development of policies and plans for a total pedestrian environment; revision of standards and regulations to promote the walkable city; research on walking behavior in varied urban environments; urban designers and transportation planners need to begin to work together in creative and experimental ways; involvement of the public through educational activities and participation in the planning process, which will be crucial; and finally, a new generation of transportation and urban planners is needed who see pedestrian access as a necessary and integral part of the total transportation environment.

Some authors also recognize the importance of tools which not only evaluate but also assist road design processes, beyond the problems of standard road network, since this involves a "thicker" and more multidimensional description of the urban environment and its actors (Blecic et al. 2015). In this respect, a multicriteria evaluation approach is needed to analyze the problem from different perspectives or points of view.

Multicriteria Evaluation Approach

To differentiate the importance of each criterion in the design process, a weighting process is required. There are many ways to calculate weights, and MCDA techniques are widely adopted. Several authors have introduced the use of MCDA techniques (Barba-Romero and Pomerol 1997; Belton and Stewart 2002; Loken 2007). One of the most used methods is the so-called analytic hierarchy process (AHP) by Saaty (1990), based on the creation of a problem hierarchy, and pairwise comparisons between criteria through the building of matrices to derive priority scales and weights.

AHP for mobility issues has been used, for example, to compare route alternatives in terms of different variable weights (Kim et al. 2014), to find the best transport system among different alternatives (Ignaccolo et al. 2017), and to examine the interconnection between the retail activity and the nonmotorized accessibility (Arranz-López et al. 2017). Applications related to pedestrian mobility also include some works related to locating pedestrian zones (Sayyadi and Awasthi 2013); ranking walkability performance metrics for prioritizing pedestrian corridors (Oswald Beiler et al. 2015); understanding of environmental attributes, which encourage pedestrians to walk (or not) (Mateo-Babiano 2016); developing a GIS-based integrated approach to assess a pedestrian network by combining multicriteria and network analysis based on space syntax (Jabbari et al. 2017); and developing a methodology based on the integration of geospatial information science, remote sensing, and group multicriteria analysis to assess the walkability of pathways in a city (Taleai and Taheri Amiri 2017).

In this case, authors propose the more evolved ANP technique. The ANP method, developed by Saaty (2001) to generalize his original AHP, provides a framework to address decision-making or problem assessment. It allows for more complex, interdependent, and feedback relationships between the elements (Sipahi and Timor 2010). In this respect, it defines the prioritization model as a network, instead of as a hierarchy, composed of different elements, grouped into clusters, and connected to each other. A detailed description of the method can be found in Saaty (2001), Ligardo-Herrera et al. (2019) and others.

So far, no ANP application to pedestrian problems has been found in the literature. However, the use of ANP is considered more appropriate in this field, since the complexity of the urban environments makes the criteria for pedestrian routes highly correlated.

In addition, multiple actors can have different views and express heterogeneous preferences related to pedestrian mobility. Addressing stakeholder needs and taking into account different perspectives is important to design spaces capable of promoting a potential shift toward walking avoiding potential oppositions to the rehabilitation of urban realms.

Participatory Approach and Stakeholders' Analysis

Public participation in transport decision-making and planning processes is considered fundamental to foster decisions that are technically consistent, while maximizing stakeholder consensus and acceptability of the proposed solutions (Le Pira 2018). The involvement of citizens, stakeholders, and policy-makers should be guaranteed all along the planning process, with appropriate methods and tools according to the specific decision-making context and the desired level of involvement (Cascetta et al. 2015).

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

However, in recent years, only a few studies have dealt with the involvement of stakeholders and decision-makers in the planning process of pedestrian mobility. In this respect, Moura et al. (2017) propose a participatory walkability assessment framework for distinct pedestrian groups and trip purposes. Taleai and Taheri Amiri (2017) develop a participation process in which "experts" and "non-experts" are asked to rate criteria based on their importance in terms of encouraging people to walk. The European Union Pedestrian Quality Needs Project (2010) encourages cooperation and dialogue with stakeholders outside government/administration.

Identifying the relevant stakeholders who need to be involved is one of the most challenging phases of a participation process. It is desirable to use tools that can help to identify and select stakeholders. In this respect, the "snowballing" technique aims at identifying stakeholders starting from a small number of people who are asked to nominate others; the nominees are in turn asked for further nominations and the network builds up like a snowball (Scott 2013). In addition, in recent years, techniques belonging to the SNA have been used to study the social importance of a given individual in a network via centrality indexes, and understand the potential problems due to topology (Scott 2013). General information regarding stakeholder involvement can be found in Glicken (2000) and a detailed description of SNA can be found in Wasserman and Faust (2007), Reed et al. (2009), and Gonzalez-Urango and García-Melón (2018).

Research Methods

The proposed participatory multicriteria approach was arranged in three main stages (Fig. 1). First, understanding the context of the problem. The problem was analyzed by defining the objective to be achieved. This could derive from specific needs expressed by local administration, users, or from programs and planning documents currently in force. The case study was then designed. Second, involving stakeholders. Following the approach proposed by Bryson (2004), Prell et al. (2009), Saint Ville et al. (2017) and Yang (2014) a group of stakeholders was interviewed to assess the relationships among them and to define the final list of criteria to be assessed through the ANP model. The main aim of this stage was to determine stakeholders' centrality measures through SNA in order to analyze their influence and select some key stakeholders. They were analyzed with UCINET software (Borgatti et al. 2002). Third, evaluation of criteria for designing pedestrian routes through ANP. In the ANP model, according to (Saaty 2001), a problem is represented as a network composed of decision elements, that is, criteria and alternatives, grouped in clusters and connected by influences among them. In this case, criteria express quantitative and qualitative characteristics or attributes that should be evaluated in the existing road network. We developed the ANP model at the criteria level by evaluating criteria that should be defined before considering some streets for pedestrians.

The selection and evaluation of criteria for designing pedestrian routes was solved following the ANP procedure (Saaty 2001).

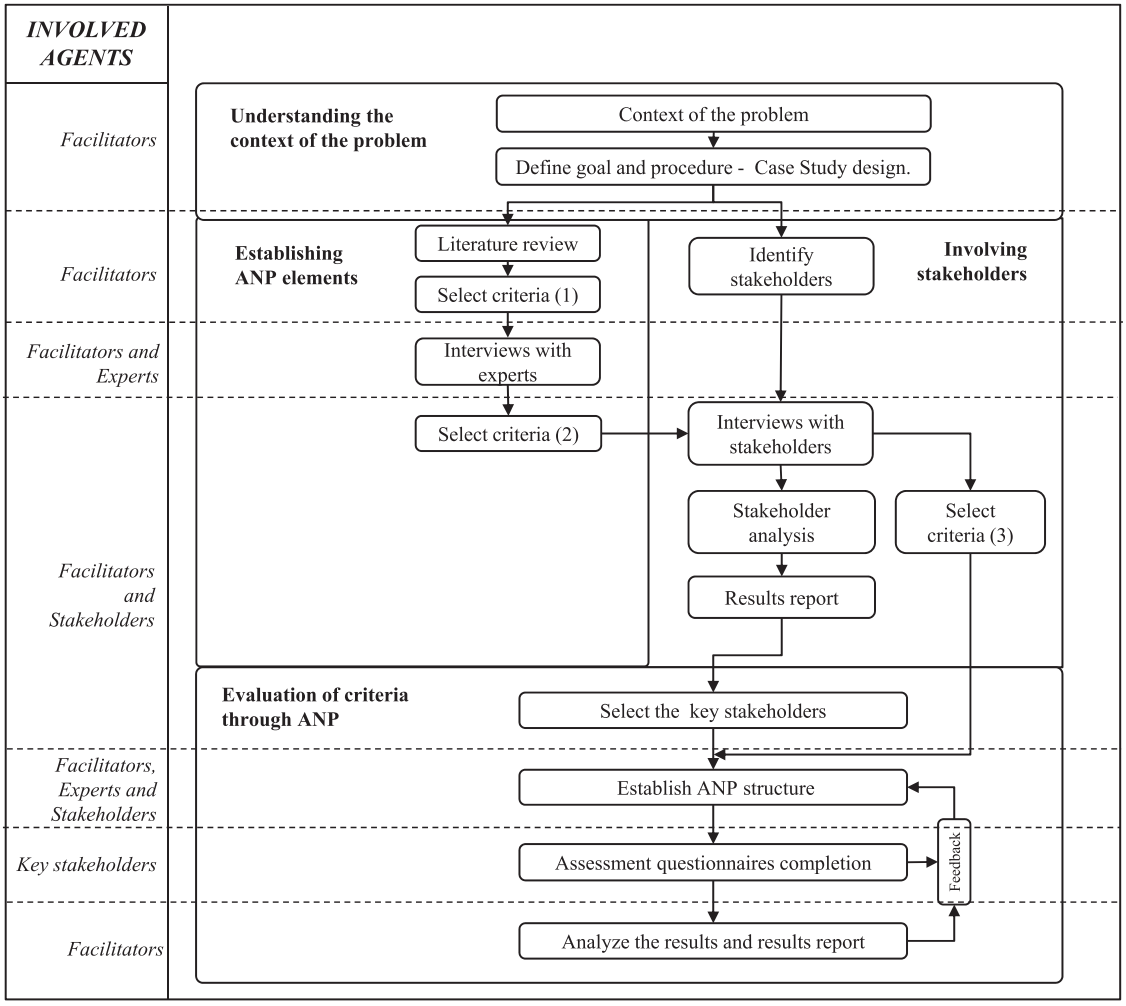


Fig. 1. Methodology proposed.

