The introduction of the Index of Sustainable Urban Mobility in a Scenario-Based Planning Approach

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Abstract

Adaptations of the urban structure for encouraging trips by sustainable modes, as well as the selection and implementation of actions and policies with the same objective, are still a challenge to urban managers and planners. The Index of Sustainable Urban Mobility (I_SUM) was used here as the basis of a scenario-based planning strategy aiming at mobility planning. The 87 indicators of the index were evaluated by experts in a customized computer spreadsheet, based on the following criteria: implementation costs, time, and political risk of proposed actions. The results obtained with a pilot application suggest that the method is a promising urban planning strategy, given that it can indicate several sets of practical actions with clear potential to conduct the city to the goal of sustainable mobility. It is also a useful tool for evaluating the existing conditions of urban mobility and for highlighting strengths and weaknesses of the current situation.

Introduction

There is currently a general understanding that the problems affecting urban areas are not only physical and economic. They also encompass social, environmental, political, and cultural issues. Therefore, the search for sustainable development involves several urban planning options and means of intervention, as well as preventive actions. These planning elements give an indication of the complexity of the questions faced by urban managers and planners. As an extension of sustainable development, the concept of sustainable urban mobility also incorporates most of those elements, in addition to traditional questions directly related to transport planning (Rodrigues da Silva *et al.*, 2008; Schiller *et al.*, 2010).

The most common transport planning strategy employed up to now has been guided by the ‘predict and provide’ principle, which implies that new infrastructures can solve the mobility problem. However, as observed by Owens (1995), new transport infrastructures are essentially short term solutions. The author also defends that the ‘predict and provide’ principle should be replaced by the idea of ‘predict and prevent’. This is not an easy change, though. One of the possible alternatives to help in this transition process is the capacity to anticipate the results of different actions, what can be done through the construction of scenarios.

As a possible alternative for the problems discussed above, Costa (2008) developed the Index of Sustainable Urban Mobility (or I_SUM). Composed by a hierarchical structure with 9 domains, 37 themes, and 87 indicators (as summarized in Table 1), the index was designed to help urban managers and planners in the evaluation of mobility conditions in urban areas. The identification of indicators with low scores, for example, can provide important information to support planning actions aiming at sustainable mobility. Furthermore, the index can be used to support a scenario-based planning approach, in which different management strategies (e.g., conservative or ambitious, as suggested by Mancini, 2011) can be simulated.

Table 1. I_SUM's hierarchical framework of criteria and associated weights

Domain	Theme	Indicator
Accessibility (0.108)	Accessibility to transport systems (0.290)	• Accessibility to transit (0.333) • Public transportation for users with special needs (0.333) • Transport expenses (0.333)
	Universal accessibility (0.280)	• Street crossings adapted to users with special needs (0.200) • Accessibility to open spaces (0.200) • Parking spaces to users with special needs (0.200) • Accessibility to public buildings (0.200) • Accessibility to essential services (0.200)
	Physical barriers (0.220)	• Urban fragmentation (1,000)
	Legislation for users with special needs (0.210)	• Actions towards universal accessibility (1,000)
Environmental aspects (0.113)	Control of environmental impacts (0.520)	• CO Emissions (0.250) • CO_2 Emissions (0.250) • Population exposed to traffic noise (0.250) • Studies of environmental impacts (0.250)
	Natural resources (0.480)	• Fuel consumption (0.500) • Use of clean energy and alternative fuels (0.500)
Social aspects (0.108)	Support to the citizens (0.210)	• Information available to the population (1,000)
	Social inclusion (0.200)	• Vertical equity (income) (1,000)
	Education and active citizenship (0.190)	• Education for sustainable development (1,000)
	Public participation (0.190)	• Participation in decision-taking (1,000)
	Quality of life (0.210)	• Quality of life (1,000)
Political aspects (0.113)	Integration of political actions (0.340)	• Integration of different government levels (0.500) • Public-private partnerships (0.500)
	Acquisition and management of resources (0.330)	• Acquisition of resources (0.250) • Investments in transport systems (0.250) • Distribution of resources (public x private) (0.250) • Distribution of resources (motorized x non-motorized) (0.250)
	Urban mobility policy (0.330)	• Urban mobility policy (1,000)
Transport infrastructure (0.120)	Provision and maintenance of transport infrastructure (0.460)	• Density of the street network (0.250) • Paved streets (0.250) • Maintenance expenditures in transport infrastructure (0.250) • Streets signaling (0.250)
	Distribution of transport in-	• Transit lanes (1,000)

