Evaluation and selection of alternatives for the promotion of sustainable urban mobility

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SUMMARY

This study aims at the adjustment and application of a strategy to assess and select alternatives for improving the mobility conditions of a city. The approach was tested in the city of Itajubá, MG, Brazil, as follows: i) assessment of the current conditions, as given by the Index of Sustainable Urban Mobility, and ii) application of a strategy designed to indicate alternatives for the improvement of the mobility conditions in a sustainable way. The overall value of the index in Itajubá was 0.452, in a scale varying from zero to one. The comparison of this value with the results of reference cities, such as Curitiba (0.754) and Uberlândia (0.714), indicates an important difference. However, the approach seems to indicate lines of action for the improvement of mobility, given that it allows a fast identification of positive or negative points raised by the experts. Based on the results obtained, it can be assumed that the level, activity or profession of the participant will influence the results. In this case, for example, the external specialist presented a more pessimistic evaluation than the manager. Keeping in mind the viability of these responses, every change proposal must take into consideration the potential evaluator bias. It is evident that, if the number of evaluators is substantially raised, these discrepancies tend to diminish, and would also enable the analysis using mean values.

1. INTRODUCTION

The search for sustainable development may result in options and means of intervening, or even preventing, urban planning from facing the problems which modern-day cities face. Aside from physical and economic questions, there are also social, environmental, political and cultural questions to be considered. Developing a greater understanding of such issues sheds light on the complexity which city planners come up against. Sustainable urban mobility encompasses all of these aspects while also tackling traditional questions in reference to transportation planning.

The Sustainable Urban Mobility Index (I_SUM) is an instrument which was conceived to help managers and urban planners evaluate mobility conditions in municipalities (Costa, 2008). It involves global characteristics and, at the same time, highlights specific points for each issue. Applying I_SUM is possible under any geographic context, easing the monitoring of management strategies. With the method's results, one can create a collection of data with mobility comparisons with other cities. Using planning based on scenarios, different forms of management (such as conservative or ambitious, as proposed by Mancini (2011) may be evaluated. This type of strategy, however, still requires improvements, mainly for the evaluation and selection of actions to be applied in real cases, which is the focus of this article.

The general objective of this study is to develop and apply a strategy to assess and select alternatives for improving urban mobility conditions in a real case study. The methodology proposed was applied in the city Itajubá, located in the southeastern Brazilian state of Minas Gerais. Branching from the general objective, the specific objectives to be met are: i) diagnosis of current mobility conditions within the city, based on I_SUM, and ii) apply a planning strategy which is capable of indicating sustainable improvement opportunities. One specific preoccupation was to assess how individuals with different profiles may affect the results generated by the proposal. In this case, the participants were professionals involved in urban or transport planning; however, they all maintained different relationships with the city.

2. LITERATURE REVIEW

There are a great number and variety of problems directly- or indirectly-related to urban transport and mobility questions: such as accidents, traffic jams, inaccessibility for those with restricted mobility, sound and atmospheric pollution. Beyond a municipality's limits, there are other economic, social, political and environmental questions, such as global warming, to take into consideration. Although many of these problems take on the characteristics of the city, region or country in question, as observed in Rodrigues da Silva et al. (2010), there is a growing perception of a need for continuously more innovative strategies which enable sustainable mobility standards.

The guide for elaboration of Urban Mobility Plans, from the Brazilian Ministry of the Cities (2007), defines urban mobility as an attribute associated to a city, relative to the movement of people and goods, considering vehicles, routes and general urban infrastructure. When speaking about sustainability, urban mobility implies that people may move or transport themselves in ways which do not harm the environment while still partaking in the benefits of urban life. Thus, a successful integration of sustainability demands a shift in the paradigm, requiring an understanding of the complex interactions between transport and the environment, society and economy (Zheng et al., 2011). City development must start with the connection between urban and transport policies in such a way that sustainable mobility is able to unite important elements, such as land use, public transport corridors, parks, and pathways for pedestrians and cyclists, thus leading to a way which is both sustainable and developable.