J. Urban Plann. Dev., 2020, 146(3): 05020007

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

1. *Establishing the elements*. The ANP elements are the criteria for pedestrian routes. To define them, three steps were developed in this study: (1) document analysis, (2) revision by experts, and (3) by stakeholders. Following the method proposed by Liao et al. (2011) and others.
2. *Developing the evaluation problem as a network model*. Experts established the structure of the ANP model by determining influences among criteria.
3. *Application of the ANP model*. Once the model was agreed upon, the ANP questionnaire with the required judgments based on pairwise comparisons was designed and sent to key stakeholders, selected via SNA. The obtained results were analyzed with the help of Superdecision v.2.0.8. Software (https://www.superdecisions.com/), which is widely used to support the resolution of ANP/AHP problems. A prioritization result for each individual stakeholder was obtained according to his/her judgments. In order to obtain a global judgment, individual judgments' aggregation via AIJ (Saaty and Peniwati 2008) was performed using the geometric mean for all the stakeholders. Priorities obtained for each criterion could be considered their "Importance Index", so the higher this index value, the more important the criterion will be. These results could be used to analyze the existing road network in the city center, and to eventually select a set of priority streets in the city center to be considered as pedestrians and redesigned accordingly. A detailed description of the approach implementation was presented in the case study in the following sections.

Case Study: Defining Criteria for Pedestrian Routes in the City Center of Cartagena de Indias

Context

Cartagena de Indias is located along the northern coast of Colombia (Fig. 2). It is the fifth largest city in the country with more than one million inhabitants (National Administrative Department of Statistics DANE, https://www.dane.gov.co/). It is one of the most important tourist destinations in the Caribbean, recognized for its natural attractions and historical heritage.

Mobility in Cartagena is mainly focused on motor vehicles. Since 2008 the number of motor vehicles registered in the city have increased year by year, mainly motorcycles and cars (Cartagena Cómo Vamos 2018). The city has only two main avenues, where a massive transport system has been working since 2016. Hence some illegal services have arisen in response to the lack of alternatives for mobility.

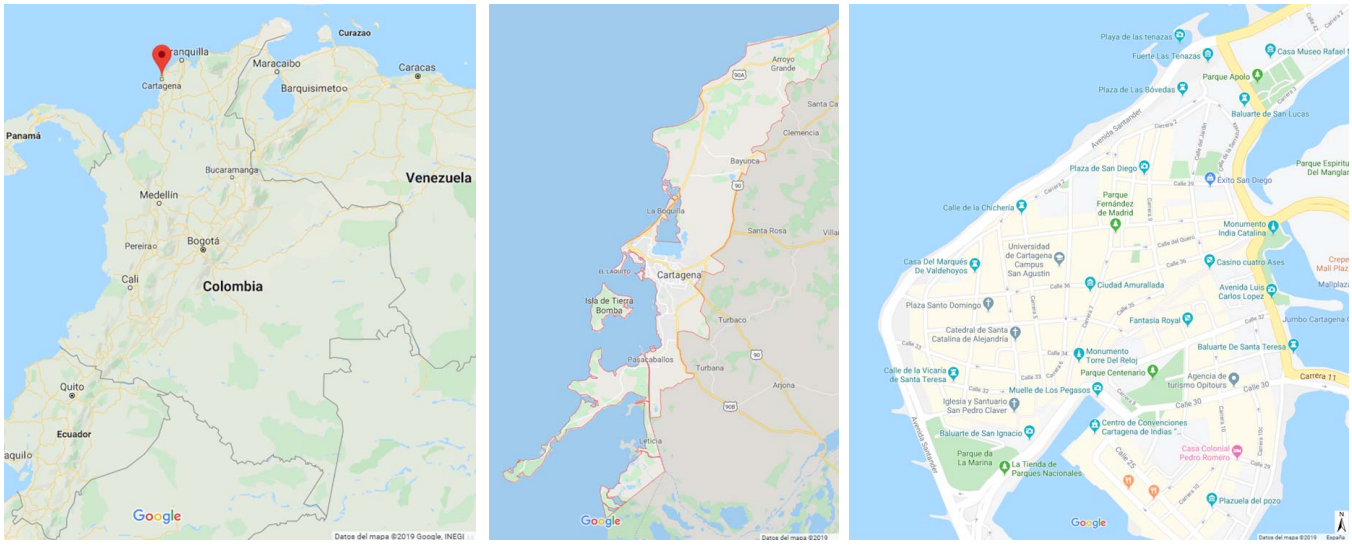
As a part of an intervention in the city center, the local administration is currently proposing different plans and alternatives to improve mobility and rehabilitate spaces to make them available for locals and tourists (Local Tourism Plan 2016-2019, Municipality of Cartagena de Indias 2014), as follows:

1. Design of different pedestrian paths through the main historic and tourist places around the city center.
2. Better distribution of the traffic of vehicles and persons on the streets.
3. Safe-sharing of public spaces among the different traffic components, thus improving the livability of citizens and tourists.

However, these planning processes are under pressure from stakeholders belonging to public and private sectors, but, mainly, from citizens, who demand actions that generate income and well-being for them. Including an active participation of citizens and stakeholders from the beginning of any transport decision-making process is a precondition to avoid the failure of a project as a consequence of a lack of consensus (Le Pira et al. 2017).

In the past years, the local administration has been implementing some restrictions in the area. Traffic has been restricted during certain seasons or hours of the day. However, the conditions for these measures are irregular, the hours and the restricted streets are always changing. Citizens, businesses, and transports complain about these measures even though they recognize measures for pedestrians are necessary. Pedestrians are still the most vulnerable ones. They daily interact in the same spaces with vehicles, and formal and informal commerce. Pedestrian spaces are also badly used and maintained by other types of users (Fig. 3). According to the stakeholders who were involved in the study, pedestrianizing some streets is necessary and viable, but they should be permanent with long-term investments.

City center streets are similar in terms of some geometric and infrastructure features (Fig. 4). In addition, the city center is a UNESCO World Heritage Site. Thus, it is more difficult to retrofit



(a) (b) (c)

Fig. 2. Location of: (a) Cartagena de Indias in Colombia; (b) the city center; and (c) the area of study. [Map data (a–c) ©2019 Google, map data in (c) from INEGI.]

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

builtup areas because the patterns are already established. While it is not impossible to modify existing street networks to serve pedestrians and to insert some density and mixed uses, it will require imagination and persistence (Southworth 2005), preserving the identity of places while providing an appropriate new use of the spaces (Galdini 2019).

Involving Stakeholders

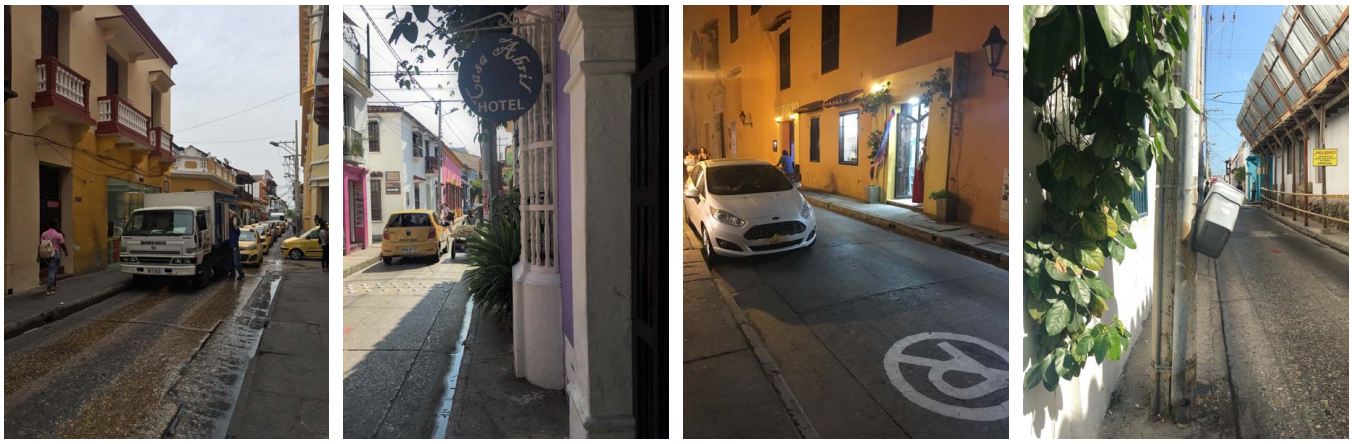
The first step was to identify the stakeholders. An initial list was defined with the assistance of the local administration, and then the "snowball technique" was used to complete it. A total of 28 actors were identified among public administration, academia, civil society, private sector, and informal commerce. The model was based on the analysis of information exchanged among stakeholders. The flow of information can be used to establish links between two nodes in a social network (Hanneman and Riddle 2005). A questionnaire to find out the amount of information exchanged was sent to all of them (Appendix).

The information gathered was scaled in the following way:

- Regarding information exchange: 0 indicates no information exchange, 1 means an exchange at least every three months, and 2 means that information exchange occurs more frequently.
- Regarding mobility projects: 0 indicates never and 1 means at least one during the last two years.

The 28 stakeholders analyzed allowed us to construct two social networks: one for the exchange of information and the other for mobility projects. Each stakeholder was represented by a node. The more central actors in the networks were considered those who have more access or control over the information within the network or those who were the more active brokers (Wasserman and Faust 2007). Centrality indices were calculated in order to reflect which actors were the most central ones (Table 1). The nodes' betweenness centrality (Prell et al. 2009; Yang 2014) was chosen as the most appropriate SNA indicator to assess the relevance of the stakeholders. It measures the number of shortest paths that pass through each actor, thus allowing the identification of the actors who can facilitate a dialogue to act as a "bridge" among distant actors (Hanneman and Riddle 2005; Wasserman and Faust 2007). A graphical representation of the whole information exchange network is shown in Fig. 5 using the results of betweenness centrality.

The analysis of the networks as a whole shows that network in Fig. 5(a) is denser than the network in Fig. 5(b). Some actors are data sources and information sinks. This means that they are useful for gathering and receiving information related to mobility, but they



(a) (b) (c) (d)

Fig. 3. Examples of scarcely used and badly maintained streets: (a) Calle de la Moneda; (b) Calle del Quero; (c) Calle Santo Domingo; and (d) Calle del Pilar. (Images by Hannia Gonzalez-Urango.)

(a) (b)

Fig. 4. Examples of city center streets: (a) Calle de las Bovedas; and (b) Calle Antonio Ricaurte. (Images by Hannia Gonzalez-Urango.)