Domain	Theme	Indicator
	frastructure (0.540)	

Table 1. I_SUM's hierarchical framework of criteria and associated weights

Domain	Theme	Indicator
Non-motorized modes (0.110)	Bicycle transportation (0.310)	• Length and connectivity of cycleways (0.333) • Bicycle fleet (0.333) • Facilities for bicycle parking (0.333)
	Pedestrians (0.340)	• Pathways for pedestrians (0.500) • Streets with sidewalks (0.500)
	Trips reduction (0.350)	• Travel distance (0.250) • Travel time (0.250) • Number of trips (0.250) • Measures to reduce motorized traffic (0.250)
Integrated planning (0.108)	Managers training (0.120)	• Expertise of technicians and managers (0.500) • Training for technicians and managers (0.500)
	Central areas and historical sites (0.110)	• Vitality of the central area (1,000)
	Regional integration (0.120)	• Intercity partnerships (1,000)
	Planning process transparency (0.120)	• Transparency and responsibility (1,000)
	Planning and control of land use (0.140)	• Vacant land (0.200) • Urban growth (0.200) • Urban population density (0.200) • Mixed land use (0.200) • Illegal settlements (0.200)
	Strategic and integrated planning (0.140)	• Integrated urban. environmental and transport planning (0.500) • Implementation and sequence of planed actions (0.500)
	Infrastructure and urban facilities planning (0.130)	• Parks and green areas (0.333) • Urban facilities (schools) (0.333) • Urban facilities (hospitals) (0.333)
	Master Plan and urban legislation (0.120)	• Master Plan (0.333) • Urban legislation (0.333) • Urban legislation actual application (0.333)
Urban circulation Traffic (0.107)	Traffic accidents (0.210)	• Traffic accidents (0.333) • Accidents with pedestrians and cyclists (0.333) • Accident prevention (0.333)
	Traffic education program (0.190)	• Traffic education program (1,000)
	Freedom of movements and circulation (0.190)	• Congestion (0.500) • Average traffic speed (0.500)
	Traffic operation and enforcement (0.200)	• Violation of traffic rules (1,00)
	Private transport (0.210)	• Motorization rate (0.500) • Vehicle occupation (0.500)

Table 1. I_SUM's hierarchical framework of criteria and associated weights

Domain	Theme	Indicator
Urban transport systems (0.112)	Transit availability and quality (0.230)	• Total extension of the transit network (0.125) • Transit service frequency (0.125) • On-time performance (0.125) • Transit average speed (0.125) • Transit fleet age (0.125) • Passengers per kilometer (0.125) • Annual number of passengers (0.125) • User satisfaction with the transit service (0.125)
	Diversity of transportation modes (0.180)	• Diversity of transportation modes (0.333) • Public versus private transport (0.333) • Motorized versus non-motorized modes (0.333)
	Transit regulations and enforcement (0.180)	• Contracts and limitations (0.500) • Informal transport (0.500)
	Transit integration (0.220)	• Intermodal terminals (0.500) • Transit integration (0.500)
	Fare policy (0.190)	• Discounts and free rides (0.333) • Transit fares (0.333) • Public subsidies (0.333)

Regarding scenario methods, Banister *et al.* (2008) state that "the aim is not to predict the future, but to show how different interpretations of the driving forces of change can lead to different possible futures. (...) Scenarios aim to assist decision-making in the present about issues that have long-term consequences for the future." Scenario-based planning methods can involve forecasting and backcasting scenarios. According to Gilbert and Wielderkehr (2002), the later can be defined as the work that starts with a careful observation of the present and of the past. Next, a future scenario containing the desired changes is built. So, the current situation and the future scenario are the elements used to define the goals that can induce the changes.

Applications of scenario-based planning with a backcasting approach aiming at sustainable mobility can be found in the studies of Gilbert and Wielderkehr (2002), Banister et al. (2008), Barrela and Amekudzi (2011), and Mancini (2011). According to TRIP (2013), "an integrated approach to urban mobility requires a global vision on urban transport policy and planning supported by appropriate decision-making tools and methodologies". As a consequence, the involvement of planners in scenario definition is very important. Furthermore, Barrela and Amekudzi (2011) also highlighted the importance of involving the population in a scenario definition process.

Given these characteristics of the approach, we believe that the Index of Sustainable Urban Mobility can be easily adapted to support all the steps of the process, as discussed in the next section of this paper. Some of the results of a pilot application are presented in the following section, in order to support the conclusions presented in the sequence.

