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Sustainable consensus? The NISTO evaluation framework to appraise sustainability and stakeholder preferences for mobility projects

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Abstract

While sustainability of transport projects is of increasing importance, the concept of sustainability can be understood in many different ways by the stakeholders that are involved in or affected by mobility projects. In this paper, we compare the outcomes of the assessment of sustainability of projects through a multi-criteria analysis (MCA) and the appraisal of stakeholder preferences through the multi-actor multi-criteria analysis (MAMCA). Evaluating projects with both tools and comparing the outcomes can provide insight into the stakeholder support of sustainable solutions and the sustainability of alternatives preferred by stakeholders. The sustainability of projects is assessed through 16 criteria grouped under the three pillars of sustainability. They were selected by in-depth review of 16 case studies of mobility projects, 18 transport evaluation schemes and the ranking of potential criteria by 214 stakeholders in North-West Europe. These criteria were weighted by 93 representatives of decision makers in the mobility domain. Stakeholder preferences were appraised through the criteria identified for each stakeholder group. We illustrate the framework by evaluating alternative solutions to improve cycling connections between the towns of Tilburg and Waalwijk in the Netherlands. The results of the comparison show that stakeholder preferences are biased towards one or two of the sustainability pillars (economy, environment, society) in three ways: through the selection of the criteria by the stakeholders, the weights of each criterion by each stakeholder group and differences in the final ranking of alternatives between the stakeholder groups and the MCA.

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Keywords: evaluation; multi-criteria analysis; multi-actor multi-criteria analysis; stakeholder participation; mobility; smart mobility concepts

1. Introduction

Sustainability in general and sustainable mobility in particular are universal concepts that are supposed to reflect the overall societal objectives in terms of economic development, environmental preservation and social progress. Sustainability, however, can be understood in many different ways by the stakeholders that are involved in or affected by mobility projects (Richardson, 2005). While an alternative to solve a particular mobility problem can be sustainable in general, it may not receive support from the majority of the stakeholders since their evaluation criteria and preferences may differ from the assessment criteria for sustainable mobility. Therefore, there is a need for evaluation frameworks and tools that can appraise project alternatives in terms of their sustainability as well as their stakeholder support.

In this paper, we propose the NISTO[1] evaluation framework that is composed of the assessment of sustainability of projects through a multi-criteria analysis (MCA) and a close integration of stakeholders into the evaluation process through the multi-actor multi-criteria analysis (MAMCA). Evaluating projects with both tools and comparing the outcomes can provide insight into the stakeholder support of sustainable solutions, or vice versa, the sustainability of alternatives preferred by different stakeholder groups. The framework has been tested through the evaluation of five demonstration projects. This paper presents the evaluation of alternative solutions to improve cycling connections between the towns of Tilburg and Walwijk in the Netherlands. Potential conflicts between the preferences of the stakeholders and the sustainability of options will be shown.

The next section gives a brief overview of the literature on the linkages between sustainability assessment and participatory evaluation. Then, in Section 3, the proposed evaluation framework is introduced. Section 4 describes the case study and section 5 presents the results. Section 6 concludes the paper by discussing the results and limitations of the study.

2. Sustainability versus participatory evaluation

The concept of sustainable transport or sustainable mobility has been derived from that of sustainability. Based on a review of sixteen planning and research projects, Jeon and Amekudzi (2005) concluded that definitions of a sustainable transport system usually cover impacts on economic development, environmental integrity and social quality of life. Similarly, a number of evaluation and indicator frameworks for transport consider at least the 'triple bottom line' that define sustainability: economy, environment and society (Nieto, 1997; Toth-Szabo *et al.*, 2011; Marletto and Mameli, 2012; Litman, 2013).

Sustainability assessment is based on two paradigms: the expert-led, top-down approach and the participatory bottom-up approach (Reed *et al.*, 2006). The former has the advantage that the comparison across different cities and regions is possible (Binder *et al.*, 2010). The latter, however, puts more emphasis on the local context, hence decisions may reflect local circumstances better (Reed *et al.*, 2006). Gibson (2006) suggests that traditional top-down approaches to sustainability assessment should be enhanced with effective public participation and attention to specific local concerns. The difficulty of involving different stakeholder groups in the assessment of sustainability, however, arises from the potential conflict between participation and a balanced view of sustainability. Some stakeholder groups may have objectives that are not sustainable. Car drivers, for example, may have objectives that conflict with those of pedestrians (e.g. more parking and road capacity vs. larger pedestrian areas). Therefore a balance between community and high-level control over the assessment process is needed to provide an objective assessment of impacts (Reed *et al.*, 2006). Several approaches have been proposed that combine top-down and bottom-up methods (Sheppard and

[1] NISTO: New Integrated Smart Transport Options: a project co-financed by the EU INTERREG IVb North West Europe Programme.