Among the research which discusses the best transport planning strategies, Barrela & Amekudzi (2011) comment that traditional planning can be summed up in the old addage "Trial and Error". When using this approach, problems are anticipated and mitigation strategies are put into action. However, this dynamism does not adapt well to the reality of cities where difficulties and uncertainties are always coming up in different ways. The above cited authors state scenario planning, undertaken in some European countries for almost two decades, through backcasting and forecasting, contemplate more effective planning strategies. While forecasting is limited to an extension of current practices, backcasting offers the liberty to introduce radical changes which are many times necessary for transport systems.

The constant search for the best way to improve sustainable urban mobility concepts generally leads to new approaches, such as the initiative to create indices which allow for an evaluation of the degree of sustainability within the city. However, there is no single, ideal method to tackle this question, but rather myriad alternatives which can be adapted to fit the needs of the area under study. City planning depends on the participation of professionals from a variety of disciplines, and many times is influenced by popular acceptance and management support. The choice of the method to be applied depends on criteria chosen for that region, being the diagnostic stage which determines the following steps to be taken. López-Lambas et al. (2010) explain that the assessment method should be flexible and sufficient to enable decision-makers to make necessary adjustments.

Bana and Costa (2001) assert that multi-criteria decision methodologies aid in interaction between actors who construct a framework and language for shared communication between all members. Another promising approach is planning through indicators. Indicators are capable of generating information for decision-making processes which enable tracking and monitoring goals, benefits, efficacy and efficiency of the proposed actions (Villela et al., 2007). According to Royuela (2001), such an indicator must be capable of providing information about the problem under study, supporting the development of policies, establishing priorities and contributing to tracking and maintaining the defined actions. It must additionally serve as a tool for spreading information among and between all levels.

Urban sustainability indicators stand out from more traditional standards. Thus, instead of dealing with isolated social, economic and environmental aspects, new indicators tackle plans involving characteristics such as integration, long-term planning and a wide-spread range of actors. For a more detailed discussion about this differentiation, the studies from Segnestam (2002), Magalhães (2004) and Costa & Rodrigues da Silva (2006) are recommended readings. An example of an indicator with an "integrationalist" vision is I_SUM, which is a tool for evaluating urban mobility based on a multi-criteria approach

(Costa, 2008). The hierarchical structure of I_SUM was constructed on a set of indicators which, as suggested by Litman (2009), were carefully selected to reflect the diverse impacts and perspectives of the theme mobility. The framework is made up of nine domains, spread over thirty-seven themes and eighty-seven indicators, which can be found in Costa (2008) and Rodrigues da Silva et al. (2010).

The simple diagnosis obtained through the use of indicators does not arrive at the crux of the matter in a direct way. According to Mancini (2011), the definition of which policies and actions should be implemented in cities seeking sustainable mobility solutions, is a great challenge. The process should involve planners, managers and decision-makers and, above all else, the population, which should exercise an active role in the change process. The consensus that has come to be in terms of democratic sustainability management of public policy involves the participation of multiple social actors which encompass the community or society (Tavares, 2005). Another important point is the hierarchy of actions to be implemented. Criteria must be established in order to identify which of the proposed changes must be undertaken firstly, and which have the possibility of a long adaptation and planning process. Among these multiple procedures proposed to answer these questions, the strategy suggested by Mancini (2011) suits the needs of this study. The principle details of this method are described in the following section.

3. METHODOLOGICAL PROCEDURES

The procedures herein adopted are directly associated to specific objectives, as stated in the introduction: i) diagnose the current conditions of urban mobility in the city of Itajubá, Brazil, using I_SUM; and ii) adapt and apply a planning strategy to evaluate and select the alternatives which would transform and improve the city's urban mobility. For this study, the strategy involves the examination of Mancini's proposal (Mancini, 2011), thus deserving an in-depth look at its workings.