Method

As the main objective of the proposed method was the evaluation of alternative actions for adapting the cities to trip patterns more sustainable than the current ones, a scenario based approach can be used. Thus, the method was based on the studies of Gilbert and Wielderkehr (2002) and Banister *et al.* (2008), but complemented with analyses conducted with a benchmarking cube, as suggested by Pinho *et al.* (2010). The method, which allows an integrated analysis of three planning dimensions, can be summarized in the following steps:

i. Calculation of the current values of the I_SUM indicators.
ii. Application of questionnaires developed in customized computer spreadsheets for the assessment of implementation costs, time, and political risks involved in the actions needed for reaching the maximum scores for each indicator. The questionnaires can be answered by urban managers, planners or by the population.
iii. Combination and transfer of the evaluations obtained with the questionnaires to the benchmarking cube. This allows the identification of the feasibility of proposed actions, based on implementation costs, time, and political risk.
iv. Definition of a future scenario to be adopted as a reference for planning. Different approaches can be considered in this definition. Scenarios can be defined, for example, as conservative or ambitious. This will affect the expected changes in the scores, and consequently the position of the actions in the benchmarking cube.
v. Analysis of the projections and anticipated changes for each indicator as a consequence of the predefined actions and policies.
vi. Selection of viable actions and policies, based on the results of the cube.
vii. Implementation of the selected actions and policies.

The application of the method described in this paper was partially done (item *vii* was not applied) in São Carlos, Brazil. In 2010, this medium-sized city located in the state of São Paulo had around 222,000 inhabitants (IBGE, 2010). As many other cities of similar size in Brazil, São Carlos is now facing many urban and transportation problems due to the fast growth in the number of private motorized vehicles and also of the urban tissue. The existence of a recent evaluation of the Index of Sustainable Urban Mobility there, as described by Plaza and Rodrigues da Silva (2010), was an important factor in the selection of this particular city for an exploratory study. In addition, the use of I_SUM as a basis for the method can be justified by the set of indicators contained in it, which can be directly affected by actions oriented to the improvement of sustainable urban mobility.

After the adoption of the index and, as a consequence, of the indicators for the evaluation of scenarios, the next step of the method (item *ii*) involved experts in urban mobility. The application was limited to experts, but it could have included the population in general. In this case, it would be interesting to have an online platform, as suggested by Magagnin *et al.* (2005). They were invited to evaluate, through a questionnaire developed in a customized computer spreadsheet application, three characteristics that can make the scores of the 87 indicators reach the maximum possible value (one, in a normalized scale going from zero to one). The three elements of evaluation were: implementation costs, time (in multiples of four years, in order to match the time available to the elected mayors), and political risk. The starting point of this evaluation, which was based on actions needed to reach the maximum value, was the current score of each indicator. The experts' judgments were then transformed into values and subsequently into an overall evaluation, according to Tables 2 and 3 (item *iii* of Method).

Table 2. Values attributed to each indicator as a result of evaluations of time, cost, and political risk of the actions that are needed to reach the maximum scores, according to the experts.

Cube evaluation	Time	Cost	Political risk	Associated points
Good (G)	4 years	Low	Low	3 points
Average (A)	8 years	Medium	Medium	2 points
Bad (B)	More than 8 years	High	High	1 point

Table 3. Overall evaluation of the three criteria (time, cost and political risk) considering a group of five experts (n = 5), as it was done in the pilot study

Sum of points (per indicator)	Overall evaluation
12 to 15	Good
9 to 11	Average
5 to 8	Bad

Next, the cube of reference displayed in Figure 1 was used to allow a simultaneous evaluation of the three-dimensions or criteria (implementation costs, time, and political risk). The 27 combinations of the evaluations bad, average or good that could be attributed to each indicator were then grouped in 10 blocks, in order to facilitate the interpretation of the results. These blocks were associated to different feasibility levels, which go from ‘viable in all dimensions’ (i.e., the three criteria - time, cost, and political risk - were classified as 'good', according to Table 3) to ‘unfeasible in all dimensions’ (i.e., the three criteria - time, cost and political risk - were classified as 'bad', according to Table 3). The 10 blocks are shown in Table 4, which also contains the association of the blocks with stages of change in the scores, as discussed in the sequence.