Meitner, 2005; Reed *et al.*, 2006; Stringer *et al.*, 2006; Chamaret *et al.*, 2007). Reed et. al. (2006), for example, developed an "adaptive learning process" for the assessment of sustainability that combines the advantages of bottom--up and top-down approaches and can be adapted to local circumstances. It provides a framework that can be applied by a wide range of stakeholders, although it does not suggest specific tools or methods for the different steps of the evaluation. In the field of transport evaluation, Castillo and Pitfield (2010) created the ELASTIC framework to include stakeholders in the selection of indicators for sustainable transport. In this framework, indicators are selected based on the evaluation of their methodological strength and relevance concerning the principles of sustainable transport. Multi-Criteria Decision Analysis (MCDA) is applied in the selection process to attach weights to the different criteria. This framework, however, only focuses on the selection of indicators, and not on the whole evaluation process or other steps thereof. In addition, the selection of the evaluation criteria is somewhat arbitrary and it is not ensured that the environmental, economic and social pillars are balanced. Marletto and Mameli (2012) proposed the combination of multi-criteria decision analysis techniques and participatory methods. Participation was, however, again only limited to the selection of core indicators for sustainable urban mobility. Vermote et. al., used the multi-actor multi--criteria analysis (MAMCA) (developed by Macharis (2004) for the assessment of different scenarios of freight transport routes (Vermote *et al.*, 2013) and alternative light rail scenarios in Flanders (Vermote *et al.*, 2014) within the assessment framework of sustainable mobility. The Multi-Actor Multi Criteria Analysis has been shown to be suitable for the evaluation of the support of the different stakeholders for specific policy measures. However, there might be a high support for a certain measure, but that does not mean the measure is sustainable from the ecological, social and economic point of view. Therefore, in this paper, we propose to complement the MAMCA tool with a sustainability assessment.

3. Methodology: the NISTO evaluation framework

To overcome the barriers of integrating sustainability assessment and the needs of stakeholders into the decision making process, the NISTO evaluation framework aims to link the advantages of traditional MCDA techniques with the stakeholder-based Multi-Actor Multi-Criteria Analysis (MAMCA) methodology (Macharis *et al.*, 2012). This novel approach makes it possible to carry out a sustainability assessment (top-down approach), whilst highlighting any potential stakeholder conflicts that may hinder the implementation of the projects (bottom-up approach). A comparison of the outcomes of the two evaluations can reveal any conflicts between stakeholder preferences and sustainability. The NISTO evaluation framework consists of two main elements (Figure 1). On the one hand, there is a set of evaluation tools (MCA, MAMCA, Target monitoring[2]) to assess projects based on the objectives of sustainable urban and regional transport. On the other hand, there is a set of core (MCA) and local (MAMCA) evaluation criteria and indicators that are used by the evaluation tools.

The sustainability of projects is assessed by multi-criteria analysis through 16 criteria grouped under the three pillars of sustainability. They were selected based on an in-depth review of 16 case studies of mobility projects, 18 transport evaluation schemes and the ranking of potential criteria by 214 stakeholders from the UK, Belgium, France, Germany and the Netherlands in a survey. The aim was to ensure that all relevant evaluation criteria for sustainability for urban and regional mobility are included covering all three sustainability pillars. (Bulckaen *et al.*, 2015a). These criteria were weighted by 93 representatives of decision makers in the mobility domain from Belgium, France, Germany, the Netherlands and the United Kingdom. The weightings were carried out for each pillar separately maintaining the balance between the three pillars (Table 1).

Given the fixed set of criteria and weights, the main step of the sustainability assessment is the evaluation of the alternatives on each core criterion. In the first step, indicators are identified and data is collected. Indicators for which no quantitative data is available are evaluated qualitatively by experts with local knowledge. A seven-point qualitative scale (from very negative to very positive) can be used to indicate the extent and direction (positive, negative or neutral) of the impact of the alternative on each criterion.

[2] Target monitoring aims to monitor and follow up targets set at the beginning of the implementation. This evaluation tool is not covered in this paper.