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

Table 1. List of stakeholders and multiple centrality measures

Stakeholder	ID	Group		Information betweenness	Projects betweenness
City Center Administration	A1. CenterAd	Public administration	Public	55.537	86.752
Local Council	A2. LocalCouncil	Public administration	Public	3.134	0.000
Local Authority of Transit and Transportation	A3. TransAuth	Public administration	Public	48.650	94.456
Local Public Space Administration Office	A4. PublicSpaceAd	Public administration	Public	80.858	60.345
Local Planning Office	A5. PlanningOff	Public administration	Public	5.232	0.000
Local Institute of Heritage and Culture	A6. Herit&CultInst	Public administration	Public	66.851	62.667
Local Tourism Office	A7. TourimOff	Public administration	Public	77.779	33.622
Environmental advisor	A8. EnvironAdv	Public administration	Public	10.559	2.160
The Ministry of Culture	A9. MinistryC	Public administration	Public	52.726	44.519
Police	A10. Police	Public administration	Public	4.492	0.000
The Workshop School of Cartagena	A11. WorkShopSch	Academia	Public	0.000	0.000
Academic expert in transportation	A12. AcademicET	Academia	Public	2.874	13.345
Academic expert in local development	A13. AcademicELD	Academia	Public	1.530	0.000
Residents representative 1	A14. ResidentsR1	Civil Society	Public	9.839	29.881
Residents representative 2	A15. ResidentsR2	Civil Society	Public	0.742	6.733
Environmental activist	A16. EnvironActiv	Civil Society	Public	5.881	42.668
Tourists	A17. Tourists	Civil Society	Public	0.000	0.000
Local merchant representative	A18. MerchantsR	Private Sector	Private	3.012	33.942
tour operator	A19. TourOperat	Private Sector	Private	13.719	0.000
NGO on heritage conservation	A20. NGOHeritg	Private Sector	Private	8.635	17.050
Association of peddlers of Cartagena	A21. PeddlersAsoc	Informal	Private	1.252	1.333
Craftsmen/Informal seller representative	A22. CraftmenR	Informal	Private	2.892	0.000
Street artist representative	A23. StreetAR	Informal	Private	5.396	0.000
Local artist representative	A24. LocalArtists	Informal	Private	1.869	0.000
Taxi driver association 1	A25. TaxiAsoc1	Informal	Private	1.707	0.250
Taxi driver association 2	A26. TaxiAsoc2	Informal	Private	2.669	1.751
Coachmen representative Carriages	A27. Carriages	Informal	Private	15.095	1.525
Tour guide	A28. TourGuide	Informal	Private	9.069	0.000

have never been considered for mobility projects. In order to select the actors who would likely have a major role regarding mobility issues, the authors decided to focus on the network in Fig. 5(b).

In the networks for mobility projects [Fig. 5(b)], only a few actors are linked by more than one connection, which denotes bad communication within the network. There are few connections among private actors while there are many among the public ones. According to the group to which they belong, public administration is the best connected one, civil society and private sector have few connections, and academia and the informals are disconnected. Local administration is the main broker in the network.

In Fig. 5(b) the bigger the size of the geometric figure, the higher the betweenness centrality, which means a higher influence of the actor within the network. They are the actors who would have more control on the network, because more information would pass through them (Yamaki 2017). High betweenness centrality grants the actor the ability to influence the flow of resources between others, and it also provides him/her with a diversity of resources provided by the bridging tie (Bodin and Crona 2009). According to this measure, the most influential actors form a preliminary list of key stakeholders for the ANP process. Most of them belong to public administration. Since decision-making regarding local development projects requires different points of view and opinions (Bodin et al. 2006; Newman and Dale 2007), it may be beneficial to increase the diversity of stakeholders involved, making the group more resilient and adaptive to changes (Bodin et al. 2006; Prell et al. 2009). Therefore, for the next phase of the study, authors decided to include two more actors who were not among the most central ones, but who nevertheless knew the problem very well. More information about the stakeholders selected is presented in the section "Application of ANP."

Evaluation of Criteria for Designing Pedestrian Routes through ANP

Establishing the Elements: Criteria

Three steps were developed to define the criteria: document analysis, revision by experts and by stakeholders.

Document analysis was based on a literature search with the following keywords: "pedestrian accessibility," "walkability," "urban planning," and similar terms focused on "decision-making" and "designed process." There is an abundant literature on pedestrian mobility, but it is mainly devoted to encourage pedestrian mobility and assess a pedestrian level of service. After studying the first findings, initial keywords and equations were reviewed yielding the ones included in Table 2.

In the end, the document analysis comprised a definitive set of 35 papers and 12 reports and guidelines. They were read in full and analyzed guided by the question: Which criteria were considered? A list of 30 criteria categorized in five groups was defined.

An in-depth discussion with experts on transport planning and mobility followed this literature review in order to reduce the initial list of criteria and the complexity of the decision-making model. The initial list was reduced to 22 criteria grouped in five clusters.

The next step was to present the selected criteria to stakeholders in order to obtain a more comprehensive and understandable model and to adapt it to the case study. All the stakeholders considered in the "Stakeholder" section were asked to evaluate the corresponding criteria. Each criterion was evaluated according to its importance via a scale from "Not at all" (0) to "Extreme" (4) (Table 3).

According to Chang (2013), Soleimani and Valmohammadi (2017), and Tavana et al. (2016), a cutoff value based on the

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

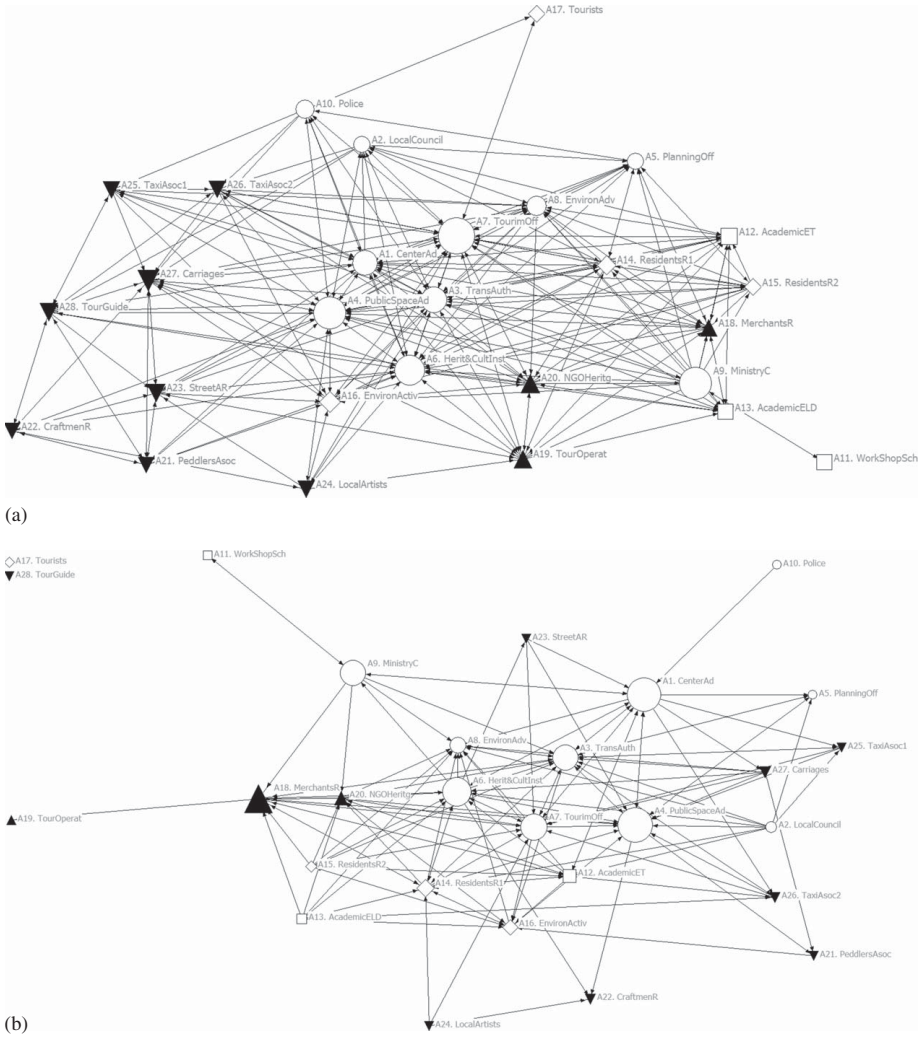


Fig. 5. Graphs showing the social network of stakeholders, according to betweenness: (a) network related to information exchange; and (b) network related to mobility projects. Obtained by UCINET software. Colors: white = public; black = private. Shapes: circle = public administration; square = academia; diamond = civil society; up triangle = private sector; and down triangle = informal.

Table 2. Outcomes of the literature review

No.	Equation query	Results	Comments
1	"pedestrian zones" OR "pedestrian routes" OR "pedestrian way" OR "pedestrian facilities" AND design	103	Analyzed by ToS[a] tool Robledo et al. (2014)
2	"pedestrian zones" OR "pedestrian routes" OR "pedestrian way" OR "pedestrian facilities" AND design AND Decision making	6	—
3	"pedestrian zones" OR "pedestrian routes" OR "pedestrian way" OR "pedestrian facilities" AND decision making	15	—
4	walkability AND design AND path	26	All related literatures developed in recent years, 2005 onwards
	Total without unrelated and duplicates	35	

[a]Tree of Science. ToS is a free web-based tool for science articles selection.