The Sustainable Urban Mobility Index (I_SUM) was selected for this study due to its ability to reveal current conditions and measure the impact of means of strategies which aim to provide sustainably mobility. The city of Itajubá was chosen for this study due to its relevance, both economic and culturally, in the area, and the fact that it is undergoing a phase suitable for interventions and sustainable urban planning. Located in the southeastern state of Minas Gerais, Brazil, Itajubá has a population of 90,654 inhabitants, according to the latest census figures (IBGE, 2010).

Having selected the city, the investigation process begins by verifying the data available for calculating indicators based on two criteria: availability and quality. The method developed by OECD (1999) for analyzing indicator sets, whose objective is to integrate a variety of transport policy aspects, was adapted for this evaluation. In terms of data availability, they were classified into different categories: Short-Term (ST), Medium-Term

(MT) and Long-Term (LT). This distribution considers that the intervals of short-, medium- and long-term respectively corresponded to: one year, one governmental administration and more than one governmental administration. As for quality, data are classified as: Optimal (O), Good (G), and Poor (P), following a decreasing scale of reliability. Individual analysis of each indicator allows for selection for application, which has already been demonstrated in Itajubá by Rodrigues da Silva et al. (2013). More details about these procedures can be found in Rodrigues da Silva et al. (2010) and Azevedo Filho et al. (2011).

These indicators are distributed among diverse themes. Each theme has a global scoring equivalent of 1 which is divided into indicators. In the case of an indicator not being applicable, the weights are redistributed to the rest of the weights in order to guarantee that the final sum remains the same. All themes are grouped into nine domains: accessibility, environmental aspects, social aspects, political aspects, transportation infrastructure, non-motorized modes, integrated planning, traffic and urban circulation, and urban transport systems. Finally, with I_SUM calculated, it is possible to carry out other analyses. With other cities in possession of their indices, comparisons may be drawn between municipalities.

It is possible to propose actions to improve some indicators which consequently increase the global index. These actions are identified in different ways. The method herein explored for viability assessment is a variation of planning based on scenarios, proposed by Mancini (2011), which corresponds to an analysis of viability combinations. Once I_SUM is calculated, specialists are invited to evaluate it, by means of a questionnaire which utilizes the predefined scale (based on original status from Likert, 1932) of degree of difficulty, time-frame (in intervals of four years, coinciding with the mandate of a mayoral administration), and the political risk involved if indices reaching the maximum value of 1. Such an evaluation can be extended to managers and the population in general, and involves presenting each current indicator and the actions necessary to reach the maximum score or the implementation of immediate improvement measures, regardless of its index value.

Mancini (2011) proposes the utilization of a reference cube, exemplified in Figure 1, which allows for simultaneous analysis of three dimensions or categories (cost, time and political risk). The interpretation of these results can be carried out based on the viability combinations (Table 1) for all questionnaires. These combinations range from “viable for all categories” (attaining a “good” evaluation in cost, time and political risk) to “very improbable” (that is, “bad” in all three dimensions).