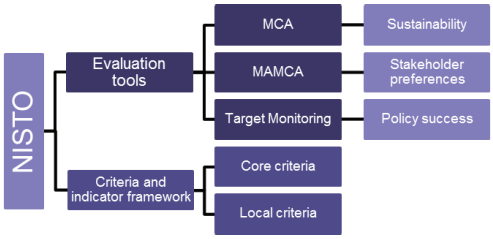

Fig. 1. Overview of the NISTO Evaluation Framework (source: own setup).

For the evaluation of the criteria we chose the PROMETHEE method developed by Brans (1982) because PROMETHEE offers advantages in terms of avoiding trade-offs between scores on criteria and simplifying the evaluation procedure (De Brucker *et al.*, 2004). PROMETHEE has also the advantage that indicator values can be entered irrespective of their dimension and both quantitative and qualitative indicators can be used.

Table 1. The 16 NISTO core criteria, grouped under the three pillars of sustainability, with the aggregated weights (in brackets) from 93 governmental representatives in North-West Europe.

Economy (0.33)	Environment (0.33)	Society (0.33)
Economic activity (0.21)	Land consumption (0.20)	Safety (0.20)
Cost effectiveness (0.24)	Greenhouse gas emissions (0.21)	Security (0.11)
Reliability and travel time (0.31)	Air quality (0.22)	Health of citizens (0.16)
Public funding of transport (0.24)	Resource use (0.20)	Liveability (0.18)
	Noise (0.17)	Equity (0.13)
		Socio-political acceptance (0.09)
		Accessibility for people with special needs (0.13)

Stakeholder preferences are appraised through the MAMCA methodology. It is based on assessing the evaluation criteria of the different stakeholder groups rather than appraising the project based on a set of criteria agreed on with all stakeholders at the beginning of the process (Macharis *et al.*, 2012). For a more objective comparison of the evaluation outcomes between MCA and MAMCA and to ease the classification of MAMCA criteria into the sustainability pillars we considered limiting the choice of stakeholders' criteria to the core criteria identified for the MCA (Table 1). This, however, turned out to be a significant limitation given the large variety of transport and mobility projects, stakeholders and their objectives. Therefore, in this research, stakeholders were offered an initial list of criteria (the NISTO core criteria; see Table 1) to choose their own criteria from, but the addition of project--specific criteria was also allowed to reflect local circumstances and specific project objectives.

Similarly to the MCA, we applied the PROMETHEE methodology for the evaluation of the alternatives. The MAMCA evaluation is carried out with custom criteria weights that are always elicited by the stakeholders themselves. Guidelines for weight elicitation are, however, not integrated into PROMETHEE, so it is up to the decision analyst to choose an appropriate method (Turcksin *et al.*, 2011a). Macharis *et al.* (2004a) suggest that a combination of AHP for weighting and PROMETHEE for evaluation can benefit from the advantages of both methodologies. Therefore, the NISTO framework combines pairwise comparisons of criteria for the weight elicitation and evaluation by PROMETHEE integrated in a software tool (NISTO toolkit). For PROMETHEE we used the V preference function and a preference threshold equal to the difference between the largest and the smallest indicator value assuming that the decision maker considers even the smallest difference in the indicators relevant. The identification of and data collection for indicators is carried out the same way as for the MCA. Alternatives are evaluated separately for each stakeholder group.

The main outputs of the MAMCA are the sets of criteria selected by the stakeholders (one discrete set for each stakeholder group), the weights of these criteria based on the stakeholders' ratings and the final ranking of alternatives. In MAMCA, the rankings of the stakeholder groups are not aggregated, so there are as many discrete rankings as

stakeholder groups. In this paper, these outputs will be compared to the outcome of the corresponding elements of the sustainability assessment (sustainability criteria, weights, ranking).

4. Case study description

We applied the NISTO evaluation framework in a real-world evaluation exercise to appraise alternative super cycle highways between the cities of Waalwijk (population: 46,500) and Tilburg (population 206,000) in the province of Noord-Brabant in the Netherlands. In consultation with the region Hart van Brabant (part of the province of Noord--Brabant), five alternatives were defined for the approximately 14 kilometers of cycle path (in addition to the business as usual). The alternatives differ in urban and natural environment, choices between level- and split-level junctions and infrastructural design (width, curves, lighting, pavement choices). Alternatives A and A- follow the same route via the village Kaatsheuvel (population: 16.000) where alternative A has split level junctions while alternative A-level has level junctions. Second, alternative B and B1 pass through a national park creating a fast direct connection between the two main cities and the village Loon op Zand (6.075) where alternative B1 has an additional link connecting the super cycle highway to an existing cycle network and the most famous themepark in the Netherlands, Efteling. Finally, alternative C is less direct but connects the cities as well as the two villages and therefore it would potentially attract more cyclists.