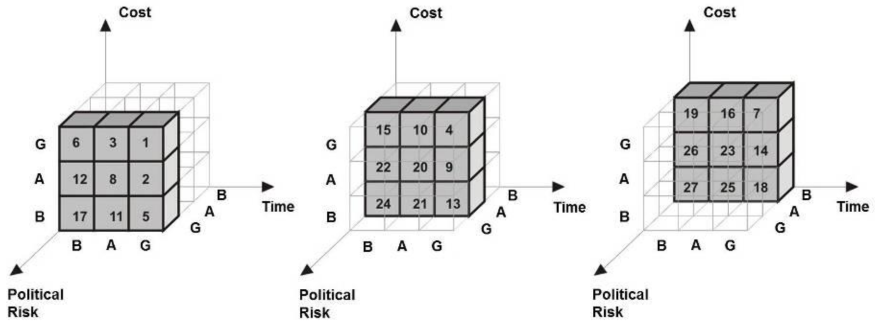

Fig. 1. Benchmarking cube used for simultaneous analyses of the dimensions time, cost, and political risk. The internal cubes that form each of the 10 blocks with similar characteristics are listed in the fourth column of Table 4

Table 4. Blocks associated to different feasibility levels (based on combined evaluations of time, cost, and political risk) and stages of change in the scores under the assumption of an ambitious scenario, as it was adopted for the pilot study

Blocks (based on feasibility levels)		**Combination of the evaluations (*)**	**Position in the cube of reference**	**Stages of change**
1	VIABLE in ALL dimensions	G, G, G	1	2.00
2	VIABLE in two dimensions and DIFFICULT TO IMPLEMENT in one	G, G, A	2, 3, 4	1.75
3	VIABLE in two dimensions and UNFEASIBLE in one	G, G, B	5, 6, 7	1.75
4	VIABLE in one dimension and DIFFICULT TO IMPLEMENT in two	G, A, A	8, 9, 10	1.50
5	VIABLE in one dimension, DIFFICULT TO IMPLEMENT in one, and UNFEASIBLE in one	G, A, B	11, 12, 13, 14, 15, 16	1.50
6	VIABLE in one dimension and UNFEASIBLE in two	G, B, B	17, 18, 19	1.25
7	DIFFICULT TO IMPLEMENT in all dimensions	A, A, A	20	1.00
8	DIFFICULT TO IMPLEMENT in two dimensions and UNFEASIBLE in one	A, A, B	21, 22, 23	0.50
9	DIFFICULT TO IMPLEMENT in one dimension and UNFEASIBLE in two	A, B, B	24, 25, 26	0.50
10	UNFEASIBLE in all dimensions	B, B, B	27	no change

* G - Good, A - Average, B - Bad

A classification of indicators based on feasibility conditions made possible the definition of priorities for the implementation of actions, in such a way that actions with high levels of feasibility were defined as priority (item *v* of Method). The scenario examined in this study was named as 'ambitious', given that we have assumed that most viable actions will be fully implemented in two terms of the local government (i.e., eight years). It was also considered that all other actions, even with lower levels of feasibility, will be at least initiated in the same period of time.

As the scores of the indicators are all normalized between zero and one, fractions of change between these two extreme values are possible. They are also desirable, if moving up in the scale, as a result of the implementation of appropriate actions. These fractions of change in the scores, as shown in the example of Table 5, were called stages. In order to simulate a future scenario, we have considered that most viable actions would be implemented within the next eight years. This process was quantitatively represented through a variation in stages, which was associated to the levels of feasibility described in Table 4. In practical terms, we assumed in this case that the values shown in the right column of Table 4 would be added to the current scores of the indicators. Given the distribution of values in the right column of Table 4, the indicators associated to viable actions would have a larger variation in the scores, whereas the indicators associated to unfeasible actions would have little variation (or no variation, as in the case of block 10). It is always important to recall that the feasibility levels are defined, for each one of the indicators and for the conditions of the city under consideration, by the invited experts or by the population.

Table 5. Stages of variation in the score (normalized between zero and one) of the indicator 'Urban Idle Land' and actions associated to the scores (in terms of the proportion of vacant land in relation to the total urban area)

Normalized scores	Percentage of vacant land in relation to total urban area
1.00	10 % or less
0.75	20 %
0.50	30 %
0.25	40 %
0.00	50 % or more

Variations in the scores would be therefore a consequence of changes in the stages. These changes are dependent on actions, which can be determined in many ways (e.g., in quantitative terms). Thus, a list of actions can be established and introduced to urban managers (and also to the citizens), always accompanied by an evaluation of time, cost, and political risk (item *vi* of Method). The classification of actions based on feasibility levels can also be used to simulate different scenarios. This could be the case, for example, of particular preferences or priorities of the city managers in terms of indicators. In any case, the alternative scenarios can be translated into actions (and therefore into associated stages of change) and new estimates of the index of sustainable urban mobility can be produced for a predefined time horizon (eight years, for example) for comparisons.