Table 3. Rating scale

			Rate				
Cluster	Criteria	Definitions	Not at all	Moderate	Medium	High	Extreme
1. Connectivity	1. Presence of public transport	Access to public transport e.g., bus, taxi.	0	1	2	3	4
	2. Access to final destination	Evaluate the accessibility to a final destination in a route. In terms of presence of destinations, e.g., shops, workplaces, and elements that facilitate the access to them.	0	1	2	3	4
…	…		0	1	2	3	4

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

Table 4. Clusters and criteria

Cluster	Definition		Criteria	Mean	Definition	References
1. Connectivity	It refers to the connection between areas and with key "attractors" such as public transport stops, schools, work, and leisure destinations. Routes should form a comprehensive network.	C1.1	1. Presence of public transport	3,51	Access to public transport e.g., bus, taxi	Aghaabbasi et al. (2017), Cambra (2012), Cervero et al. (2009), Jabbari et al. (2017), Mateo-Babiano (2016), Sayyadi and Awasthi (2013), Southworth (2005), Taleai and Taheri Amiri (2017); Pedestrian Environment Review System PERS software; Walk Europe Project.
		C1.2	2. Access to final destination	3,78	Evaluate the accessibility to a final destination in a route. In terms of presence of destinations, e.g., shops, workplaces, and elements that facilitate the access to them	
		C1.3	3. Street connectivity	3,41	Related to the presence of intersections in a route, e.g., presence of alternative routes, connection among paths	
		C1.4	4. Pathway continuity	3,46	Absence of interruptions or physical elements that force to change a route	
		C1.5	5. Path directness	3,46	Between two nodes, evaluate the difference between shortest route and designed one	
2. Urban function	It refers to the different uses that the inhabitants develop on the territory. Determine the purpose or role of a space and therefore the usability of a territory.	C2.1	6. Parking areas	3,62	Proximity to or presence of parking areas	Lotfi and Koohsari (2011) and Sayyadi and Awasthi (2013)
		C2.2	7. Cultural elements	4,17	Presence of cultural elements or convivial points	Mateo-Babiano (2016), Moura et al. (2017), Nuworsoo and Cooper (2013), Singh (2016); Cedex Centro de Estudios y Experimentation de Obras Públicas; Montgomery County's PBEF Pedestrian and Bicycle Environmental Factor; Walk Europe Project
		C2.3	8. Street vitality	3,35	The liveliness that a space can transmit, e.g., areas available for street vendors, bazaars.	
3. Route attributes	Elements in the routes and their context related to urban design and performance.	C3.1	9. Path performance	4,03	Characteristics and performance measures of streets or routes, related to volumes, densities, effective spaces, etc.	Cervero et al. (2009), Huff Herbie and Liggett (2014), Kadali and Vedagiri (2016), Kalakou and Moura (2014), Monteiro and Odete (2015), Oswald Beiler et al. (2015), Rahman et al. (2013), Sayyadi and Awasthi (2013) and Sisiopiku et al. (2007)
		C3.2	10. Street traffic	3,67	Vehicular traffic conditions	Cambra (2012), Guo and Loo (2013), Kadali and Vedagiri (2016), Moura et al. (2017), Park et al. (2017), Sayyadi and Awasthi (2013), Talavera-Garcia and Soria-Lara (2015)
4. Comfort	Elements that affect performance, behavior & perceptions of a path.	C4.1	11. Aesthetic	3,61	Related to the enjoyment or the perception of a nice and beautiful environment, e.g., maintenance, cleanliness, attractiveness from an architectural and urban point of view, transparency and permeability of the public-private space.	Aghaabbasi et al. (2017), Bentley et al. (2010), Blečić et al. (2015), Cambra (2012), Gant (1997), Guo and Loo (2013), Jabbari et al. (2017), Moura et al. (2017), Sahani and Bhuyan (2013), Singh (2016); Walkanomics; Walk Europe Project
		C4.2	12. Feeling/ Perception	3,38	Attributes that generate less stress or a nice feeling of being relaxed, e.g., pollution, quality of path, noise and construction, path enclosure, etc. Reflect attributes that could protect pedestrians from climate conditions	Aghaabbasi et al. (2017), Cambra (2012), Guo and Loo (2013), Kadali and Vedagiri (2016), Kalakou and Moura (2014), Mateo-Babiano (2016); Mayor of London (2005), Moura et al. (2017), Sahelgozin et al. (2015), Sayyadi and Awasthi (2013), Singh (2016), Sisiopiku et al. (2007), Southworth (2005), Tong et al. (2016), Zegeer and Bushell (2012); Walkanomics; Walk Europe Project

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

Table 4. (*Continued*.)

Cluster	Definition		Criteria	Mean	Definition	References
		C4.3	13. Personal Security	3,47	Evaluate the state of being and feel safe from harm or danger	Aghaabbasi et al. (2019), Bentley et al. (2010), Guo and Loo (2013), Mateo-Babiano (2016), Moura et al. (2017), Sahelgozin et al. (2015), Sisiopiku et al. (2007), Southworth (2005); Cedex, Walkanomics; Walk Europe Project

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

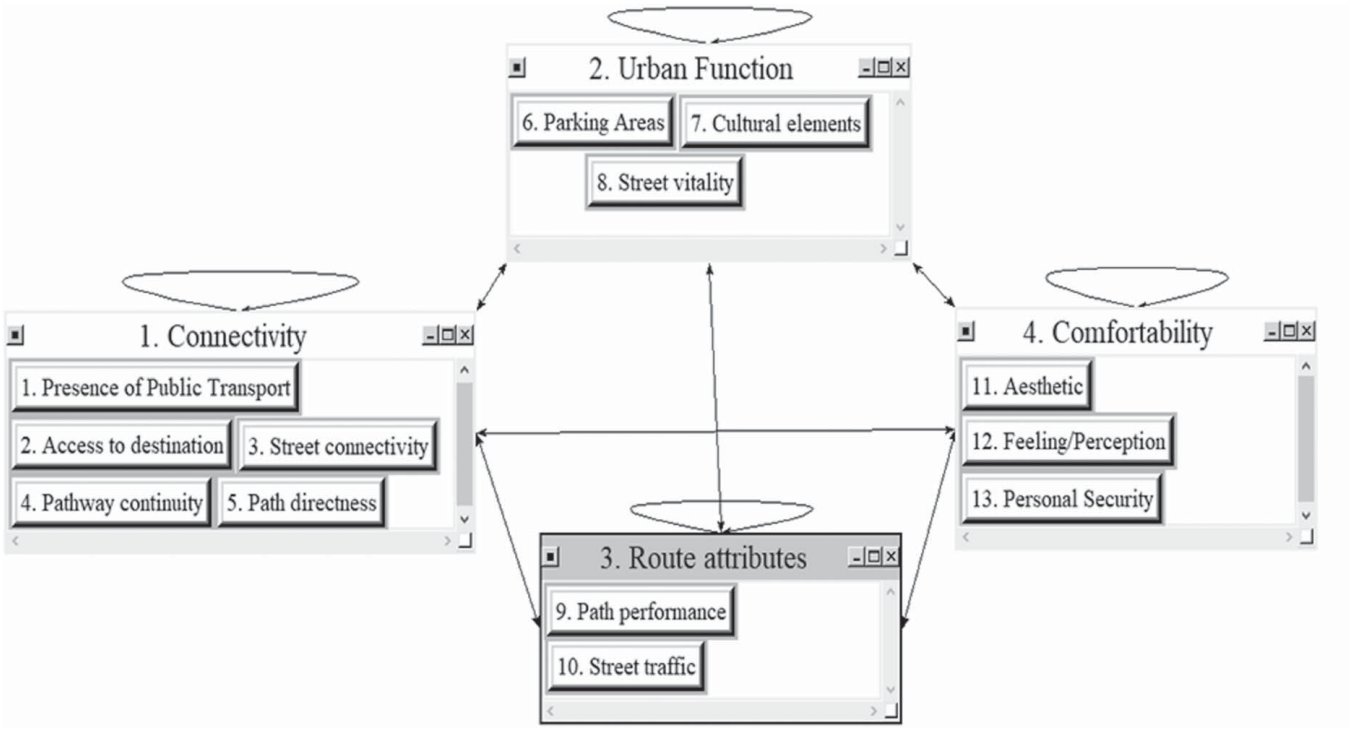


Fig. 6. ANP network model of the case study.

In your opinion, which of the two criteria has more influence on criterion ***1. Presence of Public Transport***?

	Extreme	Very Strong	Strong	Moderate	Equal	Moderate	Strong	Very Strong	Extreme	
C2 Access to destination	9	7	5	3	1	3	x	7	9	C3. Street connectivity

The answer in this example means that: With respect to ***C1. Presence of Public Transport, C3. Street connectivity*** influences **strongly (5) more** than ***C2 Access to destination*** .

Fig. 7. Example of a question used for the ANP questionnaire.

geometrical mean was used to determine the most important criteria. Thirteen criteria grouped in four clusters were selected for the ANP Model (Table 4). Some criteria such as land use diversity, infrastructure, physical features, quality features, path quality, technical features, amenities, universal design, and climate protection are widely used in literature. However, they are excluded from the model, maybe because of the specific conditions of the case study where there are no major differences among streets in the city center. In this respect, they show very similar physical conditions and features, and land use.

A total of four clusters and 13 criteria were chosen for the prioritization model.

Evaluation Problem as a Network Model

Influences among criteria were determined using a relationship matrix. This procedure was carried out during face-to-face meetings with experts in transport planning and mobility. The proposed network model is shown in Fig. 6.

Application of ANP

This step was carried out with the collaboration of the seven key stakeholders (KS). Selected according to the results of the SNA and who demonstrated as being willing to collaborate in this process. Five of the most influential ones were

- KS 1. Local Authority of Transit and Transportation,
- KS 2. City Center Administration,
- KS 3. Local Public Space Administration Office,
- KS4. The Ministry of Culture, and
- KS 5. Local Merchants.

Two among the non-central were

- KS 6. Academic, and
- KS 7. Citizens.

Once experts and KS agreed upon the model, the ANP questionnaire was designed and sent to the KS with the aim of determining an importance index for each criterion (Fig.7).

Since a total of seven KS were interviewed, seven individual results were obtained; Aggregation of individual judgments (AIJ) was performed using the geometric mean to obtain a global judgment (Saaty 2001). Care was taken to ensure that all pairwise comparison matrices had a consistency ratio (CR) of less than 10% (Saaty 1990).

