Sustainability Benefits Assessment in Urban Transport Project Appraisal: A New Method of Transport Project Appraisal

Somesh Sharma and Harry Geerlings

Abstract Transport project appraisal is an important tool in complex decision making. It helps in comparing options and prioritizing between competing choices. It can also influence the distribution of financial resources across various projects that are often executed from common sources of funding. Many important decisions taken during the development of a transport project critically rely upon estimates resulting from the project appraisal process. Most widely used appraisal methods are project based such as cost-benefit analysis (CBA), multi-criteria analysis (MCA) and environmental-impact assessment (EIA). For the appraisal of certain types of macro-level transport projects strategic appraisal methods like strategic environmental assessment (SEA) are also applied. Each of these methods has its own limitations and shortcomings which have not improved over time. In this position paper, we present a new methodological approach to transport project appraisal. This approach is based on a systematic assessment of sustainability benefits of a project, hence this approach is named Sustainability Benefits Assessment in Urban Transport Project Appraisal (SBA-UT). The approach has evolved from an in-depth review of the scientific literature about technical constructs and applications of various project appraisal methodologies used for transport project appraisal.

Keywords Urban transport · Project appraisal · Sustainability benefits · Assessment methodologies and techniques

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1 Introduction

Transport is one of the key factors that influence urban growth. The decrease of cost and travel time for transport has made cities more accessible. But this has a trade-off with sustainable development and congestion (Piet and Bruinsma 2015). Transport infrastructure is strongly correlated with urban areas; society is dependent on accessibility. Thus, any kind of intervention or changes in the transport system directly affects social, economic, and environmental aspects of the society.

Urban transport plans are the reflection of a city's spatial development strategy (ADB 2009). From this perspective, it is important that the decision making process in urban transport sector should be based on comprehensive assessment of the social, economic, and environmental impacts of transport-sector interventions. Project appraisal provides useful information for gated decision making for project implementation phases, allocation of resources, and project timelines. It also indicates risks, critical barriers, and opportunities for optimization and improving the effectiveness of efforts. Institutionally, the significance of project appraisal can also be understood as a part of communication strategy, as well as a means of introducing transparency to, and justification for, public investment projects.

This chapter is based on a systematic review of selected literature on transport project appraisal. In Sect. 2 of this chapter, we analyze various challenges with widely applied methodologies in transport project appraisal. Section 3 shows to what extent existing project appraisal methodologies can help in justifying a decision. In Sect. 4 of this chapter, we present the new methodological approach Sustainability Benefits Assessment in Urban Transport Project Appraisal (SBA-UT), which we have derived from lessons learned from the literature. This paper concludes with a theoretical discussion on positioning SBA-UT in the project appraisal process.

2 A Systematic Review of Urban-Transport Project Appraisal and Sustainability

Project appraisal is a process tool that guide governments and investors in making choices for achieving their goals (DIRD 2014). Most often transport projects are appraised primarily for examining the financial viability and economic profitability of various options (Sartori et al. 2014). However, in order to operationalize sustainability, it is imperative to identify comprehensive as well as collective effects of a project on three interrelated systems: the economic system, the ecological system, and the social-cultural system (Sharma and Geerlings 2015). The text below provides a comprehensive review of (successfully) applied methods in transport project appraisal and the challenges of these methods when it comes to a comprehensive assessment for sustainable development.

2.1 Cost-Benefit Analysis

Cost–benefit analysis (CBA) is primarily used at the stage of the assessment of options and project prioritization. A cost-benefit analysis process is primarily based on the concepts of opportunity cost from a long-term perspective. The CBA process is carried out with a set of pre-determined indicators where each indicator is associated with a positive or negative monetary value and is broadly applied to the transport sector (EIB 2013). It is a typical macro-economic approach that is meant to help assessing the welfare benefits to the society represented by economic indicators (Sartori et al. 2014).

A cost-benefit assessment is essentially limited to only those costs and benefits that could be converted into monetary values. In CBA uncertainties mainly arise from the fact that—(1) it is not possible to measure all benefits of a project accumulating over the entire life of the project; and (2) all benefits are not measurable in monetary terms. Estimating benefits of a project over its useful life are difficult to predict because factors on which benefits depend are highly dynamic (Iacono and Levinson 2015). The cost-benefit cost method is sensitive to assumptions. Quantities used, such as the discount rate, are very sensitive to local conditions, and local conditions can change frequently. These induced changes bring several benefits which are not captured in cost-benefit method. Cantarelli and Flyvbjerg (2015) in their study concluded that the main sources of error in CBA are—(1) technical limitations; (2) psychological reasons; and (3) political-economic reasons. Of these three factors, errors in cost estimates pertain to technical limitations, and this has not improved over time (Cantarelli and Flyvbjerg 2015).