Results

The analysis of the pilot study results started from the existing conditions of mobility in São Carlos, city where the most recent value of the Index of Sustainable Urban Mobility obtained was equal to 0.568 (in a scale from to zero to one), according to Plaza and Rodrigues da Silva (2010). This was the reference point for the evaluation of each one of the eighty-seven indicators, in order to have estimates of time, costs and political risks associated to the improvement of the index in a time frame of eight years. A summary of these evaluations is shown in Figures 2, 3, and 4 (for time, costs, and political risks, respectively).

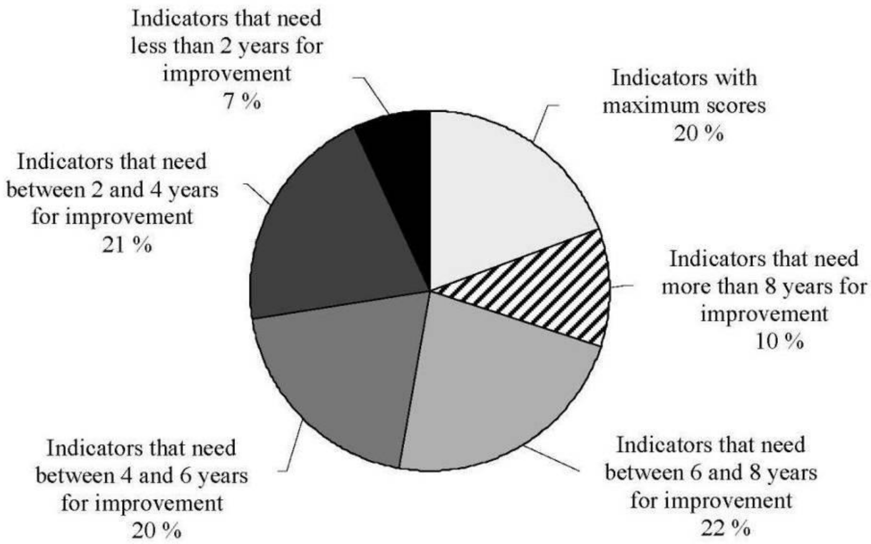

Fig. 2. Classification of the 87 indicators of the Index of Sustainable Urban Mobility regarding the time involved in the actions needed for reaching the maximum scores in the city of São Carlos, Brazil

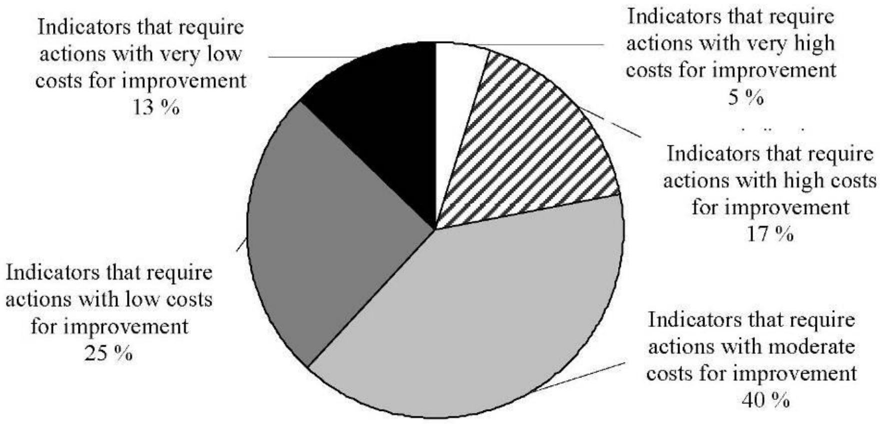

Fig. 3. Classification of the 87 indicators of the Index of Sustainable Urban Mobility regarding the costs involved in the actions needed for reaching the maximum scores in the city of São Carlos, Brazil