Results and Discussion

Results Obtained for the Clusters

At the global level, the Urban Function cluster (C2) is the most valued one, followed by Route attributes (C3) and Connectivity (C1). The comfort (C4) cluster is less valued. The results were quite different for each KS. Therefore, it is worth analyzing their individual results (Fig. 8 and Table 5). The cluster weighting provides

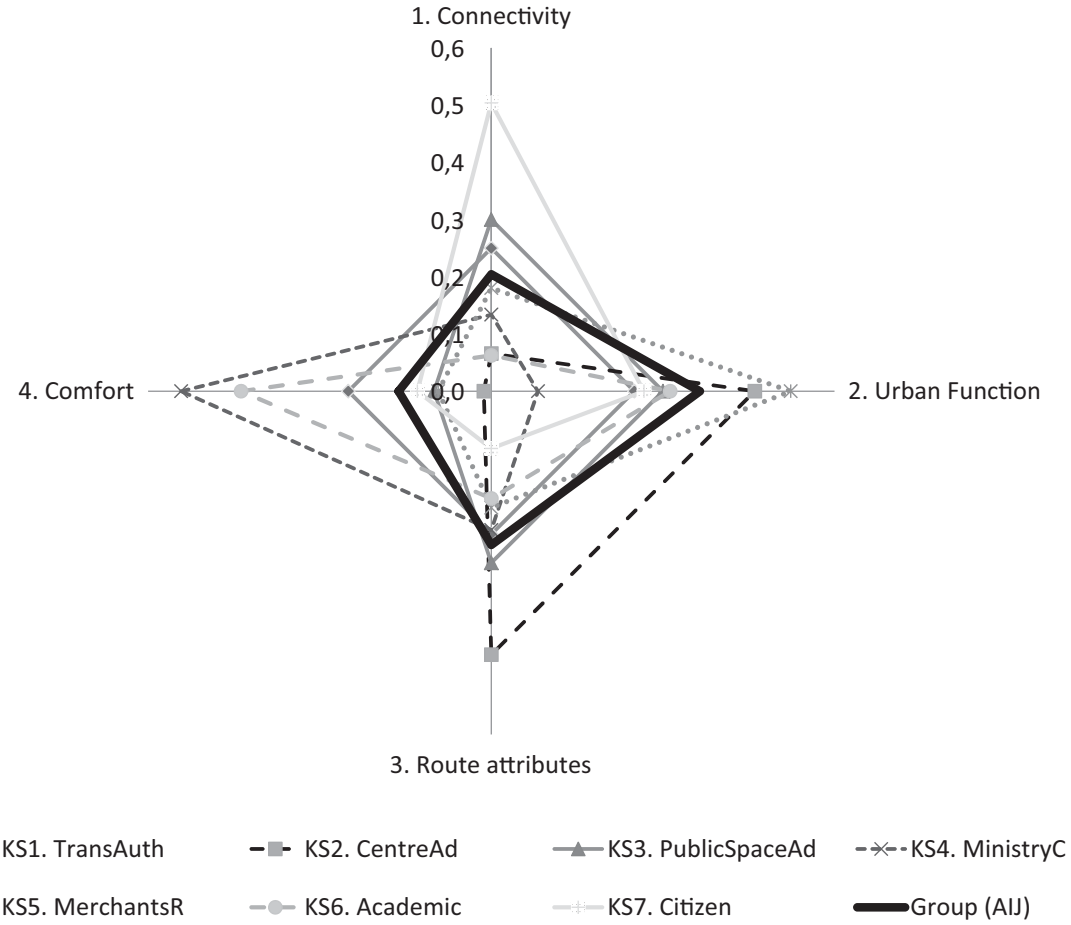


Fig. 8. Results obtained for the clusters.

Table 5. Cluster results according to different KS and global result

Cluster	KS 1. Tranp Auth	KS 2. Center Ad	KS 3. Public Space Ad	KS 4. Ministry Cul	KS 5. Merchant	KS 6. Academic	KS 7. Citizen	Group AIJ
1. Connectivity	0.250	0.066	0.300	0.134	0.180	0.062	0.504	0.204
2. Urban Function	0.250	0.461	0.300	0.082	0.523	0.312	0.267	0.365
3. Route attributes	0.250	0.461	0.300	0.243	0.204	0.188	0.100	0.269
4. Comfort	0.250	0.013	0.100	0.542	0.093	0.438	0.129	0.162

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

important insights into the overall attitude and underlying participants' conception of what aspects are the most important for improving pedestrian accessibility in the city center of Cartagena. In general, KS present results in line with the profile they represent:

- KS 1. Transport Authority: Is the most balanced profile. It gives equal importance to all clusters.
- KS 2. Center Administration: Is more concerned with the different uses and elements in the routes (C2. Urban Function and C3. Route attributes).
- KS 3. Public Space Administration: In addition to the previous two (C2. Urban Function and C3. Route attributes), gives high importance to C1. Connectivity.
- KS 4. Ministry of Culture: Gives the highest importance to the elements that affect performance, behavior and perceptions of a path (C4. Comfort), and the lowest importance to Urban Function (C2) and Connectivity (C1) aspects.
- KS 5. Merchant: Gives the highest importance to the different uses of the territory (C2. Urban Function) and very little to the comfort aspects (C4).
- KS 6. Academic: Recognizes the importance of Comfort (C4) and the Urban Functions (C2).
- KS 7. Citizen: Values more the Connectivity (C1) and the function of the territory (C2).

Results Obtained for the Criteria

At the criteria level, results are more similar among KS, except for some specific points (Fig. 9), even the results between KS4 (The Ministry of Culture) and KS7 (Citizen) which were the ones with the most difference at the cluster level. They have a high degree of concordance at a criteria level. Therefore, the results can be analyzed as a whole. Parking Areas (C6) is the criterion that presents the most controversial results. It reflects a problem that the city has been having for years, since there is a deficit of parking lots in the city center, which has favored illegal parking lots and the occupation of public spaces as parking areas. The main conclusion is that the most relevant criterion for all the KS is *C8. Street vitality* (21.8%), followed by *C10. Street traffic* (15.4%), *C3. Street connectivity* (12.2%), and *C7. Cultural elements* (11.7%). Next in importance are a group of criteria formed by *C2. Access to destination* (8.23%), *C1. Presence of Public Transport* (8.02%), and *C13. Personal Security* (6.29%) The least important criteria show an importance between 1% and 5% (Fig. 10).

The results represent an important index of each criterion in designing pedestrian routes. These allow a weighted evaluation in a spatial analysis of the existing road network in the city center, and to eventually select a set of priority streets to be considered as pedestrian and reconfigured accordingly. Based on the results, the assessment of current walkability conditions as well as some policies can be developed.

Policy Implications

The participatory procedure adopted allowed for an understanding of which factors are most likely to be effective in making pedestrian routes attractive in the city center of Cartagena de Indias. The stakeholders felt included, both in the definition and in the evaluation of criteria, which facilitates the acceptance of the results by the participants. Authors also confirmed that the problem is relevant for all the involved actors. Stakeholders recognize the problem and consider

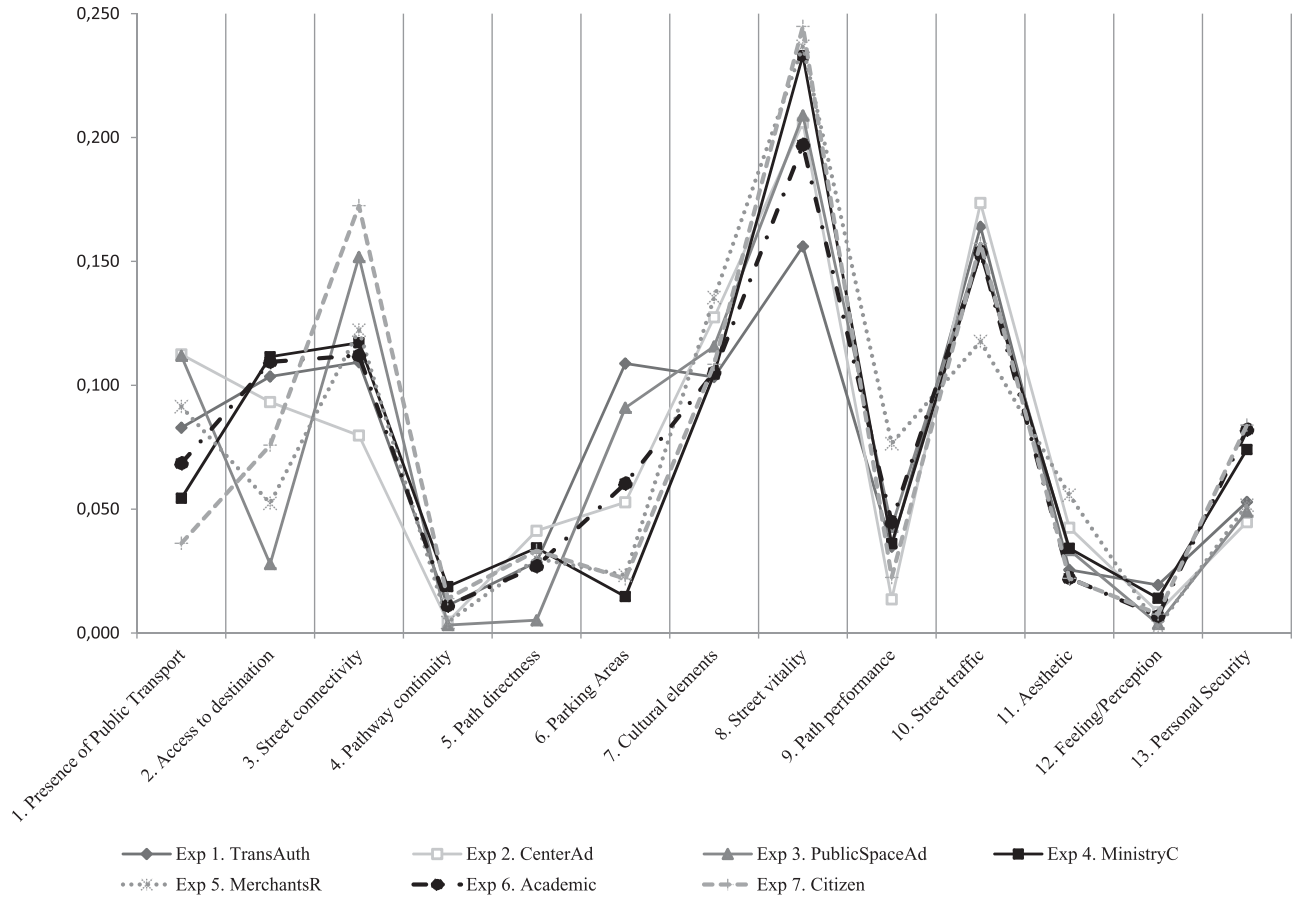


Fig. 9. Results obtained for the criteria.