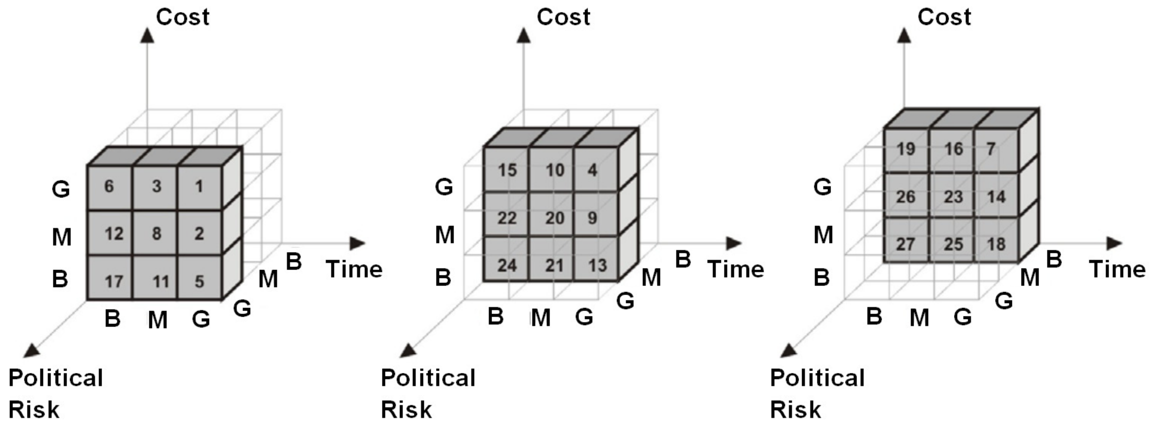

Fig. 1. Reference cube - Benchmarking (G = Good; M = Medium, and B = Bad). Source: Mancini (2011).

Table 1. Combination of cost, time and political risk, according to viability.

Blocks - Viability classifications		Combinations*		
1	VIABLE in all categories	G	G	G
2	VIABLE in two categories and IMPROBABLE in one	G	G	M
3	VIABLE in two categories and VERY IMPROBABLE in one	G	G	B
4	VIABLE in one category and IMPROBABLE in two	G	M	M
5	VIABLE in one category, IMPROBABLE and VERY IMPROBABLE in two	G	M	B
6	VIABLE in one category and VERY IMPROBABLY in two	G	B	B
7	IMPROBABLE in all categories	M	M	M
8	IMPROBABLE in two categories and VERY IMPROBABLE in one	M	M	B
9	IMPROBABLE in one category and VERY IMPROBABLE in two	M	B	B
10	VERY IMPROBABLE in all categories	B	B	B

*G = Good, M = Medium, and B = Bad. Source: adapted from Mancini (2011)

Furthermore, for a global evaluation, points may be added to the respondents' choices. The worst alternatives (more than eight years, high cost and high political risk), can receive, for example, a value of 1, while the best alternatives (four years, low cost and low political risk) would receive a scoring of 3. In this case, value 2 would be attributed to the intermediate options (eight years, medium cost and medium political risk). The opinions of n specialists are added up for each indicator, resulting in a classification of high, medium or low degrees of viability. For this study, only two respondents were considered: one being a manager related to city administration and the other being a planning and mobility specialist who is not connected to city administration. Thus, values between 15 and 18 would be equivalent to a high degree of viability, between 11 and 14 being an intermediate degree of viability and below 11 having a low level of viability.

Given the low number of questionnaires for this study's sample, an adaptation was made to the methodology to expose and evaluate the results simultaneously. The assessments of the two respondents can be seen together, what allows a direct comparison of the answers of two individuals performing different roles in the planning process. This makes it possible to make some conclusions in respect to the results considering the respondents' profiles.

4. RESULTS

The methodology application for the I_SUM calculation in Itajubá was undertaken in steps, as suggested by Costa (2008) and Rodrigues da Silva et al. (2010). Initially, researchers had to evaluate if it would be possible to apply the assessment method given the city's real situation. Data were collected along with the city's administrative organizations, as well as through field research and direct observation. These data were classified according to their quality and availability, as discussed by Morais & Rodrigues da Silva (2011). The I_SUM calculation in Itajubá was done for 73 of the 87 indicators which compose the index. Among the main motives which did not permit the calculation of 14 indicators (Table 2) are: absence of information and specific surveys, in particular an Origin-Destination survey, and control of existing data in municipal organs.