2.2 Multi-criteria Analysis

Multi-criterion analysis (MCA) is a decision-making tool that involves several qualitative and quantitative criteria (Hüging et al. 2013) under a common framework of analysis, which considers the relative importance of each criterion (Mendoza et al. 1999). This approach involves the development of a composite score for each project alternative (Schutte and Brits 2012), based on the relative weight and score given to each criterion. The weights and scoring of criteria are based on analytical calculations complemented by the judgment of stakeholders and experts involved in the analysis. The use of multi-criteria analysis in transport project evaluation is considered since there is always a conflict in regard to the impacts of the project (Schutte and Brits 2012) from the perspective of various stakeholders concerned. The primary advantage of MCA over CBA is that it enables inclusion of impacts that cannot be monetarized or cannot be quantified easily in an appraisal (Gühnemann et al. 2012).

A general criticism of MCA is that it is less objective and that there is an inevitable element of subjectivity involved in assigning weights and rankings to different criteria (Gühnemann et al. 2012). The weights are assigned by decision makers' preferences, thus it often appears arbitrary (OECD 2011). That also makes it difficult to replicate a MCA framework from one case to another. In many EU countries, the national appraisal framework for transport infrastructure projects mandates a CBA and (or) MCA (Hüging et al. 2014) with majority applying only MCA (Odgaard 2006; Hüging et al. 2014). Both CBA and MCA are popular applied tools in transport project appraisal, but it can be concluded that neither CBA nor MCA is holistic.

2.3 Environmental Impact Assessment

Environmental Impact Assessment (EIA) can be explained as a systematic assessment of the effects of a proposed project, plan, or program on the environment (Ogola 2009). EIA's key proximate aim of 'providing environmental information' is to enable rational decision making by taking into consideration the likely environmental impacts of different alternatives to a project (Stephen et al. 2007). The EIA was established in 1970 in the USA under the National Environmental Policy Act (NEPA), and is currently practiced in more than 100 countries (Stephen et al. 2007). All major investment banks and bilateral financial institutions recommend a mandatory EIA for all infrastructure projects requiring more than a certain amount of investment. In many countries, EIA is adopted as a national-policy instrument, and it is mandatory to conduct an EIA for major infrastructure projects to obtain project acceptance (Ogola 2009).

The effectiveness of EIA in decision making has increasingly been challenged (Owens et al. 2004; Stephen et al. 2007). The objectivity of EIA is considered to be limited because, in an EIA, impacts are not calculated in monetary terms and this leaves room for bias in decision making as the decision-makers are usually operating within a political arena (Stephen et al. 2007). The transport sector is considered to be one of the biggest emission sources of substances that cause environmental damage like acidification and eutrophication of soil, contamination of water, and direct harm to vegetation (Rolf and Linda 2000). In the transport sector, environment impact assessment (EIA) is typically only applied at the individual project level and less frequently to wider policies, plans, or programs. As a consequence, the consideration of environmental effects is conducted at a local level (Niel and Steer 1996). Niel and Steer (1996) highlighted sever limitations of EIA applied to the transport sector, concluding that EIA can only be applied to short time-scale projects and that it excludes many important aspects in appraisal, such as cumulative effects of various phases of a project.

2.4 Strategic Environmental Assessment

Therivel et al. (1992) defined SEA as "the formalized, systematic and comprehensive process of evaluating environmental impacts of a policy, plan or program and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the findings in publicly-accountable decision making" (Niel and Steer 1996). SEA is a more comprehensive assessment as compared to EIA, and most researchers have recommended making SEA a more flexible process (Jong and Geerlings 2004). The National Environment Policy Act (NEPA) in the USA laid the foundation for SEA in 1969, and the term SEA was coined in the UK in 1989. Since 2004, SEA is a mandatory requirement in EU member countries. SEA is more specifically applied in transport and land-use planning sectors (Ehrhardt and Nilsson 2012). Application of SEA varies from sector to sector and from case to case. While executing an SEA, specific methodologies have to be adopted to capture different stages of the process. An SEA can contain applications of several analytical tools in the process of execution. SEA can be considered as a systematic process tool rather than a precise analytical methodology.