Table 2. The characteristics of the alternatives appraised.

Alternative	Municipalities to be connected	Type of land use	Level of service (infrastructure)
A	Waalwijk, Kaatsheuvel, Tilburg	Urban environment, rural environment, industrial area, Efteling theme park	Split level junctions
A-	Waalwijk, Kaatsheuvel, Tilburg	Urban environment, rural environment, industrial area, Efteling theme park	Level junctions
B	Waalwijk, Loon op Zand, Tilburg	Urban environment, Efteling theme park, natural environment (national park)	Level junctions
B1	Waalwijk, Loon op Zand, Tilburg	Urban environment, Efteling theme park, natural environment (national park), Efteling theme park	Level junctions + additional split level junction
C	Waalwijk Kaatsheuvel Loon op Zand Tilburg Loon op Zand	Urban environment, rural environment, Natural environment, industrial area, Efteling theme park	Level junctions + additional split level junction

As a first step of the evaluation, the following stakeholder groups for the specific problem were identified:

- Citizens: citizens living in the area between the “five big cities” in Noord-Brabant (Breda, Tilburg, ‘s Hertogenbosch, Eindhoven & Helmond) who are potential users of the new infrastructure were represented by members of lobby and pressure groups.
- Government: Three types of governments were defined. Members of the national, provincial or regional government formed the first group, governmental representatives from the “big 5 cities” were part of the second group and the third group consisted of representatives from local municipalities.
- Public transport operator: a private operator who operates regional services, under concession from the regional government.
- Employers: companies and public employers in the Tilburg – Walwijk area (hospital, amusement park, furniture company and the coordinating firm for employers in an industrial site near Waalwijk)

Potential objectives and corresponding criteria were identified for each stakeholder group based on the knowledge of local experts. These initial ideas were then compiled into an online questionnaire. A workshop was organized in ‘s Hertogenbosch on 03/12/2014 to finalise the list of stakeholder objectives and the derived evaluation criteria and to collect the weights for each criterion. Stakeholders who were invited to the workshop were requested to fill in an online questionnaire to validate their objectives and propose additional ones. The final list of objectives was converted into criteria Table 3.

At the workshop, participants carried out an interactive weighting of their criteria using AHP pairwise comparisons in the newly developed online NISTO toolkit software. The weighting was carried out in groups of 3 and the results were aggregated using the arithmetic mean to create an aggregated weight for the specific stakeholder group. Public transport operators and employers were not represented at the workshop (no one registered), therefore they were approached after the workshop by telephone.

In the next step, indicators were identified for the criteria and data was collected to estimate the impact of each alternative on each criteria both in the MCA and in the MAMCA. The core criteria for the MCA and stakeholders' criteria for the MAMCA largely overlapped (8 criteria) so most of the data collected could be used for both evaluations. Most of the indicators (air quality, greenhouse gas emissions, safety, noise, health of citizens) were estimated using a transport model. The transport model is a classic multimodal transport demand model, distinguishing between car, public transport and bicycle. The five alternatives were calculated as network scenarios to an already existing baseline situation of the region Midden-Brabant. The super cycle highway alternatives differ in travel time, and directness of route affecting travel speed. The result of the modal split and distribution models are five multi modal sets of origin-destination matrices. The direct results from the transport model are the increase and decrease of traffic volumes and accessibility levels, where, as an indirect effect, the shift from car and public transport to bicycle was translated into the indicators for air quality, noise, health of citizens, etc.

Other indicators like socio-political acceptance, accessibility and liveability were evaluated qualitatively by local experts. The values that were used in the evaluation are presented in Table 3.

Table 3. Indicator values for the MAMCA. (Econ=Economy, Soc=Society, Env=Environment) .