Table 2. Uncollected I_SUM indicators for Itajubá; data either deemed "Not Collected" or classified as Weak Performance "Zero Score"

INDICATORS	SCORE
CO Emissions	NOT CALCULATED
CO_2 Emissions	NOT CALCULATED
Use of clean energy and alternative fuels	NOT CALCULATED
Vertical equity (income)	NOT CALCULATED
Participation in decision-taking	0,00
Urban mobility policy	0,00
Transit lanes	0,00
Length and connectivity of cycleways	0,00
Bicycle fleet	NOT CALCULATED
Number of trips	NOT CALCULATED
Measures to reduce motorized traffic	0,00
Training for technicians and managers	0,00
Vitality of the central area	NOT CALCULATED
Intercity partnerships	0,00
Vacant land	NOT CALCULATED
Urban growth	NOT CALCULATED
Urban population density	0,00
Illegal settlements	NOT CALCULATED
Parks and green areas	0,00
Violation of traffic rules	NOT CALCULATED
Vehicle occupation	NOT CALCULATED
Total extension of the transit network	0,00
Transit service frequency	0,00
Public versus private transport	NOT CALCULATED
Motorized versus non-motorized modes	NOT CALCULATED
Intermodal terminals	0,00
Transit integration	0,00
Transit fares	0,00

The calculation of Itajubá's index resulted in a global value of 0.452. For this value to be compared to other cities, however, three situations had to be considered, as presented in Table 3. In the first case, there are index values effectively calculated for the Itajubá case. In following, maximum values were attributed for the 14 indicators not calculated. Finally, zero values were attributed to the same indicators. This procedure was carried out for the three cities, which produced value ranges to be compared. The direct comparison of the calculated results would not be suitable; as it would have involved results obtained from partial indicator sets and would not necessarily coincide.

Table 3. Results comparison from the Sustainable Urban Mobility Index, obtained in Itajubá and two other cities

Index variation range	I_SUM values in different cities		
	Itajubá	Curitiba (Morais & Rodrigues da Silva, 2011)	Uberlândia (Assunção, 2010)
Maximum value **	0.575	0.792	0.737
Calculated value *	0.452	0.754	0.714
Minimum value ***	0.419	0.656	0.667

* Obtained by calculating available indicators (73 in Itajubá, 75 in Curitiba and 82 in Uberlândia).
** Value recalculated with the inclusion of originally unavailable indicators, each of which was attributed a maximum score (equal to one).
*** Value recalculated with the inclusion of originally unavailable indicators, each of which was attributed a minimum possible score (equal to zero).

It was seen that the I_SUM variation range in Itajubá oscillates from 0.419 to 0.575, greater than cities such as Curitiba and Uberlândia. As expected, the index, at its maximum value considering a value of 1.00 for those indicators which could not be calculated, increased significantly. This indicates the necessity for an alternative selection methodology aimed at promoting urban mobility. For this type of approach to be effective, the indicators which didn't meet the methodology's expectations need to be identified. In the case of Itajubá, these are listed in Table 2, in two categories: indicators without data (indicated by Not).

In following, in the second part of the methodological procedure, questionnaires were given to evaluators for them to assess the perception of urban and transport planning specialists throughout the city. In the case of this study, a local administration technician and an external transports and mobility expert were chosen to complete the survey. The results are shown in Table 4.

TABLE 4 Results of Viability Analysis for Sustainable Urban Mobility Index Improvement

