MULTI-CRITERIA APPROACH TO IDENTIFY THE ENVIRONMENTAL IMPACTS OF THE RAILROAD CONNECTION BETWEEN THE CITY OF SÃO PAULO AND THE VIRACOPOS INTERNATIONAL AIRPORT

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ABSTRACT

The objective of this paper is to propose a multi-criteria approach to support the scoping activity of the environmental impact assessment process (EIA). The methodological framework used is the Multiple Criteria Decision Aid (MCDA) which consists of three interacting phases: structuring, evaluation of the alternatives and recommendation. The paper emphasizes the structuring phase. The proposed multi-criteria approach is applied to identify the environmental impacts of the railroad connection between the city of São Paulo and the Viracopos International Airport in the State of São Paulo, Brazil. The results show that the MCDA methodology can be formally integrated into the EIA process to help identify and structure the environmental impacts and the corresponding environmental indicators.

Keywords: Environmental impact assessment, Impact identification, Multiple criteria decision aid, Structuring, Rail transport

INTRODUCTION

Environmental impact assessment (EIA) is a systematic procedure to identify, predict and evaluate the environmental impacts of development actions. Impact identification is an important step of the EIA process, in which those impacts requiring investigation are determined.

One of the main problems involved in impact identification has been a tendency to identify all possible impacts and to investigate them in depth. This has given rise to an activity known as scoping, which involves discussion between those implementing an EIA, those responsible

for the project, government agencies and members of the public. The aim of scoping is to select those impacts which deserve further study.

The objective of this paper is to propose a multi-criteria approach to support the scoping activity. The methodological framework used is the Multiple Criteria Decision Aid (MCDA) which seeks to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter (Belton and Stewart, 2002). The multi-criteria approach is applied to identify the environmental impacts of the railroad connection between the city of São Paulo and the Viracopos International Airport in the State of São Paulo, Brazil.

METHODOLOGY

Taking as a point of reference the decision model proposed by Simon (1960), "intelligence, design and choice", the MCDA is a process consisting of three interacting phases: structuring, evaluation of the alternatives and recommendation.

The structuring phase aims to help those involved in the decision-making process better understand the decision situation. In the evaluation phase, the performances of the proposed alternatives are aggregated by multi-criteria methods, which take into account the preferences of the stakeholders. The recommendation phase aims to discuss the evaluation results with the stakeholders to enable them to recommend a solution to the decision-maker.

The paper emphasizes the structuring phase which encompasses the following activities: characterizing the decision-making context and the project, identifying and structuring the fundamental objectives of the stakeholders, and selecting the attributes.

The decision-making context was characterized by the following components: the geographical and time limits, the environmental setting of the study area, the stakeholders and the decision-maker. A stakeholder is an individual or a group of individuals having a specific value system (Roy, 1996). The decision-maker is an individual or a group with responsibility for a decision or for recommending a decision (Keeney, 1992).

Once the decision-making context has been characterized, the railroad connection was described in terms of its planning, construction and operation stages. Two options were considered: express train and bullet train.

The next activity consisted of identifying the objectives of each stakeholder for the planning, construction and operation stages of the express train and the bullet train. Keeney (1992) distinguishes between fundamental and means objectives. A fundamental objective expresses an essential reason for interest in the decision situation while a means objective is important for the achievement of a fundamental objective.

In EIA documents, effects and impacts are often used interchangeably. However there is an important difference between them. Development actions result in changes in the state of environmental variables (for example, increased pollutant concentrations in the air). These

changes are effects. The predicted consequences of the environmental changes on humans, animals or plants are impacts (Bisset, 1985). Therefore effects represent means objectives while environmental impacts correspond to fundamental objectives.

The environmental impacts were identified by a group of three specialists from the School of Civil Engineering, Architecture and Urban Design, University of Campinas. The group was assisted by a facilitator who is skilled in the MCDA methodology. Following the procedure suggested by Keeney (1992), the group was asked to think of the impacts from the perspective of the decision-maker as well as from the perspective of each stakeholder.

Then, for each impact, the facilitator asked "Why is this impact important?" If the answer is that the impact is one of the essential reasons for interest in the situation, it is an impact that should be investigated in depth. If the answer is that the impact is important because of its implications for another impact, it is a "means" impact. Changes in environmental components subject to legislation were also considered as environmental impacts.

The environmental impacts of each stage of the project were then detailed and structured in a hierarchy. An attribute, which is a measure of the degree to which an objective is met by the alternatives, was associated with each of the lowest-level environmental impacts of the hierarchy. The attributes can be considered as environmental indicators which will guide the impact prediction and evaluation steps of the EIA process. The indicators were selected by the group of specialists, based on their experience and the literature.