	Pillar	Weight	BAU	A	B	B1	C	A-
Citizens								
Air quality (BAU=1)	Env	0.38	1	0.966	0.981	0.98	0.976	0.986
Noise (BAU=1)	Env	0.23	1	0.982	0.989	0.989	0.987	0.992
Equity (BAU=1)	Soc	0.16	1	1.008	1.005	1.005	1.006	1.003
Health of citizens (modal share of active travel modes in %)	Soc	0.23	0.49	0.5056	0.4988	0.499	0.5008	0.4965
Government								
Air quality (BAU=1)	Env	0.19	1	0.966	0.981	0.98	0.976	0.986
Noise (BAU=1)	Env	0.34	1	0.982	0.989	0.989	0.987	0.992
Health of citizens (modal share of active travel modes in %)	Soc	0.27	0.49	0.506	0.499	0.499	0.501	0.497
Socio-political acceptance (qualitative*)	Soc	0.19	0	2	-1	-1	1	1
Public transport operators								
Cost effectiveness of public transport operation (Number of passengers on bus services)	Econ	0.68	28,200	27,567	27,843	27,833	27,760	27,937
Public funding of transport (level of public funding to operate bus services) (qualitative*)	Econ	0.07	0	0	0	0	0	0
Accessibility of stops (qualitative*)	Soc	0.26	0	3	2	1	2	1
Employers								
Economic activity (no. of jobs in the region)	Econ	0.26	23,675	23,734	23,713	23,714	23,720	23,699
Accessibility (qualitative*)	Soc	0.33	0	2	2	2	2	1
Health of employees (modal share of active travel modes in %)	Soc	0.28	0.49	0.5056	0.4988	0.499	0.5008	0.4965
Liveability (qualitative*)	Soc	0.12	0	1	1	1	1	1

* Qualitative scale between very negative (-3) and very positive (3).

The first indication of the sustainability of the stakeholders' preferences comes from the choice of evaluation criteria. In the first column of Table 5, we have indicated the sustainability pillars that correspond to each stakeholder criteria. The distribution of the stakeholders' criteria shows that none of the stakeholder groups has a balanced distribution of criteria in terms of the three sustainability pillars (Table 4). Societal criteria are overrepresented and are present for each stakeholder group, while economic criteria are only present for the public transport operator and the employers; environmental criteria were selected by only by the citizens and the government. Apart from the specific preferences of the stakeholders, another reason for the imbalanced distribution of criteria is the limited number of criteria for each group. For practical reasons, in order to decrease the burden on the participants, the maximum number of criteria for each stakeholder group was limited to five.

Table 4. Aggregated number and weights of the stakeholders' criteria.

Pillar	Number of criteria	Aggregated weight*	MCA**
Environment	4	1.14	1.33
Economy	3	1.00	1.33
Society	8	1.85	1.33
Total	15	4	n.a.

* The values do not add up to 4 due to rounding.
** These are the weights of each pillar if the aggregated weights of criteria under each pillar was equal.

The second indication of stakeholder preferences in terms of sustainability is the aggregated weight of their criteria grouped under the three pillars across all stakeholder groups. In Table 4, we aggregated the weights of all criteria selected by the stakeholders (the aggregate total equals 4 as there are four stakeholder groups). The table shows the distribution of the weights of the stakeholders across the sustainability pillars. In our case, societal criteria received the highest weight, followed by the environment and the economy (Table 4). Compared to the distribution of weights if all pillars were equally weighted (see column MCA in Table 4), societal criteria are over- while environmental and economic criteria are underrepresented.

Thirdly, we compared the outcome of the evaluations of the MCA and the MAMCA. The MCA gives an overall ranking of the alternatives based on the evaluation of the alternatives on every core criterion (Figure 2). The graph shows that the Alternative A performs the best on almost all criteria except cost effectiveness (due to the investment cost) and land consumption (due to natural areas that will be sacrificed for the cycle path) therefore it is also the first in the overall ranking. There are a few criteria, which were not relevant for the evaluation because the project does not have any impact on them (reliability and travel time, resource use, accessibility for people with special needs, security). These criteria were treated as if the alternatives had the same (zero) impact on them.