INDICATORS		Specialist			Manager			Quantitative Evaluations		
		Time	Cost	Risk	Time	Cost	Risk	Specialist	Manager	Spc. + Mgr
1.1.1	Accessibility to transit	B	M	G	M	M	G	6	7	13
1.1.2	Public transportation for users with special needs	G	M	G	G	G	G	8	9	17
1.1.3	Transport expenses	G	M	M	G	G	G	7	9	16
1.2.1	Street crossings adapted to users with special needs	B	B	M	G	G	G	4	9	13
1.2.2	Accessibility to open spaces	B	B	M	G	G	G	4	9	13
1.2.3	Parking spaces to users with special needs	M	M	M	G	G	G	6	9	15
1.2.4	Accessibility to public buildings	B	B	G	G	G	G	5	9	14
1.2.5	Accessibility to essential services	B	B	G	M	B	G	5	6	11
1.3.1	Urban fragmentation	B	B	B	B	B	M	3	4	7
1.4.1	Actions towards universal accessibility	M	M	G	G	G	G	7	9	16
2.1.1	CO Emissions	B	B	M	B	B	B	4	3	7
2.1.2	CO2 Emissions	B	B	M	B	B	B	4	3	7
2.1.3	Population exposed to traffic noise	B	M	G	M	M	M	6	6	12
2.1.4	Studies of environmental impacts	M	M	G	G	G	B	7	7	14
2.2.1	Fuel consumption	M	M	M	G	M	G	6	8	14
2.2.2	Use of clean energy and alternative fuels	B	B	M	B	B	G	4	5	9
3.1.1	**Information available to the population**	G	G	G	G	G	G	9	9	18
3.2.1	Vertical equity (income)	M	B	M	B	B	M	5	4	9
3.3.1	Education for sustainable development	B	G	G	G	G	G	7	9	16
3.4.1	Participation in decision-taking	M	M	G	G	G	G	7	9	16
3.5.1	Quality of life	M	B	G	M	M	G	6	7	13
4.1.1	Integration of different government levels	M	G	M	G	G	G	7	9	16
4.1.2	Public-private partnerships	M	G	G	M	G	G	8	8	16
4.2.1	Acquisition of resources	M	G	G	G	G	G	8	9	17
4.2.2	Investments in transport systems	B	M	M	M	B	G	5	6	11
4.2.3	Distribution of resources (public x private)	B	G	M	G	G	M	6	8	14
4.2.4	Distribution of resources (motorized x non-motorized)	B	M	M	M	M	G	5	7	12
4.3.1	Urban mobility policy	B	M	G	G	G	G	6	9	15
5.1.1	**Density of the street network**	G	G	G	G	G	G	9	9	18
5.1.2	Paved streets	M	G	M	G	M	G	7	8	15
5.1.3	Maintenance expenditures in transport infrastructure	M	M	M	M	B	G	6	6	12
5.1.4	Streets signaling	G	G	G	G	M	M	9	7	16
5.2.1	Transit lanes	B	M	B	B	B	M	4	4	8
6.1.1	Length and connectivity of cycleways	B	M	G	M	B	G	6	6	12
6.1.2	**Bicycle fleet**	G	G	G	G	G	G	9	9	18
6.1.3	Facilities for bicycle parking	M	M	G	G	G	G	7	9	16
6.2.1	Pathways for pedestrians	M	M	G	G	M	G	7	8	15
6.2.2	Streets with sidewalks	B	B	M	M	M	M	4	6	10
6.3.1	Travel distance	B	B	B	M	M	M	3	6	9
6.3.2	Travel time	G	G	G	G	M	M	6	7	13
6.3.3	**Number of trips**	G	G	G	G	G	G	9	9	18
6.3.4	Measures to reduce motorized traffic	M	M	G	B	B	B	7	3	10
7.1.1	**Expertise of technicians and managers**	G	G	G	G	G	G	9	9	18
7.1.2	Training for technicians and managers	M	M	G	G	G	G	7	9	16

TABLE 4 (cont.) Results of Viability Analysis for Sustainable Urban Mobility Index Improvement