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

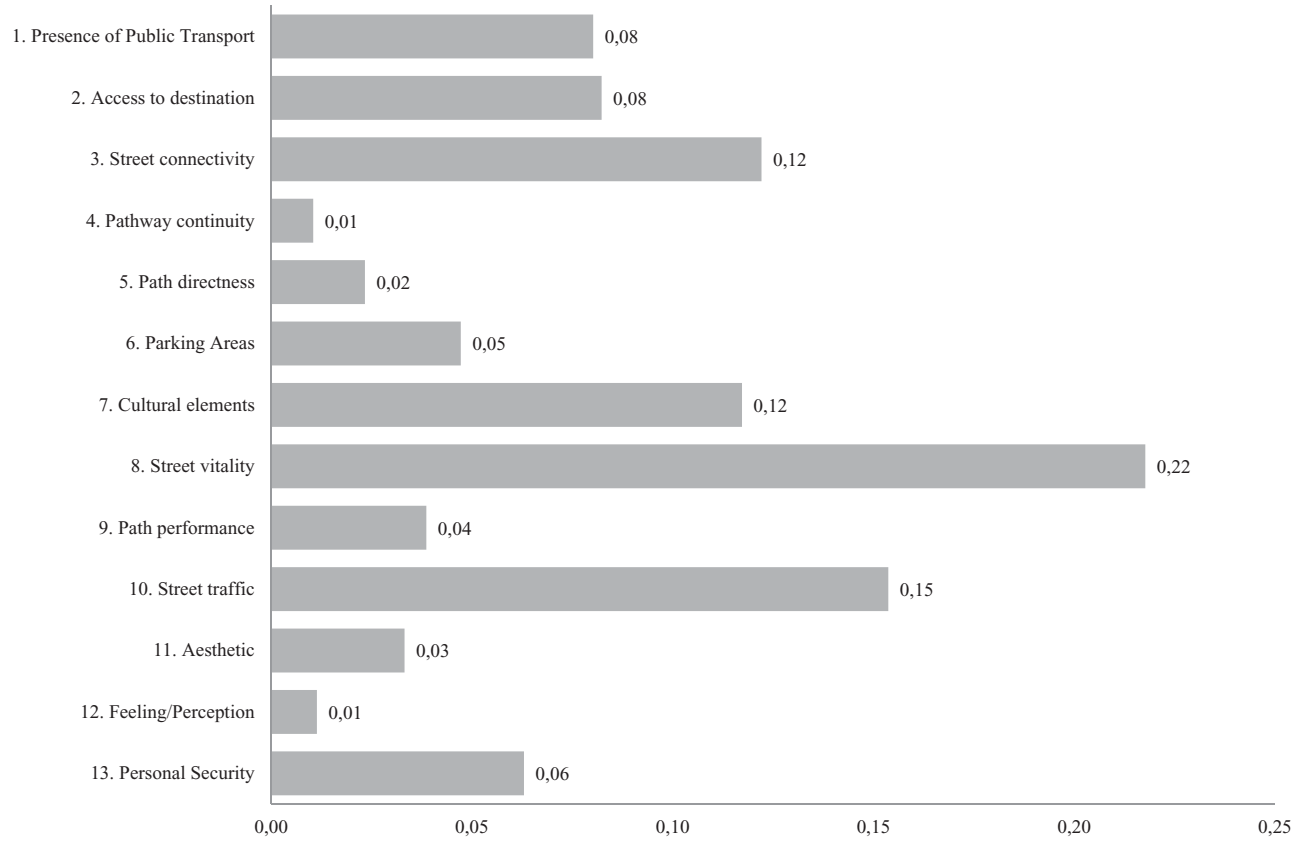


Fig. 10. Group results for all the criteria.

that better planning and management of urban spaces in the area is required. This concern has to be translated into pedestrian-oriented policies that increase walkability and focus on pedestrianizing as an alternative for improving the mobility of the area.

According to the most relevant criterion, some context-specific recommendations on both long- and short-term policies to be implemented could be formulated. First, in order to increase *street vitality* and *cultural elements*, local administrations should encourage and promote different events, reserving spaces for those activities, and activating a long-term land use change by fostering land use diversity via economic incentives and tax benefits. Second, for controlling *street traffic*, some traffic restriction/calming measures are also recommended to encourage the presence of pedestrians, limiting the amount of car traffic (e.g., via limited traffic zones) and its impact (e.g., via 30 km/h zones). This could also foster cycling in the streets or other soft mobility modes (e.g., e-scooter, segway). Third, the importance attributed to the criterion *street connectivity* reinforces the idea that priority should be given to revitalize and redesign streets in urban areas with a grid network structure (i.e., with many intersections), fostering accessibility by guaranteeing multiple path alternatives and an easy access to destinations. Finally, regarding the most controversial criterion, *parking areas*, regulatory and economic policies aimed at discouraging on-street parking by providing alternative off-street parking areas at a walkable distance from points of interests could be beneficial to avoid cruising for parking (Shoup 2011) and releasing spaces for other street uses (e.g., peddlers, restaurants, cycling lanes).

Although literature and guidelines dedicated to policies and design methods to improve walkability are abundant, the abovementioned policies are likely to be accepted and be effective in a context since they are the result of a well-thought out and methodologically sound participatory approach. In this respect, stakeholder involvement should be guaranteed in all the phases of a planning process to tailor policies and find appropriate measures in line with stakeholder needs. Although those recommendations often require a top-down approach to planning, it is important to consider them as a mechanism toward sustainable development planning (Cheshmehzangi and Thomas 2016). In addition, these and other policy implications will have to be discussed with pedestrians.

Conclusions

The proposed methodology is a novel application for defining and ranking criteria for pedestrian routes. It is addressed in two phases, the first one focuses on an analysis of the actors involved in the evaluation of criteria and the second one on criteria prioritization. The aim is to support the local administrations in the designing of walkable routes to improve pedestrian accessibility, involving stakeholders in the definition of the important elements and characteristics of pedestrian routes. Authors found that a procedure based on a participatory multicriteria approach (SNA-ANP) is appropriate to collect stakeholder preferences on the issues of designing pedestrian routes. Stakeholders related to the case study were analyzed through SNA. The results of this analysis allow the identification of different types of networks. In this case, authors identified two. The first one related to the exchanged information. This network is dense and it is well connected, allowing for a good information flow. The second one is related to the collaboration in mobility projects. It shows a certain degree of connection thanks to the local administration.

The goal of improving pedestrian mobility was broken down into four clusters or groups of criteria related to connectivity, urban function, route attributes, and comfort. These clusters were disaggregated into criteria to be evaluated through ANP. The selection of the

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

criteria to be included in the ANP model is one of the main contributions of this methodology. They were selected through a document analysis, a revision by experts and stakeholders, and an evaluation of them via ANP by key stakeholders. Given the number of selected criteria (13), the ANP model was viable and the questionnaire for evaluating them was easy to understand, which allowed us to obtain an index for each criterion. The index values the greater or lesser importance of criteria in designing pedestrian routes. Regarding the results of the evaluation of criteria via ANP, the criterion (C8) Street Vitality was considered the most important one.

ANP allowed accounting for complex interrelationships among criteria. This is particularly important for the specific case of designing walkable routes, where activities and people with heterogeneous interests and needs share the same public space, and criteria can be strongly related. For example, street connectivity or multiple destinations in a street can favor the presence of public transport. Results allowed formulating tailored policy implications for the specific case study, for both the long and the short term, related to transport and land use, and identified future steps of the research.

This work has also a potential impact on professional and urban communities. In this respect, findings will allow urban managers to make better decisions combining the opinions of experts with different profiles and answering the greater demand for more inclusive decisions and more accessible walking routes. This is performed by taking into consideration some tangible and intangible characteristics affecting walking and getting more transparent and traceable results. To the best of the authors' knowledge, this is the first time that this participatory multicriteria approach (SNA-ANP) is considered for issues related to the planning of pedestrian routes or mobility. Thus, for urban and planning studies the methodology proposed will facilitate and support the design of urban routes, spatial analysis, assessment of walkability conditions, and the proposition of some policies, especially in sensitive zones and those involving multiple stakeholders. In this respect, a new application of participatory multicriteria decision analysis for sustainable mobility has been presented. The methodology could be easily extended to other urban planning areas.

Regarding limitations and avenues for future research, the participatory multicriteria approach (SNA–ANP) is a proper combination of two well-known methodologies. Such integration will help to make use of the strengths of both methods. However, a poor application of one of them can affect the validity of the results. Careful identification of the stakeholders in the SNA is needed in order to avoid some tendencies such as homophily, when actors associate and bond with similar ones, leaving some other actors out of the network. The size of the network can be another problem. To deal with both problems, selecting and combining proper techniques during stakeholder identification is recommended. Another important limitation can be caused if the suitable person is not selected for answering the questionnaire, particularly when networks are composed by organizations. In addition, for SNA the relational contents, that is, what to study (flow of information, the content of the information or for how long the relationships have existed) can be considered but sometimes does not offer much valuable information. As regards ANP limitations, a very important concern is which actors to include. Involved actors should have a key role in the decision process, be aware of the problem, and be interested in the results. Some of the key stakeholders invited to carry out our model did not answer. Finally a general limitation was the availability of resources, especially time.

The next step in the case study has to consider the definition of measurement scales for each criterion for a spatial analysis (weighted evaluation), and then the first routes and the reconfiguration of some spaces will be proposed. Pedestrians will be involved in these later steps, validating and evaluating results. More appropriate techniques and procedures should be considered to capture information from larger groups, for example, surveys. We recommend the communication of the results in different environments. It allows a constant feedback of the process and the participation of other audiences.