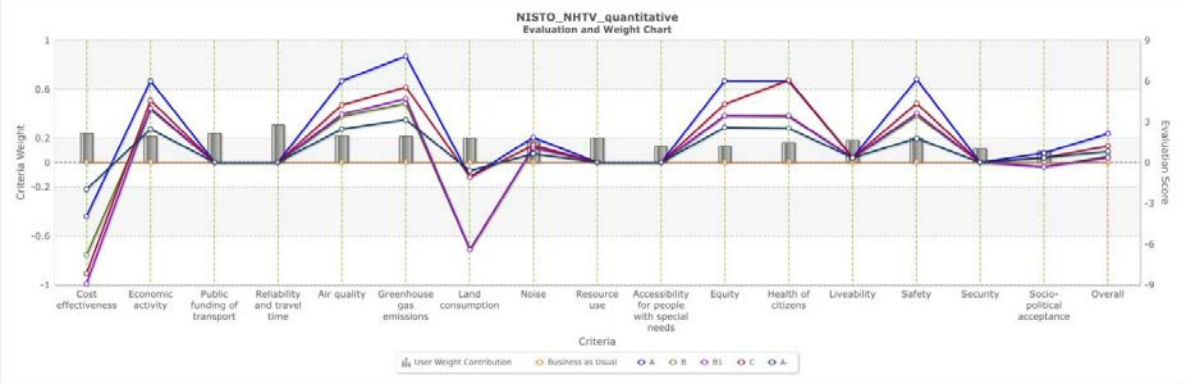

Fig. 2. Performance of the alternatives on the MCA core criteria and overall sustainability ranking. The performance of the business as usual alternative is always zero (source: NISTO Toolkit – www.nistotoolkit.eu).

The output of the MAMCA is the multi-stakeholder view displaying the preference scores of each stakeholder group but no overall ranking (Figure 3). Here also Alternative A performs best for three out of the four stakeholder groups (citizens, government, employers), while public transport operators would prefer the business as usual as better cycling infrastructure would mean a 3.3% modal shift form public transport to cycling according to our modelling results therefore a loss of revenues.

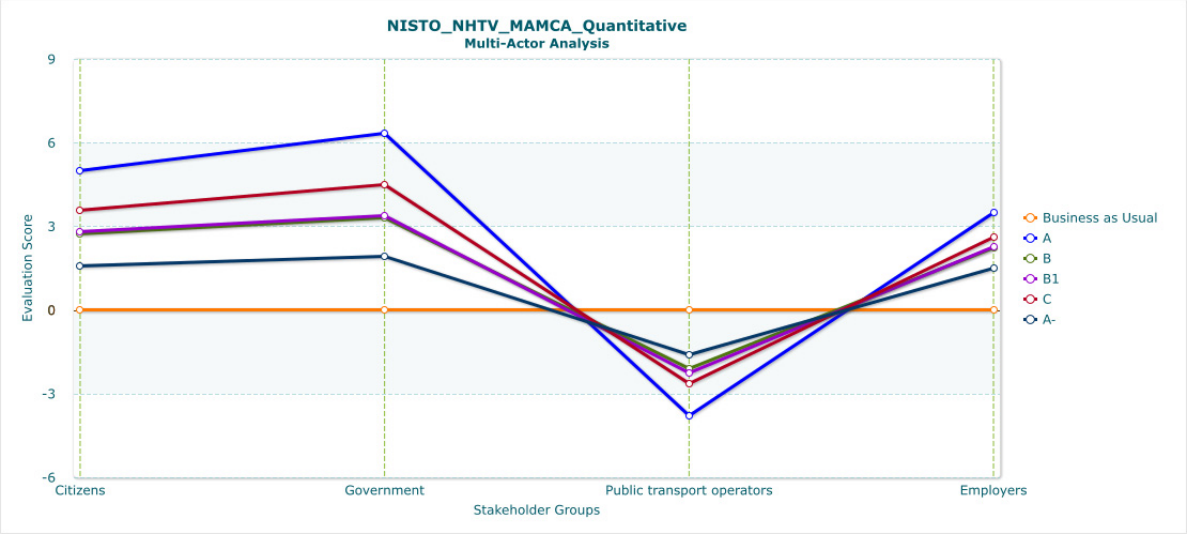

Fig. 3. Multi-stakeholder view of the MAMCA evaluation. The performance of the business as usual alternative is always zero (source: NISTO Toolkit – www.nistotoolkit.eu).

We compare the preference rankings of the stakeholder groups (MAMCA) and the sustainability assessment (MCA) in Table 5. If we assume that the outcome of the MCA is a reflection of sustainability, we can determine how the preferences of the stakeholders compare to the sustainability rankings. According to Table 5, none of the stakeholder groups has exactly the same preferences as the outcome of the MCA. There is, however an agreement in terms of the best (A) and worst (BAU) alternatives in three out of the four stakeholder groups, which is also reflected in the MCA evaluation. The only exception is the group of the public transport operators, which has a low preference for all cycle path alternatives favouring the business as usual since increasing cycle travel would decrease public transport patronage and hence profitability.