Based on a review of 'Sustainability A-test', Ehrhardt and Nilsson (2012) concluded that SEA barely assesses cross-cutting sustainability aspects. On the contrary, an SEA is expected to be an integrated appraisal of a wider range of sustainability aspects. Furthermore, assessment of cumulative impacts is almost non-existent in SEA. There is a lack of explicit guidance on tool use within the framework of overall SEA guidance. There is a need for improved guidance for SEA and for strengthening the use of tools.

2.5 Multiple-Benefits Assessment

In the recent study 'Climate Smart Development', supported by the World Bank in 2014, there was an emphasis on the integrated assessment of the benefits of green-growth projects. The analytical framework termed as 'multiple-benefits assessment (MBA)' presented in the study provides a four-step set for the assessment of socio-economic benefits that may accrue from low-carbon development policies and projects. The framework attempts to integrate multiple benefits into a macroeconomic model. It demonstrates the additional benefits that can accrue in terms of GDP and employment as the benefits flow through the economy (Akbar et al. 2014). The methodology was applied to seven cases out of which three cases demonstrated multiple benefits from low-carbon policies and four cases demonstrated multiple benefits from developmental projects.

The MBA approach is an attempt to link the benefits of carbon-emission reduction with the local socio-economic benefits of a low-carbon development project. There is a great emphasis on monetization of the benefits. Conceptually, this approach is based on the theories of macroeconomics rather than the theories of sustainable development. Assessment of sustainability benefits requires a new approach that can help in explaining the process of sustainable development from a socio-economic perspective at all levels of interaction between societal systems and natural systems (Sharma and Geerlings 2015).

3 Findings from the Literature

There are several challenges involved in quantification and assessment of all benefits of an urban transport intervention. Benefits of a project can accrue at individual level, local community level or at global level. Different levels and different types of benefits cannot be estimated using a single calculus or econometric method. Currently, there is no standardized method available for assessing all relevant costs, benefits and overall impacts of urban transport projects, which affects the reliability of existing assessments, the comparability of results, and the transferability of measures (Hüging et al. 2014).

Based on the review of various project/appraisal methodologies applied to the transport sector in Sect. 2 of this chapter, it can be concluded that among all the appraisal methodologies, CBA is the most widely applied and is most successful as far as the transport sector is concerned. As seen in the literature, several methods and tools for transport project appraisal were discussed by different authors, however every author has tried to compare other appraisal method with the CBA. It indicates the success, popularity, and prominence of CBA among numerous project-appraisal methodologies. It is also proven that the amount of uncertainty involved in cost-benefit analysis is huge and estimates are often incorrect. In spite of that, CBA is adopted as a mandatory procedure in many advanced countries. It shows the lack of robust and flawless assessment methods and also that only a very limited level of accuracy can be achieved in estimating the impacts of a project. Yet project appraisal is unavoidable in investment projects. Moreover, in review of all the appraisal methodologies, it was evident that decision making using project appraisal is highly sensitive to political considerations.

EIA can be considered as yet another successful method of project appraisal which has a long history of application. However, the main role of EIA is to assess the environmental impacts of transport-sector policies, plans, and projects. As a tool for sustainability assessment, EIA is inadequate because, over and above its intrinsic technical limitations, it provides information about only one pillar of sustainability (environment).

4 Sustainability Benefits Assessment for Transport Project Appraisal

This section presents a new approach for urban-transport project appraisal. The approach is based on benefits assessment (SBA) of transport projects, and in this chapter it is referred to with an acronym SBA-UT. Underlying the concept in the SBA-UT approach is the triple bottom line (TBL) concept of sustainable development,[1] which is also the most widely accepted concept of sustainable development. Operational framework of the methodology can be visualized as an instrument that can help in a systematic appraisal of social, economic, and environmental benefits of transport sector at various scales (individual, local, and global). Sustainability is a sate, but sustainable development is a process of change (Sharma and Geerlings 2015). The model SBA-UT framework (Fig. 1) integrates the three pillars of sustainability (social, economic, and environmental) with the process of transition to sustainable development. The SBA-UT approach assumes that improvements in social, economic, and/or environmental conditions at any level of the societal hierarchy (individual, local, and/or global) is a sustainability benefit which aggregates to overall sustainable development. One of the key postulates of SBA-UT framework is that the sustainability benefits of the transport sector (or a transport project) shall be accounted differentially at individual, local, and global levels.

The conceptual framework of SBA-UT (Fig. 1) portrays the path of how an intervention can lead to social, economic, and environmental improvements in a system. Point X_1 (Fig. 1) indicates the point of intervention, and the three levels (individuals, local community, global community) signify the distributary nature of the benefits. The underlying assumption is that a change in the transport sector of an area can bring a different nature of benefits at different levels of the societal hierarchy. However, all the benefits can be categorized in terms of social, economic, or environmental benefits. The SBA-UT framework implies that analytically benefits should be measured at the level where they accrue (individual, local, or global) and then can be aggregated (represented by point X_2 in Fig. 1).