INDICATORS		Specialist			Manager			Quantitative Evaluations		
		Time	Cost	Risk	Time	Cost	Risk	Specialist	Manager	Spc. + Mgr
7.2.1	Vitality of the central area	B	B	B	M	B	B	3	4	7
7.3.1	Intercity partnerships	G	M	M	G	M	G	7	8	15
7.4.1	Transparency and responsibility	M	G	G	G	G	M	8	8	16
7.5.1	Vacant land	B	B	B	G	G	G	3	9	12
7.5.2	Urban growth	B	B	M	M	M	M	4	6	10
7.5.3	Urban population density	B	B	B	M	M	M	3	6	9
7.5.4	Mixed land use	B	B	B	G	G	M	3	8	11
7.5.5	Illegal settlements	B	B	B	M	M	B	3	5	8
7.6.1	Integrated urban. environmental and transport planning	M	M	G	G	M	G	7	8	15
7.6.2	Implementation and sequence of planed actions	M	G	M	G	M	M	7	7	14
7.7.1	Parks and green areas	B	M	B	G	M	G	4	8	12
7.7.2	Urban facilities (schools)	M	M	G	M	B	G	7	6	13
7.7.3	Urban facilities (hospitals)	M	M	G	B	B	G	7	5	12
7.8.1	Master Plan	M	G	M	M	M	M	7	6	13
7.8.2	Urban legislation	G	G	M	G	G	G	8	9	17
7.8.3	Urban legislation actual application	G	G	M	G	M	B	8	6	14
8.1.1	Traffic accidents	G	G	G	G	M	G	9	8	17
8.1.2	Accidents with pedestrians and cyclists	G	G	G	G	M	G	9	8	17
8.1.3	Accident prevention	M	M	G	M	M	G	7	7	14
8.2.1	Traffic education program	G	G	G	G	G	G	9	9	18
8.3.1	Congestion	G	M	M		M		7	2	9
8.3.2	Average traffic speed	G	M	M	G	M	G	7	8	15
8.4.1	Violation of traffic rules	M	G	M	G	G	G	7	9	16
8.5.1	Motorization rate	B	B	B	G	M	M	3	7	10
8.5.2	Vehicle occupation	B	G	G	G	M	M	7	7	14
9.1.1	Total extension of the transit network	B	M	M				5		5
9.1.2	Transit service frequency	B	M	M	G	B	G	5	7	12
9.1.3	On-time performance	G	G	G	G	G	G	9	9	18
9.1.4	Transit average speed	M	M	G	G	G	G	7	9	16
9.1.5	Transit fleet age	G	M	G	G	M	G	8	8	16
9.1.6	Passengers per kilometer	G	M	G	G	G	G	8	9	17
9.1.7	Annual number of passengers	M	M	M	G	M	G	6	8	14
9.1.8	User satisfaction with the transit service	M	M	G	G	M	G	7	8	15
9.2.1	Diversity of transportation modes	B	B	B	M	B	G	3	6	9
9.2.2	Public versus private transport	B	M	M	M	B	G	5	6	11
9.2.3	Motorized versus non-motorized modes	B	M	M	M	B	G	5	6	11
9.3.1	Contracts and licitations	G	M	G	G	G	G	8	9	17
9.3.2	Informal transport	G	M	M	G	G	G	7	9	16
9.4.1	Intermodal terminals	B	M	G	B	B	M	6	4	10
9.4.2	Transit integration	B	M	G	B	B	M	6	4	10
9.5.1	Discounts and free rides	M	M	G	G	M	B	7	6	13
9.5.2	Transit fares	M	M	B	G	G	G	5	9	14
9.5.3	Public Subsidies	G	M	B	G	M	G	6	8	14

A reasonably optimistic vision can be observed in relation to indicator improvement from the evaluators, with 7 of them (around 8% of the total) considered as VIABLE in all of the categories (time, cost and political risk), as defined in line 1 of Table 1 and shown in Table 4. Furthermore, 30 indicators (approximately 34% of the total) were considered highly viable by the two evaluators, which resulted in different combinations in lines 2 and 6 of Table 1. At the same time, 31 indicators (approximately 36% of the total) were classified in an intermediary viability condition; that is, when the sum of evaluations resulted in a value between 11 and 14. These and all the other values are condensed into Table 5. An analysis of the evaluations based on the matrix presented in Table 5 indicates a certain difference between the evaluators' perceptions, since the result are not aligned along the main diagonal line, which would indicate a coincidence in the quantitative aspects of this study. Furthermore, it can be seen through the quantity of values in the upper right-hand corner that, in general, the manager had a more optimistic vision than the mobility and transport specialist. The manager also left two evaluations in blank.