Finally, some general suggestions are provided regarding some key aspects to take into account in future works using the SNA–ANP as evaluation tool: first, involved decision-makers have to be interested in the decision problem; second, previous references and experiences related to the case have to be collected; third, the points of view and opinions of central and noncentral stakeholders have to be collected; fourth, appropriate channels between them have to be provided and; fifth, ANP has to be considered as a complete procedure and needs to be allocated the necessary time. In this way, the ANP procedure becomes not only interesting in terms of reaching a final prioritization of projects, indicators, or criteria under evaluation, but also in terms of allowing debates and reflections.

Appendix. Example of the Questionnaire

Stakeholder	Regarding mobility in the city center, with whom of the following actors have you exchanged information? How often? Daily, weekly, monthly…	Have you ever worked or developed a project together related to mobility issues?
City Center Administration		
Local Council		
Local Authority of Transit and Transportation		
…		

Data Availability Statement

All data, models, or code generated or used during the study are available from the corresponding author by request.

Acknowledgments

The authors would like to thank all the participants for answering the questionnaires and providing information to conduct the case study, especially to City Center Administration office for their enthusiastic cooperation. The authors also thank the "Bolivar Gana Con Ciencia" project from the Gobernación de Bolívar (Colombia) for financial support.

References

Aghaabbasi, M., M. Moeinaddini, Z. Asadi-Shekari, and M. Z. Shah. 2019. "The equitable use concept in sidewalk design." *Cities* 88: 181–190. https://doi.org/10.1016/J.CITIES.2018.10.010.

Aghaabbasi, M., M. Moeinaddini, M. Zaly Shah, and Z. Asadi-Shekari. 2017. "A new assessment model to evaluate the microscale sidewalk design factors at the neighbourhood level." *J. Transp. Health* 5: 97–112. https://doi.org/10.1016/j.jth.2016.08.012.

Arranz-López, A., J. A. Soria-Lara, C. López-Escolano, and Á Pueyo Campos. 2017. "Retail Mobility Environments: A methodological

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

framework for integrating retail activity and non-motorised accessibility in Zaragoza, Spain." *J. Transp. Geogr.* 58: 92–103. https://doi.org/10.1016/j.jtrangeo.2016.11.010.
Barba-Romero, S., and J.-C. Pomerol. 1997. *Decisiones multicriterio : Fundamentos teóricos y utilización práctica*. Alcalá de Henares, Spain: Universidad de Alcalá.
Belton, V., and T. J. Stewart. 2002. *Multiple criteria decision analysis*. Boston: Springer.
Bentley, R., D. Jolley, and A. M. Kavanagh. 2010. "Local environments as determinants of walking in Melbourne, Australia." *Soc. Sci. Med.* 70 (11): 1806–1815. https://doi.org/10.1016/j.socscimed.2010.01.041.
Blečić, I., A. Cecchini, T. Congiu, G. Fancello, and G. A. Trunfio. 2015. "Evaluating walkability: A capability-wise planning and design support system." *Int. J. Geog. Inform. Sci.* 29 (8): 1350–1374. https://doi.org/10.1080/13658816.2015.1026824.
Blecic, I., A. Cecchini, and G. A. Trunfio. 2015. "Towards a design support system for urban walkability." *Procedia Comput. Sci.* 51 (1): 2157–2167. https://doi.org/10.1016/j.procs.2015.05.489.
Bodin, Ö, and B. I. Crona. 2009. "The role of social networks in natural resource governance: What relational patterns make a difference?" *Glob. Environ. Change* 19 (3): 366–374. https://doi.org/10.1016/j.gloenvcha.2009.05.002.
Bodin, Ö, B. I. Crona, and H. Ernstson. 2006. "Social networks in natural resource management: What is there to learn from a structural perspective?" *Ecol. Soc.* 11 (2): r2. https://doi.org/10.5751/ES-01808-1102r02.
Borgatti, S. P., M. G. Everett, and L. Freeman. 2002. *Ucinet for windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.
Bryson, J. M. 2004. "What to do when stakeholders matter." *Public Manage. Rev.* 6 (1): 21–53. https://doi.org/10.1080/14719030410001675722.
Cambra, P. 2012. "Pedestrian accessibility and attractiveness indicators for walkability assessment." Master thesis, Dept. of Civil Engineering and Architecture, Technical Institute of Lisbon.
Caprì, S., M. Ignaccolo, G. Inturri, and M. Le Pira. 2016. "Green walking networks for climate change adaptation." *Transp. Res. Part D* 45: 84–95. https://doi.org/10.1016/j.trd.2015.08.005.
Cartagena Cómo Vamos. 2018. "Informe de Calidad de Vida 2017." [Quality of Life Report 2017] [In Spanish.] Accessed April 17, 2018. http://www.cartagenacomovamos.org/nuevo/wp-content/uploads/2014/11/Presentacion-Calidad-de-Vida-2017-FINAL.pdf.
Cascetta, E., A. Cartenì, F. Pagliara, and M. Montanino. 2015. "A new look at planning and designing transportation systems: A decision-making model based on cognitive rationality, stakeholder engagement and quantitative methods." *Transp. Policy* 38: 27–39. https://doi.org/10.1016/j.tranpol.2014.11.005.
Cervero, R., O. L. Sarmiento, E. Jacoby, L. F. Gomez, and A. Neiman. 2009. "Influences of built environments on walking and cycling: Lessons from Bogotá." *Int. J. Sustainable Transp.* 3 (4): 203–226. https://doi.org/10.1080/15568310802178314.
Chang, K.-L. 2013. "Combined MCDM approaches for century-old Taiwanese food firm new product development project selection." *Br. Food J.* 115 (8): 1197–1210. https://doi.org/10.1108/BFJ-08-2011-0204.
Cheshmehzangi, A., and S. M. Thomas. 2016. "Prioritizing accessible transit systems for sustainable urban development: Understanding and evaluating the parameters of a transportation system in Mumbai." *J. Urban Plann. Dev.* 142 (4): 05016005. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000338.
Fichera, A., M. Frasca, V. Palermo, and R. Volpe. 2018. "An optimization tool for the assessment of urban energy scenarios." *Energy* 156: 418–429. https://doi.org/10.1016/j.energy.2018.05.114.
Galdini, R. 2019. "Urban re-use practices in contemporary cities: Experiences in Europe." *Cities* 87: 103–105. https://doi.org/10.1016/j.cities.2018.12.026.
Gant, R. 1997. "Pedestrianisation and disabled people: A study of personal mobility in Kingston town centre." *Disability Soc.* 12 (5): 723–740. https://doi.org/10.1080/09687599727010.
Gehl, J. 2010. *Cities for people*. Washington, DC: Island Press.
Glicken, J. 2000. "Getting stakeholder participation "right": A discussion of participatory processes and possible pitfalls." *Environ. Sci. Policy* 3 (6): 305–310. https://doi.org/10.1016/S1462-9011(00)00105-2.
Gonzalez-Urango, H., and M. García-Melón. 2018. "Stakeholder engagement to evaluate tourist development plans with a sustainable approach." *Sustainable Dev.* 26 (6): 800–811. https://doi.org/10.1002/sd.1849.
Guo, Z., and B. P. Y. Loo. 2013. "Pedestrian environment and route choice: Evidence from New York City and Hong Kong." *J. Transp. Geogr.* 28: 124–136. https://doi.org/10.1016/j.jtrangeo.2012.11.013.
Hanneman, R. A., and M. Riddle. 2005. *Introduction to social network methods*. Riverside, CA: Univ. of California.
Hickman, R., and D. Banister. 2014. *Transport, climate change and the city*. Abingdon, UK: Routledge.
Huff Herbie, K., and R. Liggett. 2014. *The highway capacity manual's method for calculating bicycle and pedestrian levels of service: The ultimate white paper*. Oxford, UK: Lewis Center for Regional Policy Studies.
Ignaccolo, M., G. Inturri, M. García-Melón, N. Giuffrida, M. Le Pira, and V. Torrisi. 2017. "Combining analytic hierarchy process (AHP) with role-playing games for stakeholder engagement in complex transport decision." *Transp. Res. Procedia* 27: 500–507. https://doi.org/10.1016/j.trpro.2017.12.069.
Ignaccolo, M., G. Inturri, M. Le Pira, S. Caprì, and V. Mancuso. 2016. "Evaluating the role of land use and transport policies in reducing the transport energy dependence of a city." *Res. Transp. Econ.* 55: 60–66. https://doi.org/10.1016/j.retrec.2016.04.011.
Jabbari, M., F. Fonseca, and R. Ramos. 2017. "Combining multi-criteria and space syntax analysis to assess a pedestrian network: The case of Oporto." *J. Urban Des.* 23 (1): 23–41. https://doi.org/10.1080/13574809.2017.1343087.
Kadali, B. R., and P. Vedagiri. 2016. "Review of pedestrian level of service." *Transp. Res. Record* 2581 (1): 37–47. https://doi.org/10.3141/2581-05.
Kalakou, S., and F. Moura. 2014. "Bridging the gap in planning indoor pedestrian facilities." *Transp. Rev.* 34 (4): 474–500. https://doi.org/10.1080/01441647.2014.915441.
Kim, H. Y., D. Wunneburger, M. Neuman, and S. Y. An. 2014. "Optimizing high-speed rail routes using a spatial decision support system (SDSS): The texas urban triangle (TUT) case." *J. Transp. Geogr.* 34: 194–201. https://doi.org/10.1016/j.jtrangeo.2013.11.014.
Le Pira, M. 2018. "Transport planning with stakeholders: An agent-based modelling approach." *Int. J. Transp. Econ.* 45 (1): 15–32. https://doi.org/10.19272/201806701002.
Le Pira, M., G. Inturri, M. Ignaccolo, A. Pluchino, and A. Rapisarda. 2017. "Finding shared decisions in stakeholder networks: An agent-based approach." *Physica A* 466: 277–287. https://doi.org/10.1016/j.physa.2016.09.015.
Liao, S.-K., Y.-C. Chen, K.-L. Chang, and T.-W. Tseng. 2011. "Assessing the performance of Taiwanese tour guides." *Afr. J. Bus. Manage.* 5 (4): 1325–1333. https://doi.org/10.5897/AJBM10.871.
Ligardo-Herrera, I., T. Gómez-Navarro, and H. Gonzalez-Urango. 2019. "Application of the ANP to the prioritization of project stakeholders in the context of responsible research and innovation." *Central Eur. J. Oper. Res.* 27 (3): 679–701. https://doi.org/10.1007/s10100-018-0573-4.
Loken, E. 2007. "Use of multicriteria decision analysis methods for energy planning problems." *Renewable Sustainable Energy Rev.* 11 (7): 1584–1595. https://doi.org/10.1016/j.rser.2005.11.005.
Lotfi, S., and M. J. Koohsari. 2011. "Neighborhood walkability in a city within a developing country." *J. Urban Plann. Dev.* 137 (4): 402–408.https://doi.org/10.1061/(ASCE)UP.1943-5444.0000085.
Mateo-Babiano, I. 2016. "Pedestrian's needs matters: Examining Manila's walking environment." *Transp. Policy* 45: 107–115. https://doi.org/10.1016/j.tranpol.2015.09.008.
Mayor of London. 2005. "Transport for London: Improving walkability." September 29, 2017.
Monteiro, M., and P. Odete. 2015. "Competitividade de destinos turísticos: O caso das ilhas de Cabo Verde." *Revista de Turismo y Patrimonio Cultural* 13: 875–896.
Moura, F., P. Cambra, and A. B. Gonçalves. 2017. "Measuring walkability for distinct pedestrian groups with a participatory assessment method: A case study in Lisbon." *Landscape Urban Plann.* 157: 282–296. https://doi.org/10.1016/j.landurbplan.2016.07.002.
Municipality of Cartagena de Indias. 2014. "Plan Sectorial de Turismo Cartagena de Indias 2016-2019." [Tourism Plan of Cartagena de