4.1 *Operationalizing the SBA-UT Framework*

The SBA-UT methodology follows a scenario-based approach in which two scenarios are created—(1) Pre-project scenario representing the situation before intervention; and (2) Post-project scenario, representing the situation after intervention. The first scenario (pre-project) shall essentially be a fact-based scenario,

[1]In 1987, the World Commission for Environment and Development (WCED) introduced the triple bottom line concept of sustainable development in their report 'Our Common Future' (the Brundtland Report (WCED 1987)).

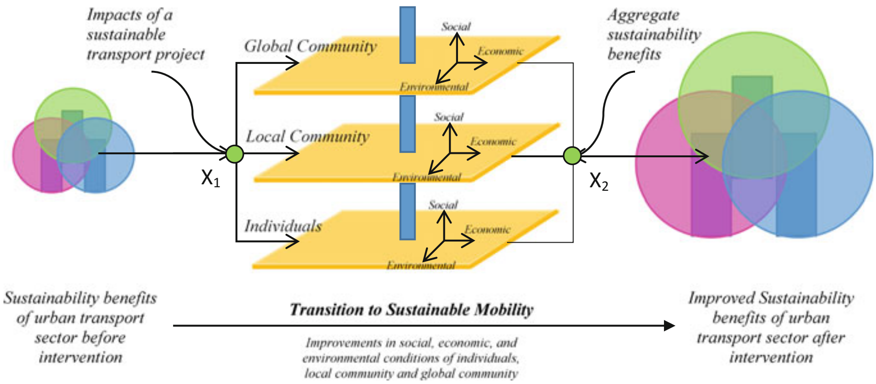

Fig. 1 The model SBA-UT framework for Urban Transport project appraisal (SBA-UT)

whereas the second scenario (post-project) can be predictive if the methodology is used for ex-ante appraisal. It is recommended that pre-project and post-project scenarios shall be created as a Geographical Information System (GIS) database. The advantage of using GIS-based scenario analysis is that mapping helps in measurement of physical as well as thematic quantities (Sharma and Geerlings 2015). Secondly, a GIS enables multi-layer analysis of several datasets which helps in bringing out insights that might remain unnoticed otherwise. A GIS is also the most suitable tool for analyzing temporal effects. After the first scenario (pre-project scenario) is created, a team of experts and stakeholders shall identify a set of (qualitative and quantitative) sustainability indicators that they find as most representative in the given context. The selection of indicators shall be done with the help of existing literature, the goals of the project, and situation analysis using pre-project scenario. It is important to define indicators in such a manner that they can be applied to the second scenario (post-project scenario). Thereafter, the short-listed indicators shall be classified into a 3 × 3 matrix with beneficiary categories (individual, local community, global community) in the column and types of impact (social, economic, environmental) in the rows. The matrix is termed as 'Sustainability Indicators Matrix' (Fig. 2). The sustainability benefits referred to in this framework may be defined as "the relative change in the value of sustainability indicators obtained by comparing pre-project and post-project scenarios". The difference in the value of each indicator is computed respectively in terms of percentage points, which are dimensionless numbers. After computing relative change in each indicator respectively, the values are presented in the form of 'Sustainability Benefits Matrix' (Fig. 2). The aggregation of indicator values in SBA-UT is similar to the process of MCA, however there is less subjectivity in SBA-UT as it does not involve assumption-based weighting of the criteria. A typical equation for calculating sustainability benefits is shown in the Fig. 2:

$$\begin{bmatrix} SISo_{ki} & SIEc_{ki} & SIEn_{ki} \\ SISo_{kl} & SIEc_{kl} & SIEn_{kl} \\ SISo_{kg} & SIEc_{kg} & SIEn_{kg} \end{bmatrix}_{[SI]_k} - \begin{bmatrix} SISo_{ji} & SIEc_{ji} & SIEn_{ji} \\ SISo_{jl} & SIEc_{jl} & SIEn_{jl} \\ SISo_{jg} & SIEc_{jg} & SIEn_{jg} \end{bmatrix}_{[SI]_j} = \begin{bmatrix} \Delta SISo_{i} & \Delta SIEc_{i} & \Delta SIEn_{i} \\ \Delta SISo_{l} & \Delta SIEc_{l} & \Delta SIEn_{l} \\ \Delta SISo_{g} & \Delta SIEc_{g} & \Delta SIEn_{g} \end{bmatrix}_{[\Delta SI]_{k-j}}$$