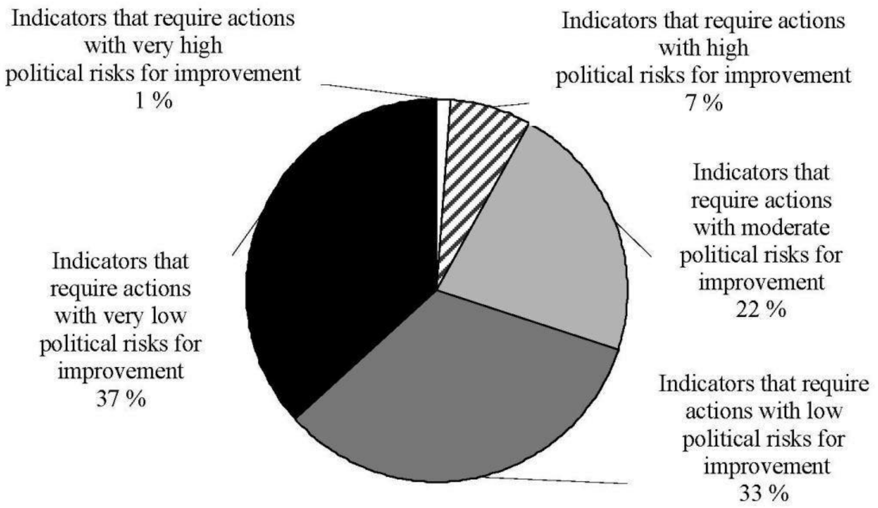

Fig. 4. Classification of the 87 indicators of the Index of Sustainable Urban Mobility regarding the political risks involved in the actions needed for reaching the maximum scores in the city of São Carlos, Brazil

Regarding the time involved in the actions needed for reaching the maximum scores (Figure 2), it is important to observe that 20 % of the indicators already had the maximum scores at the beginning of the process. This means that the measures needed are only for maintaining the services already offered, or for adjusting them to eventual demographic changes. According to the experts, among the indicators that needed improvement, 7 % of them could reach the maximum scores within 2 years and 21 % within 4 years. In other words, 28 % of the indicators could reach the maximum scores in only one municipal government term. In a second 4-years term, 20 % of the actions could be implemented in the first two years and 22 % in the third and fourth years. As a result, only 10 % of the indicators would need more than 8 years to have all actions for improvement fully implemented.

In the case of implementation costs (Figure 3), 40 % of the indicators were associated to actions classified as 'moderate' in terms of costs. In the groups below this threshold, 25 % of the indicators were associated to actions classified as 'low cost' and 13 % of them to 'very low cost' actions, summing up 38 %. Approximately 22 % of the indicators were in the groups above the 'moderate' threshold, as follows: 17 % were associated to actions classified as 'high cost' and 5 % to 'very high cost'. The political risk was also evaluated, as shown in Figure 4. Most of the actions needed for the improvement of the indicators were not seen by the experts as risky. Approximately 70 % of the indicators would be in the group classified either as of 'low risk' (33 %) or of 'very low risk' (37 %). On the opposite side, only 8 % of the indicators were associated to actions classified as 'high risk' or 'very high risk'.

However, the analysis of the actions cannot be done separately. The three dimensions of analysis have to be simultaneously considered, as indicated by the benchmarking cube shown in Figure 1. The combined classification of the experts' evaluations of the three dimensions resulted in **feasibility levels**, as suggested in Table 4.

In order to identify the distribution of the feasibility levels of the actions among the indicators, we grouped the indicators according to the original domains adopted in the hierarchical structure of I_SUM (as shown in Figure 5). These domains are: Accessibility, Environmental aspects, Social aspects, Political aspects, Transport infrastructure, Non-motorized modes, Urban circulation and traffic and Public transportation systems. It is interesting to notice, for example, that 100 % of the actions associated to indicators of the domain ´Transport infrastructure' are classified as viable in at least one of the dimensions considered (i.e., time, cost, and political risk). This favorable picture may be a consequence of the concentration, in this domain, of indicators that are somehow associated to the infrastructure predominantly available to motorized modes. This also affects the domain 'Urban circulation and traffic', which is the domain with the largest proportion of actions viable in all dimensions (almost 45 % of all indicators of the domain are in this group). The percentages of the other domains can also be individually examined in order to better understand the mobility conditions of the city. Some of these values will be briefly discussed in the section of final remarks.