Table 5. Comparison of the ranking of the alternatives by the MCA and by the stakeholder groups in the MAMCA.

Alternatives	MCA	MAMCA			
		Citizens	Government	Public transport operators	Employers
BAU	6	6	6	1	6
A	1	1	1	6	1
B	4	4	3	3	4
B1	5	3	2	4	3
C	2	2	4	5	2
A-	3	5	5	2	5

5. Discussion and conclusions

This paper investigated how stakeholder preferences and sustainability scores can be compared in the evaluation of mobility and transport projects. We have compared the evaluation outcomes of the sustainability assessment (MCA) and the stakeholder evaluation (MAMCA) of alternatives for a cycling path between the Dutch cities of Tilburg and Waalwijk. For the simultaneous evaluation of sustainability and stakeholder preferences, we proposed the NISTO evaluation framework that combines a multi-criteria analysis based on a set of core criteria and fixed weights for the sustainability assessment and the multi-actor multi-criteria analysis appraising stakeholders' preferences for each stakeholder group separately. The framework provides a tool to assess how alternatives ranked high by the individual stakeholder groups score for sustainability in general.

The results of the comparison show that stakeholder preferences are biased towards one or two of the sustainability pillars (economy, environment, society) in three ways. The selection of the criteria of the stakeholder already indicates a preference. Stakeholder criteria may be balanced towards one or two of the pillars especially if the choice of criteria is limited to just a few. Secondly, since each stakeholder group can weight their own criteria in the MAMCA methodology, they can express further preferences towards one or the other sustainability pillars. Finally, the ranking of the alternatives, which is based on the weights and the evaluation of the impact of the alternatives on each criteria indicate preferences towards less or more sustainable alternatives indicated by the MCA. These differences highlight the need for an evaluation that integrates sustainability assessment and the evaluation of stakeholder preferences. In this manner, decision makers can consider sustainability and stakeholder preferences side-by-side.

The simultaneous application of the sustainability assessment (MCA) and the assessment of stakeholder preferences (MAMCA) can contribute to better decision making, especially in the earlier phases of project development when detailed data is not yet available about the impact of the alternatives (sifting phase). The MCA would then highlight alternatives with the best contribution to sustainability, while the MAMCA can indicate the stakeholder support for those alternatives. If there is no consensus among the stakeholders about the best alternatives and if the alternatives ranked high by the stakeholders are not sustainable, the decision maker may decide to adjust the alternatives to make them more sustainable and potentially more supported by stakeholders. Alternatively, a negotiation can be initiated between the stakeholders and the decision maker to find a compromise in terms of stakeholder support and sustainability. The proposed approach has the advantage that it does not only consider economic criteria or factors that can be monetised (like in a cost-benefit analysis), but it provides a balanced assessment of the economic, environmental and social impact of the proposed alternatives. At the same time, the impact on stakeholders can also be considered.

The results presented above, however, have some limitations. The sustainability assessment does not give a yes--or-no answer to the question if an alternative is sustainable or not as suggested by Pope *et al.*, (2004). It only gives an indication of the ranking of the alternatives in terms of their sustainability. In addition, the sustainability assessment attaches equal weights to the three pillars. This may be debated as claimed by Joumard and Nicolas (2010), who advocate a hierarchical preference for environment, social and economic issues, in this order of preference. Finally, the weights of the sustainability criteria in the MCA were determined by a limited survey of governmental policy makers in Belgium, the UK, France, Germany and the Netherlands. Therefore, the validity of these weights is also limited in terms of geographic and cultural scope and representativeness to each country.

The distribution of stakeholders' criteria and criteria weights across the sustainability pillars may depend on the choice and type of stakeholders (e.g. private, public) and the type of the project evaluated (infrastructure, soft measure). Therefore, further research is needed to compare the evaluation of different types of measures.

The qualitative evaluation applied for some of the criteria may be subjective and it can substantially influence the outcome of both the MCA and the MAMCA. The same applies to the setting of the preference function of the PROMETHEE methodology. By setting the threshold to the greatest possible difference between any two criteria indicators, we assume that the smallest difference between the indicators is relevant for the decision maker. However, this difference can be negligible at the scale of a city or a region. It is then the task of the decision maker to decide if the change is relevant and if it should influence the ranking through the adjustment of the preference threshold.

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