Where,
$[SI]_k$ = Sustainability indicators matrix for the post-project scenario
$[SI]_j$ = Sustainability indicators matrix for the pre-project scenario
$[\Delta SI]_{k-j}$ = Sustainability benefits matrix
SI = Sustainability Indicator; ΔSI = Relative change in the value of indicator (in percentage points)
So = Social; Ec = Economic; En = Environmental
j = Pre-project scenario; *k* = Post-project scenario
i = individual level; l = local level; g = global level

Fig. 2 Sustainability indicators matrix: a model equation for Sustainability Benefits Assessment using SBA-UT

In order to understand that the overall impact of an intervention will be relatively more on social, economic or environmental aspects the resulting matrix $[\Delta SI]_{k-j}$ can be further aggregated by applying a unit matrix multiplication function:

$$[1 \quad 1 \quad 1] \times \underset{[\Delta SI]_{k-j}}{\begin{bmatrix} SISo_{ji} & SIEc_{ji} & SIEn_{ji} \\ SISo_{jl} & SIEc_{jl} & SIEn_{jl} \\ SISo_{jg} & SIEc_{jg} & SIEn_{jg} \end{bmatrix}} = [\sum \Delta SISo \quad \sum \Delta SIEc \quad \sum \Delta SIEn_i]$$

Similarly, in order to visualize that an intervention will produce more benefits for individuals, the local community, or the global community, the transpose resulting matrix $[\Delta SI]^T_{k-j}$ can be aggregated as shown below:

$$[1 \quad 1 \quad 1] \times \underset{[\Delta SI]^T_{k-j}}{\begin{bmatrix} SISo_{ji} & SISo_{jl} & SISo_{jg} \\ SIEc_{ji} & SIEc_{jl} & SIEc_{jg} \\ SIEn_{ji} & SIEn_{jl} & SIEn_{jg} \end{bmatrix}} = [\sum \Delta SI_i \quad \sum \Delta SI_l \quad \sum \Delta SI_g]$$

4.2 Defining Sustainability Benefits and Methods for the Assessment of Benefits

Although there is no general agreement about the definition of sustainable transportation, there is consensus among many researchers that the concept of sustainable transportation is not about a 'technological fix' or merely physical conditions, but that it requires organizational challenges, socio-political change, and political willingness (Geerlings 1998; Banister 2008; Sharma and Geerlings 2015). Sustainability is an essentially contested notion; it is intrinsically complex, normative, subjective, and ambiguous (Kasemir et al. 2003; Rotmans 2006), and inherently context-specific (Grin 2004). However, in a transport-project appraisal framework based on benefits assessment, it is imperative to define the term 'sustainability benefits of transport projects'. Based on a review of several studies and scientific articles on costs and benefits of transport projects, we have adopted a definition of sustainability benefits. The discussion on defining sustainability benefits follows.

While analyzing literature on benefit assessment studies, we observed that benefits are measured as impacts. A transport project may have numerous effects on individuals as well as on society in general (Rabl and de Nazelle 2011). Improvements in transport systems and infrastructure may change our transportation behavior. For example, policies that discourage the use of private cars may result in increased commuting by bicycle and walking. Increased physical activity can bring significant benefits to our health and environment (Rabl and de Nazelle 2011). Reduction in use of motor vehicles may help in reducing local air pollution, specifically particulate matter as in reducing greenhouse-gas emission (Woodcock et al. 2009; Xia et al. 2015). A decrease in use of motor vehicles may also significantly reduce congestion and the risk of accidents (Woodcock et al. 2009). There are several indicators of benefits that have been operationalized in cost-benefit assessment of transport projects. However, in operationalization of SBA-UT, we emphasize more understanding the selection of benefit indicators rather than creating a fixed top-down list of indicators. When observed carefully in the literature, it can be seen that benefit is the quantity that was measured in terms of a defined indicator, e.g., reduced used of cars may lead to a reduction in congestion on roads (outcome), but the benefit is the cost saving on road accidents (impact). As an illustration, sustainability benefit indicators are summarized and presented in Tables 1, 2, 3 and 4. The benefit indicators (Tables 1, 2, 3 and 4) are compiled from a systematic review of nine selected recent articles. In each of the study authors have attempted benefits assessment of reduction in the use of private cars. The tables also provide the methods used for the benefits assessment[2] in their respective study.