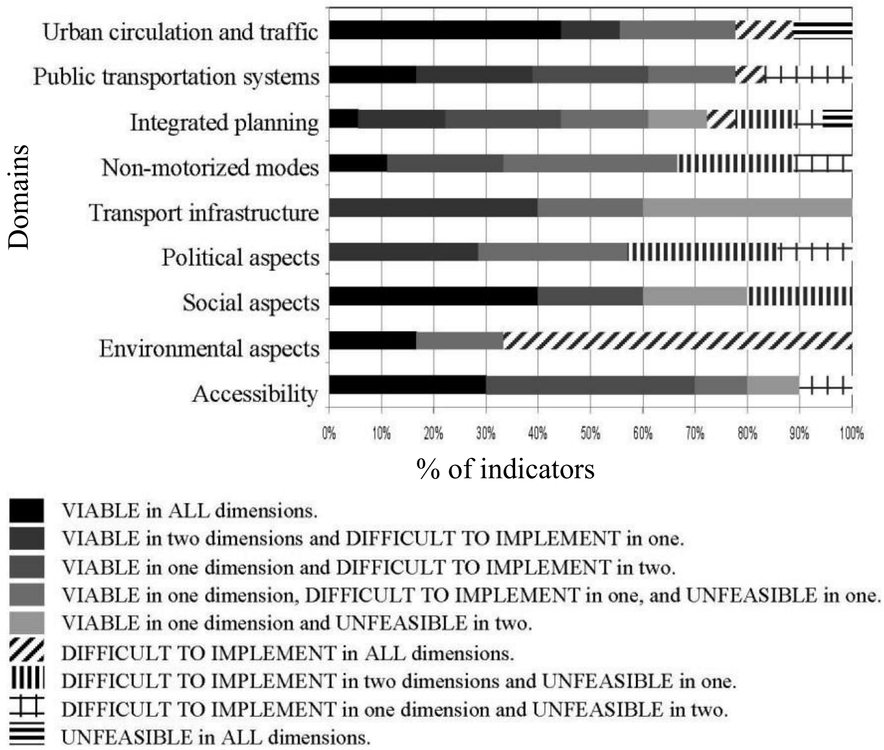

Fig. 5. Distribution of the indicators in the domains of the Index of Sustainable Urban Mobility based on the feasibility levels of the actions for their improvement

We also found a relationship between the current scores of the indicators and the feasibility levels of actions considered for their improvement in the future. In general, indicators already with the highest scores had favorable conditions for improvement. On the other hand, indicators with scores close to the minimum (i.e., zero) were often associated with unfeasible actions. A comparison of the distributions of the indicators in the domains of I_SUM, based on feasibility levels of associated actions (shown in Figure 5) and on their current scores (shown in Figure 6), supports the argument. The correspondence is visible, for example, in the case of the domain 'Transport Infrastructure', which had the highest proportion of indicators with the maximum scores (as shown in Figure 6). On the other hand, this is not the case of the domains ‘Public transportation systems’ and ‘Non-motorized modes’. They were both well classified in terms of feasibility, but 60 % of their indicators have had normalized scores below 0.40. This fact can, however, indicate a positive point in the case of these indicators, given that they are viable for improvement but had low scores in the initial evaluation. Their low scores are a visible consequence of the pro-automobile policies currently in place. Again, the other values could be also explored for detailed analysis.

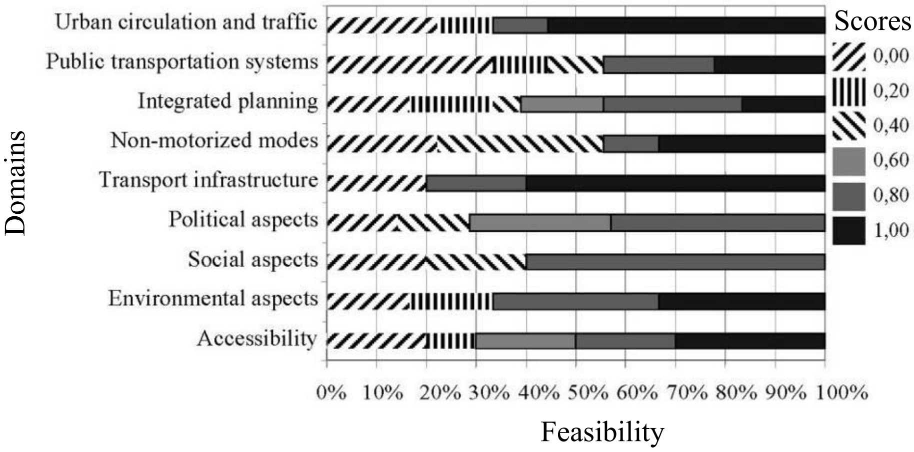

Fig. 6. Distribution of the current scores of the indicators in the domains of the Index of Sustainable Urban Mobility.