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.

Indias 2016-2019] [In Spanish.] Municipality of Cartagena, Accessed June 20, 2017. http://sigob.cartagena.gov.co/Pd2016/Anexo 6 Plan Sectorial de Turismo.pdf.
Newman, L., and A. Dale. 2007. "Homophily and agency: Creating effective sustainable development networks." *Environ. Dev. Sustainability* 9 (1): 79–90. https://doi.org/10.1007/s10668-005-9004-5.
Nuworsoo, C., and E. Cooper. 2013. "Considerations for integrating bicycling and walking facilities into urban infrastructure." *Transp. Res. Rec.* 2393 (1): 125–133. https://doi.org/10.3141/2393-14.
Oswald Beiler, M. R., M. Asce, B. Phillips, and S. M. Asce. 2015. "Prioritizing pedestrian corridors using walkability performance metrics and decision analysis." *J. Urban Plann. Dev.* 142 (1): 04015009. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000290.
Page, S. 2009. *Transport and tourism: Global perspectives*. London: Pearson Education.
Parajuli, A., and D. Pojani. 2018. "Barriers to the pedestrianization of city centres: Perspectives from the Global North and the Global South." *J. Urban Des.* 23 (1): 142–160. https://doi.org/10.1080/13574809.2017.1369875.
Park, S., K. Choi, and J. S. Lee. 2017. "Operationalization of path walkability for sustainable transportation." *Int. J. Sustainable Transp.* 11 (7): 471–485. https://doi.org/10.1080/15568318.2016.1226996.
Pedestrian Quality Needs Project. 2010. COST 358 Pedestrians' quality needs perceived needs PQN final report—Part B2: Documentation. Cheltenham, UK: WALK21.
Prell, C., K. Hubacek, and M. Reed. 2009. "Stakeholder analysis and social network analysis in natural resource management." *Soc. Nat. Resourc.* 22 (6): 501–518. https://doi.org/10.1080/08941920802199202.
Rahman, K., N. Abdul Ghani, A. Abdulbasah Kamil, A. Mustafa, and M. A. Kabir Chowdhury. 2013. "Modelling pedestrian travel time and the design of facilities: A queuing approach." *PLoS One* 8 (5): e63503. https://doi.org/10.1371/journal.pone.0063503.
Reed, M. S., A. Graves, N. Dandy, H. Posthumus, K. Hubacek, J. Morris, C. Prell, C. H. Quinn, and L. C. Stringer. 2009. "Who's in and why? A typology of stakeholder analysis methods for natural resource management." *J. Environ. Manage.* 90 (5): 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001.
Robledo, S., G. A. Osorio, and C. López. 2014. "Networking en pequeña empresa: Una revisión bibliográfica utilizando la teoria de grafos." *Revista Vínculos* 11 (2): 6–16. https://doi.org/10.14483/issn.2322-939X.
Saaty, T. L. 1990. "How to make a decision: The analytic hierarchy process." *Eur. J. Oper. Res.* 48 (1): 9–26. https://doi.org/10.1016/0377-2217(90)90057-I.
Saaty, T. L. 2001. *The analytic network process: Decision making with dependence and feedback*. Pittsburgh: RWS.
Saaty, T. L., and K. Peniwati. 2008. *Group decision making : Drawing out and reconciling differences*. Pittsburgh: RWS.
Sahani, R., and P. K. Bhuyan. 2013. "Level of service criteria of off-street pedestrian facilities in Indian context using affinity propagation clustering." *Procedia Soc. Behav. Sci.* 104: 718–727. https://doi.org/10.1016/j.sbspro.2013.11.166.
Sahelgozin, M., A. Sadeghi-Niaraki, and S. Dareshiri. 2015. "Proposing a multi-criteria path optimization method in order to provide a Ubiquitous Pedestrian Wayfinding Service." *ISPRS* 40 (1W5): 639–644. https://doi.org/10.5194/isprsarchives-XL-1-W5-639-2015.
Saint Ville, A. S., G. M. Hickey, and L. E. Phillip. 2017. "How do stakeholder interactions influence national food security policy in the Caribbean? The case of Saint Lucia." *Food Policy* 68: 53–64. https://doi.org/10.1016/j.foodpol.2017.01.002.
Santos, G., H. Behrendt, L. Maconi, T. Shirvani, and A. Teytelboym. 2010. "Part I: Externalities and economic policies in road transport." *Res. Transp. Econ.* 28 (1): 2–45. https://doi.org/10.1016/j.retrec.2009.11.002.
Sayyadi, G., and A. Awasthi. 2013. "AHP-based approach for location planning of pedestrian zones: Application in Montreal, Canada." *J. Transp. Eng.* 139 (2): 239–246. https://doi.org/10.1061/(ASCE)TE.1943-5436.0000493.
Scott, J. 2013. *Social network analysis*. London: SAGE.
Shoup, D. C. 2011. *The high cost of free parking*. Washington, DC: Planners Press, American Planning Association.
Singh, B., and M. M. Keitsch. 2016. "Cultural sustainability and space—A comparison of two cases in Kathmandu, Nepal." *Sustainable Dev.* 24 (5): 307–318. https://doi.org/10.1002/sd.1631.
Singh, R. 2016. "Factors affecting walkability of neighborhoods." *Procedia Soc. Behav. Sci.* 216: 643–654. https://doi.org/10.1016/j.sbspro.2015.12.048.
Sipahi, S., and M. Timor. 2010. "The analytic hierarchy process and analytic network process: An overview of applications." *Manage. Decis.* 48 (5): 775–808. https://doi.org/10.1108/00251741011043920.
Sisiopiku, V., J. Byrd, and A. Chittoor. 2007. "Application of level-of-service methods for evaluation of operations at pedestrian facilities." *Transp. Res. Rec.* 2002 (1): 117–124. https://doi.org/10.3141/2002-15.
Soleimani, N., and C. Valmohammadi. 2017. "Identifying and prioritizing factors influencing the selection of the top suppliers of e-procurement using FDEMATEL and FANP." *J. Multi* Criteria Decis. Anal. 24 (5–6): 286–295. https://doi.org/10.1002/mcda.1619.
Southworth, M. 2005. "Designing the Walkable City." *J. Urban Plann. Dev.* 131 (4): 246–257. https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246).
Talavera-Garcia, R., and J. A. Soria-Lara. 2015. "Q-PLOS, developing an alternative walking index. A method based on urban design quality." *Cities* 45: 7–17. https://doi.org/10.1016/j.cities.2015.03.003.
Taleai, M., and E. Taheri Amiri. 2017. "Spatial multi-criteria and multi-scale evaluation of walkability potential at street segment level: A case study of Tehran." *Sustainable Cities Soc.* 31: 37–50. https://doi.org/10.1016/j.scs.2017.02.011.
Tavana, M., M. Zareinejad, F. J. Santos-Arteaga, and M. A. Kaviani. 2016. "A conceptual analytic network model for evaluating and selecting third-party reverse logistics providers." *Int. J. Adv. Manuf. Technol.* 86 (5–8): 1705–1721. https://doi.org/10.1007/s00170-015-8208-6.
Tong, X., Y. Wang, and E. H. W. Chan. 2016. "International research trends and methods for walkability and their enlightenment in China." *Procedia Environ. Sci.* 36: 130–137. https://doi.org/10.1016/j.proenv.2016.09.023.
Wasserman, S., and K. Faust. 2007. *Social network analysis*. New York: Cambridge University Press.
Yamaki, K. 2017. "Applying social network analysis to stakeholder analysis in Japan's natural resource governance: Two endangered species conservation activity cases." *J. Forest Res.* 22 (2): 83–90. https://doi.org/10.1080/13416979.2017.1279706.
Yang, R. J. 2014. "An investigation of stakeholder analysis in urban development projects: Empirical or rationalistic perspectives." *Int. J. Project Manage.* 32 (5): 838–849. https://doi.org/10.1016/j.ijproman.2013.10.011.
Zegeer, C. V., and M. Bushell. 2012. "Pedestrian crash trends and potential countermeasures from around the world." *Accid. Anal. Prev.* 44 (1): 3–11. https://doi.org/10.1016/j.aap.2010.12.007.

Downloaded from ascelibrary.org by Universidad Politecnica De Valencia on 05/18/20. Copyright ASCE. For personal use only; all rights reserved.