From this literature review, we can learn that identification of benefit indicators can be based upon a cause-and-effect relationship that exists between outcomes of a project and associated impacts of each outcome, respectively. It can be clearly seen that all the authors have commonly associated all the benefits to the three outcomes of reduction in car use—(1) increase in physical activity (Table 1); (2) reduction in air pollution (Table 2); and (3) reduction in road congestion (Table 3). Most of the benefits related to each of these outcomes are also common among all nine articles,

[2]Within the method of benefits assessment as shown in Tables 1, 2, 3 and 4, respectively, authors have used very specific models and equations for the quantification of each benefit. We recommend that readers refer to the original studies for more detailed information on the methods used for benefits assessment.

Table 1 Benefits from increase in physical activity

Benefits indicators used	Method used for benefits assessment	Source
• All-causes mortality	System Dynamics Modelling (SDM); comparing baseline scenario with policy option scenarios	Macmillan et al. (2014)
• Burden of disease (males) • Burden of disease (females)	Integrated Transport and Health Impact Model (ITHIM); comparing business-as-usual (BAU) scenario for various countries	Thomas et al. (2015)
• All-cause mortality • Life expectancy	Health Impact Assessment (HIA); comparing BAU scenario with eight different scenarios of modal shift	Rojas-Rueda et al. (2012)
• Pre-mature deaths • Years of life lost • Years of living with disabilities • Disability adjusted life years	Comparative Risk Assessment (CRR); comparing baseline scenario and BAU scenario with different policy option scenarios	Woodcock et al. (2009)
• Deaths • Days-adjusted life years	Combination of Comparative Risk Assessment (CRA), Health Impact Assessment (HIA), air pollution models; comparing baseline scenario and BAU scenario with different policy option scenarios	Xia et al. (2015)
• Lifetime health gain benefits • Health gain benefits per year • Risk reduction • Life-expectancy gain	Health Impact Assessment (HIA); comparison of baseline scenario with different scenarios of modal shift	Rabl and de Nazelle (2011)
• Cardiovascular diseases • Dementia • Type 2 diabetes incidences • Breast cancer (women) • Colon cancer (women)	Health Impact Assessment (HIA); comparing BAU scenario with eight different scenarios of modal shift	Rojas-Rueda et al. (2013)

although different authors have used different methods for assessment. It shows that there may be more than one method relevant for the quantification of an indicator. All the methods were based on comparison of scenarios, which indicates that the measurement of benefits is preferably calculated as a relative quantity rather than as a gap or surplus when compared to a benchmark.

Table 2 Benefits from reduction in air pollution

Benefits indicators used	Method used for benefits assessment	Source
• Cardiovascular and respiratory hospitalization	System Dynamics Modelling (SDM); comparing baseline scenario with policy option scenarios	Macmillan et al. (2014)
• Travelers air pollution exposure • Public exposure to air pollution • Reduction in CO_2 emission	Health Impact Assessment (HIA); comparing BAU scenario with eight different scenarios of modal shift	Rojas-Rueda et al. (2012)
• Pre-mature deaths • Years of life lost • Years of living with disabilities • Disability adjusted life years	Comparative Risk Assessment (CRR); comparing baseline scenario and BAU scenario with different policy option scenarios	Woodcock et al. (2009)
• Deaths • Days adjusted life years	Combination of Comparative Risk Assessment (CRA), Health Impact Assessment (HIA), air pollution models; comparing baseline scenario and BAU scenario with different policy option scenarios	Xia et al. (2015)
• Damage cost due to particulate matter ($PM_{2.5}$)	Health Impact Assessment (HIA); comparing baseline scenario with different scenarios of modal shift	Rabl and de Nazelle (2011)
• Cerebrovascular diseases • Lower respiratory tract infections • Pre-term birth • Low birth weight • Cardiovascular diseases	Health Impact Assessment (HIA); BAU scenario with eight different scenarios of modal shift	Rojas-Rueda et al. (2013)

4.3 Consideration of Negative Impacts in SBA-UT

Theoretically, the impacts of a project may improve or deteriorate living conditions in an area. The positive and negative impacts of a project are treated separately in the SBA-UT framework. Where positive impacts are computed in terms of a sustainability benefits matrix (as explained above), the negative effects are given critical consideration and subjective attention. While applying SBA-UT in a transport-project appraisal, the negative impacts shall be identified in a similar manner as benefits, i.e., from the analysis of a baseline scenario, experts' intervention, and stakeholders' involvement. The list of identified potential negative impacts shall be categorized within a similar 3 × 3 matrix. It may not be necessary to create indicators and compute values for the potential negative impacts of the project, although it can be done if needed, depending upon the availability of resources. However, the systematic information about potential negative impacts