In the final step of the proposed method, a future scenario was then considered. In the case exemplified here, an ‘ambitious’ scenario was conceived. The scores of the indicators were changed in different proportions based on the feasibility levels of the actions associated to them, as explained in the methodology section. The variations followed the values shown in Table 4, in the column titled ‘Stages of change’. A direct outcome of this procedure was a list of actions, which could be translated into concrete goals for a period of eight years. If all proposed actions manage to improve the indicators as anticipated, the overall score of the Index of Sustainable Urban Mobility would change from 0.568 to 0.749. This is an increase of approximately 32 % in comparison to the initial value. Just for comparison purposes, a similar application done with a conservative scenario by Mancini (2011) produced a variation of the I_SUM value from 0.568 to 0.650.

Final Remarks

The urban transportation patterns currently found in the cities of developed and developing countries are often strongly dependent on motorized modes. Adaptations of the urban structure for encouraging trips by sustainable modes, as well as the selection and implementation of actions and policies with the same objective, are still a challenge to urban managers and planners (as discussed by Bryans and Nielsen (1999), Cervero (2008), and Sperry *et al.* (2009). In the case of developing countries, as Brazil, the difficulty is partially explained by the absence of benchmarks, i.e., successful experiences that can be used as references, as discussed by Miranda *et al.* (2009), Miranda and Rodrigues da Silva (2012), and TRIP (2013). The Index of Sustainable Urban Mobility (I_SUM) was used here, in a pilot study conducted in the city of São Carlos, Brazil, as a strategy to overcome this limitation. The 87 indicators of the index were evaluated by experts in a customized computer spreadsheet application, based on the three criteria: implementation costs, time (in multiples of four years, in order to match the time available to the elected mayors), and political risk of the proposed actions. The evaluations provided elements for the development, application and analysis of the results of a scenario-based planning method. The goal of the method is the search of alternatives to adapt cities to the concept of sustainable urban mobility while taking into account the particular characteristics of each city.

The results obtained with the pilot application suggest that the method is a promising urban planning strategy, given that it can indicate several sets of practical actions with clear potential to conduct the city to the goal of sustainable mobility. The outcomes of the analyses were compatible with the reality, as shown by the dominance of the index domains associated with the motorized modes. In the case of the domain '*Transportation Infrastructure*', all actions considered were classified as viable alternatives. A similar picture was found for the domain '*Urban Circulation and Traffic*', in which 80 % of the actions under analysis received the same classification mentioned above. These results are a consequence of the good evaluations received in the present by the indicators of the two domains. Most of them currently have very high scores and, in several cases, the maximum values.

Also highlighted by the application were the favorable conditions for the improvement of the domain '*Accessibility*', given that 90 % of the actions considered for this domain were classified as viable alternatives. This is probably a consequence of the policies of universal accessibility largely announced in Brazil in recent years. These policies were supported by a specific legislation and technical standards that aim to reduce (and, if possible, eliminate) architectonic and physical barriers. In the case of the domains '*Public Transportation Systems'*, '*Non-motorized Modes*' and '*Social Aspects*', the large number of actions also classified as viable alternatives are indications for selecting priority measures able to stimulate sustainable trip patterns. On the other hand, the biggest challenge seems to be in the domain '*Environmental Aspects*'. Seventy percent of the actions analyzed, most of them related to the reduction of pollution, were seen as difficult to implement. The picture may not be as negative as it seems, however, given that improvements in other aspects may simultaneously improve the indicators of the domain '*Environmental Aspects*'.

The results obtained also indicate the proposed methodology as a tool for evaluating the existing conditions of urban mobility and for highlighting strengths and weaknesses of the current situation. In backcasting scenarios, the definition of goals for a certain time horizon is the first step for the definition of objectives. The proposed approach, which is based on an evaluation of the current situation with the use of index, is also suitable for the creation of scenarios. These scenarios can be a combination of different sets of actions, including actions reflecting priorities established by urban managers, planners or by the population. Other positive aspects of the process are the possibility of representing the desired changes in quantitative terms, and the association of the actions to time steps, which can be easily related to the terms of the city administration.

All those conditions seem to indicate that the proposed strategy, in which a scenario-based planning approach is combined with the Index of Sustainable Urban Mobility with the support of a customized computer spreadsheet application, is a promising alternative for planning sustainable urban mobility. The main virtue of the approach is the integrated view of the decision-making process. In the case of Brazil this is particularly important, because the approach meets the requirements and recommendations of the Ministry of Cities (as discussed in Ministério das Cidades, 2006 and 2007). Also, it can be rapidly disseminated in the entire country, as it was done with other planning approaches in the European Union (TRIP, 2013).

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