TABLE 5 Combined classification of indicators according to the degree of viability

Specialist \ Manager	0	2	3	4	5	6	7	8	9	Sum
3				2	1	3	1	1	1	9
4			2	1	1	2		1	2	9
5	1			1		4	2		2	10
6				2		3	2	4	2	13
7		1	1		1	3	4	6	10	26
8						1		3	5	9
9							2	2	7	11
Sum	1	1	3	6	3	16	11	18	29	87

Analyzing some indicators by their viability for improvement, it is possible to simulate the impact produced by their variation in the final I_SUM calculation (see the indicators highlighted in Table 4). The improvement of the 7 indicators with extremely high viability would alter the I_SUM value from 0.452 to 0.465, given that 4 of them already had maximum scores. When considering the improvement of the other 30 indicators with high viability, the value grows to 0.625. In certain cases, some indicators would cause the I_SUM value to increase, but its viability score is small. This occurs, for example, with the indicator "Transit Lanes" (item 5.2.1 from Table 4). Although it carries considerable weight in the I_SUM calculation and just a maximum value would alter the final index to 0.516, its viability was considered low by the two evaluators.

5. CONCLUSIONS

In general, the conclusions of this study are two-fold. The first group deals with the results of the application of the I_SUM in the city of Itajubá. The second part examines the conclusions which refer to the viability evaluation of the actions for improvement in urban mobility within the city.

The city's global I_SUM value was 0.452 - lower than the intermediate point (0.500) of the evaluation scale, which goes from zero to one. When comparing this value with the elevated values obtained in other cities, such as Curitiba (0.754) and Uberlândia (0.714), the difference becomes more expressive. Even if all of the indicators which weren't calculated as a result of poor data quality and availability had received maximum scores of 1, the index value for Itajubá still would not come close to the minimum value found in the other comparison cities. In this case, the minimum value would be that adopted if all indicators which were not calculated for Curitiba and Uberlândia were equal to zero (0.656 and 0.667, respectively).

With the goal of improving urban mobility conditions and using the I_SUM as a reference, it is important that the indicators with low scores, in particular those equal to 0.00, be raised. This paper presented a way of structuring a hierarchy of these alterations according to their viability or feasibility, adapted from Mancini (2011). This methodology can be evaluated from different aspects. From the point of view of externally analyzing the process as a whole, it allows for a quick glimpse at both strong and weak points which were evaluated by selected professionals and experts. On the other hand, it apparently proved, for the manager, to be difficult in understanding and evaluating some indicators.
This fact can take on serious implications for the process, as the indicators that were not evaluated resulted in considerable differences in comparison with the questionnaires. This was the case for this study. Seeing that only two questionnaires were evaluated, the discrepant results had a great impact on the final result. Consequently, it is worth noting here the importance of applying the questionnaire to a greater number of people and overseeing the filling out and completion of them, due to the fact that some fields were left blank by the manager.

Based on the results obtained, it can be assumed that the level, activity or profession of the participant will influence the results. In this case, for example, the external specialist presented a more pessimistic evaluation than the manager, as shown in Tables 4 and 5. Keeping in mind the viability of these responses, every change proposal must take into consideration the potential evaluator bias. It is evident that, if the number of evaluators is substantially raised, these discrepancies tend to diminish, and would also enable the analysis using mean values.

At a last look, the decision regarding the policies to be implemented can follow two different paths. First, the global I_SUM value could become the focus. To do this, the indicators with the lowest values would be key priorities for any interventions, regardless of cost, time and political risk. Second, the focus could put on executing actions immediately at a low cost, short term and reduced political risk. It is evident that all and any indicator which belongs to these two categories must be an object of immediate action.

This compatibility is easily perceivable with an analysis done based on the list of indicators with scores equal to zero (Table 2) and, coincidentally, with a visibility and evaluation of them, according to the viability of action execution (Table 4).

In synthesis, the approach herein presented is perfectly applicable for any city. Thus, it could serve as an instrument for aiding in elaboration and implantation of Mobility Plans required by Brazilian Federal Law Number 12,587, from January 3, 2012, which was instituted by the guidelines from the National Urban Mobility Policy.

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