Table 3 Benefits from reduction in road congestion

Benefits indicators used	Method used for benefits assessment	Source
• Injury per 1000 cyclists • Number of car-occupant fatalities	System Dynamics Modelling (SDM); comparing baseline scenario with policy option scenarios	Macmillan et al. (2014)
• Pre-mature deaths • Years of life lost • Years of living with disabilities • Disability-adjusted life years	Comparative Risk Assessment (CRR); comparing baseline scenario and BAU scenario with different policy option scenarios	Woodcock et al. (2009)
• Deaths • Days-adjusted life years	Combination of Comparative Risk Assessment (CRA), Health Impact Assessment (HIA), air pollution models; comparing baseline scenario and BAU scenario with different policy option scenarios	Xia et al. (2015)
• Cost saved on fatal accidents	Health Impact Assessment (HIA); comparison of baseline scenario with different scenarios of modal shift	Rabl and de Nazelle (2011)
• Minor injuries • Major injuries	Health Impact Assessment (HIA); BAU scenario with eight different scenarios of modal shift	Rojas-Rueda et al. (2013)

Table 4 Benefits from the combined effect of all three outcomes of a project reducing use of cars for commuting (increase in physical activity, reduction in road congestion, and reduction in air pollution

Benefit indicators used	Method used for benefits assessment	Source
• Accidental deaths • Years of life lost • Years living with disabilities • Disability adjusted life years	Integrated Transport and Health Impact Model (ITHIM); comparing BAU scenario with policy option scenarios	Maizlish et al. (2013)
• Disease burden • Disability adjusted life years • Reduction in CO_2 emissions	Integrated Transport and Health Impact Model (ITHIM); comparing baseline scenario with policy option scenarios	Woodcock et al. (2013)

shall be collected through a series of consultations with stakeholders and users. Unlike other appraisal methods, the SBA-UT framework does not calculate a mathematical measure for the difference between positive impacts and negative impacts of a project. In the SBA-UT framework, the negative-impacts matrix serves as the approval mechanism rather than as a cumulative factor.

4.4 Application of SBA-UT Methodology

The SBA-UT methodology is a framework tool. The scope of potential applications of SBA-UT is much more similar to strategic tools like SEA, rather than for project-based appraisal tools such as CBA or EIA. Institutionally, SBA-UT can be adopted at national, regional, or local levels for evaluating policy, plans, or projects. Some of the potential applications of SBA-UT are briefly described next.

Project Appraisal: The SBA-UT can play a role in measuring the level of sustainability achieved at different points in time during the process of transition. The very specific advantage of SBA-UT methodology over other appraisal methods is that it provides a single framework for a comprehensive accounting of social, economic, and environmental benefits. In principle, SBA-UTS can be applied as an *ex-ante* methodology for the appraisal of proposed transport policies, projects, and plans. It can also be applied as an *ex-post* methodology for auditing. When SBA-UT is applied for a project appraisal, it will not require a supplementary framework for monitoring, reporting, and valuation (MRV) of the project outcomes.

Decision Making: The assessment of benefits or impacts of transport projects using SBA-UT can provide much more elaborate and systematic information to the decision makers at all levels of governance. The multi-level and multi-dimensional analysis of benefits can play an important role in decision making at different stages of project planning and implementation. It provides an evidence-based approach in decision making for project prioritization and phasing for project implementation.

Awareness Creation: The results of SBA-UT support easy visualization of the impacts of a project at various levels, which can help in explaining sustainability benefits of a project to the stakeholders and users. There is a high potential for the SBA-UT to serve as an effective tool for awareness creation. Since the paradigm of project appraisal is already shifting towards considering multiple benefits and co-benefits of a project, the mainstream introduction of SBA-UT will create new opportunities for research and innovations in related fields.

Financing Sustainable Transport Projects: There is an urgent need for integrated national, regional, and local urban planning that can ensure sustainable financing and support sustainable infrastructure development (World Bank 2015). The SBA-UT methodology provides an integrated assessment of local, regional, and global level outcomes of a project and much more elaborate and objective information to the investors that they can use for making their investment decisions.

4.5 Discussion

Some challenges in operationalization of SBA-UT may arise due to the complex nature of concepts involved in the framework. Benefits of a project can be observed at primary, secondary, and tertiary levels, or in the form of direct benefits and indirect benefits. Thus, the challenge is in finding a way to illustrate sustainability benefits with an orientation towards the process of governance. The application and institutionalization of SBA-UT can be greatly facilitated with an inventory of well-defined sustainability indicators. However, it would require extensive research and effort to create such an inventory of indicators. MCA has the similar challenge that there is no standard list of criteria that can be applied in every MCA, although, in the case of CBA, there are standard defined indicators (but that make CBA limited and exclusive). Functional advancement of SBA-UT can be discussed from the point of view of whether SBA-UT should be developed as a strict and exclusive methodology like CBA or if the effort shall be invested to evolve it into a more inclusive methodology like MCA.

The unique strength of the SBA-UT approach is that it highlights issues for the local governance without excluding issues in the larger context (Sharma and Geerlings 2015). However, operationalization of the methodology, along with strong technical skills, will require detailed sets of information and knowledge about the local area in context. Greater application of appraisal methodologies parallels the case of public investments. The application of CBA, EIA, MCA, and MRV frameworks require involvement of external experts because public agencies have limited in-house capacity and technical knowledge about conducting a project appraisal. It might be questionable whether the target users of SBA-UT will have enough technical capacity to adopt a new appraisal methodology or if the capacity-building requirements will pose a serious barrier for institutionalization of SBA-UT.

Present project appraisal methodologies are often presented as golden standards, but they all have their own limitations. Most of the popular appraisal methodologies exhibit an isolated focus on various aspects of sustainability, e.g., CBA has a greater focus on profitability and EIA and SEA have a greater focus on environmental impacts. The major difference between SBA-UT and other traditional project-appraisal methodologies is that SBA-UT is a more holistic, inclusive, and balanced approach. It provides a scope for equal consideration of social, economic and environmental benefits under a common appraisal framework. The use of GIS is highly recommended in the application of SBA-UT, but every change (or benefit) included in the sustainability benefits assessment cannot be assessed only with spatial methods. There will be a requirement for using multiple tools in SBA-UT applications. For example, while the reduction in greenhouse-gas emissions cannot be estimated from maps, it can still be presented in the form of maps as a thematic layer. The SBA-UT methodology in totality is a combination of various assessment methods and not merely a Geographical Information System (Sharma and Geerlings 2015), which is also a similarity with MCA. Uncertainty in estimation is a typical challenge found common in all predictive approaches, and it is also associated with the SBA-UT. The point of discussion is if the challenges to experts in the estimation of sustainability benefits will be too acute or they have faced similar challenges while applying other assessment methods.

5 Conclusions

Based on the literature review, appraisal methodologies can be classified into two types—(1) project-based appraisal methodologies, and (2) strategic appraisal methodologies. Where project-based appraisal methodologies largely include impacts on the direct users, the strategic methodologies include also the impacts on non-users (Iacono and Levinson 2015). The main conclusion of this position paper is that SBA-UT can be most appropriately placed in the category of strategic appraisal methodologies. In terms of applications, SBA-UT can be seen as closely resembling SEA. However, in terms of coverage of impacts, SBA-UT includes all three components of sustainable development (social, economic, and environmental) whereas, SEA largely focuses on environmental impacts.

At the millennium summit (September 2000), the UN-Habitat proposed Millennium Development Goals (UN-Habitat 2002) to be achieved by the year 2015. Under Post-2015 agenda, the UN-Habitat endorsed Sustainable Development Goals (SDGs) in September 2015. The first post-SDG implementation conference Habitat-III will be held in Quito, Ecuador, in October 2016 where tracking and monitoring of SDGs will be discussed. UN-Habitat's issue papers for Habitat-III specifically advocate equitable and balanced planning approaches for the cities of the future. The Habitat-III's agenda puts a clear emphasis on social aspects and quality of life rather than only on climate change and environment. It is certain that, as an effect of Habitat-III, many national, state, and local governments will adopt new goals for their infrastructure projects. The paradigm of urban development is shifting towards holistic sustainable development goals, which will require a collective consideration of all three pillars of sustainability (social, economic, environmental) in decision making.

The SBA-UT methodology presented in this position paper is conceptualized as a tool for the strategic appraisal of urban-transport projects. It is a model framework and can be easily adopted for project appraisal in other infrastructure sectors. The SBA-UT is the first attempt of an appraisal method that establishes a clear integration between sustainable development and the process of transition. The immediate future of decision making for sustainable urban development will demand new appraisal methodologies that are more inclusive, explanatory, and holistic, and this is where SBA-UT can play a role. The SBA-UT methodology is not merely a quantitative technique but is a systematic content approach that focuses on governance challenges for sustainable development.

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