RESULTS

Decision-Making Context

In order to establish the geographical limits of this study, it was taken into consideration the metropolitan regions of São Paulo and Campinas, shown in Figure 1. The city of Campinas, with about 1 million inhabitants, is 100 km away from the city of São Paulo, the state capital and the biggest city in Brazil. The Viracopos International Airport is located 14 km away from the city of Campinas. The study area was also described in terms of its environmental characteristics. Regarding the time limit, it was considered the beginning of the operation stage of the project (i.e. 5 years).

The following stakeholders were identified: Federal Government, State Secretariat of Environment, State Government, Municipal Governments, Population, São Paulo Metropolitan Train Company (CPTM), Users, Brazilian Company of Airport Infrastructure (INFRAERO), Air Companies and Real Estate Investments Funds. The State Secretariat of Environment is considered as the decision-maker because it is responsible for conducting the EIA process.

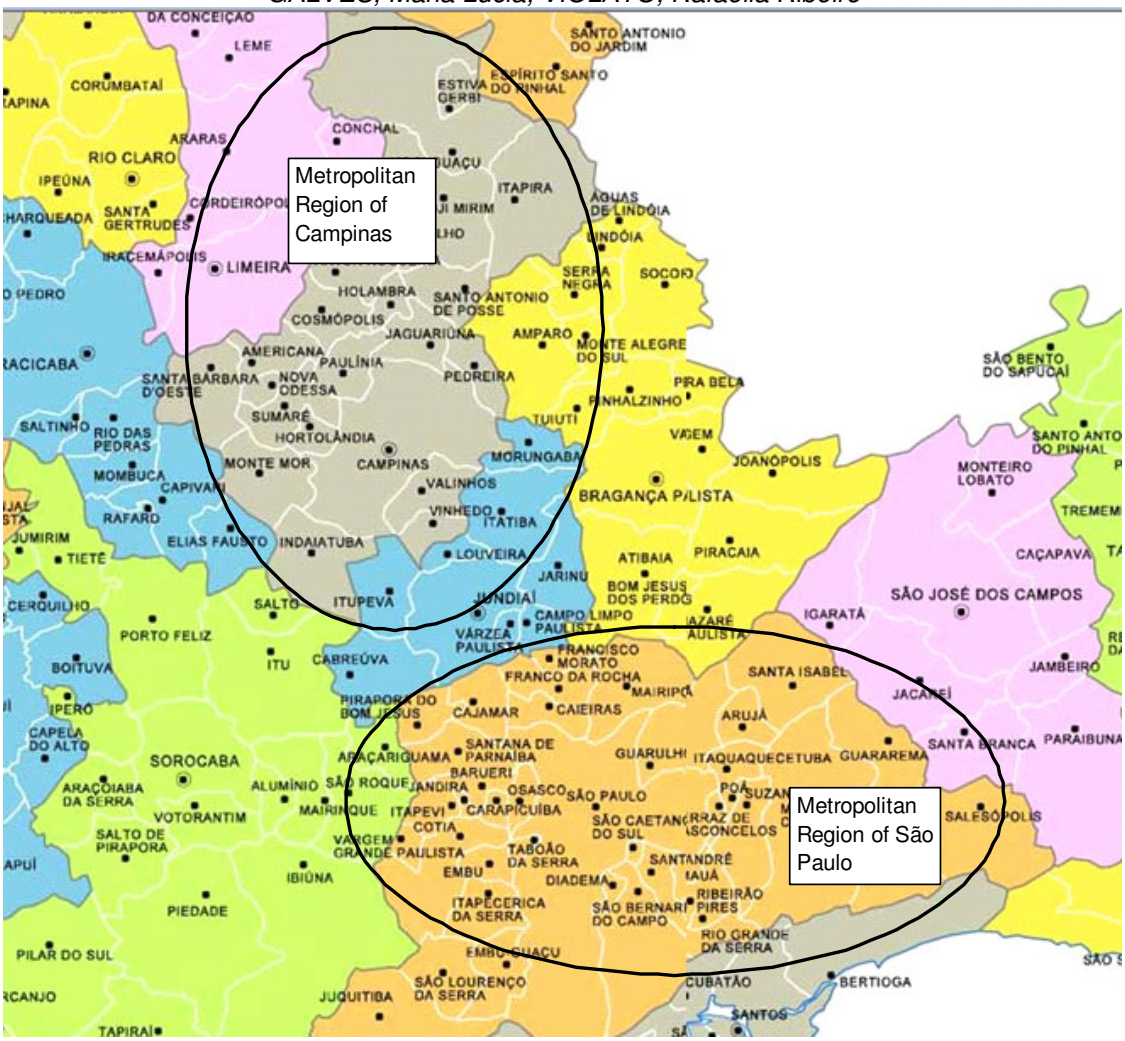

Figure 1 – Metropolitan regions of São Paulo and Campinas (Adapted from IGC, 2002)

Railroad Connection

The two alternatives of railroad connection already proposed and the existing alternative by bus are briefly described bellow.

Express Train

For over 25 years this link has been discussed. Approved by the *Conselho Gestor das Parcerias Público-Privadas – PPS* (Management Council of the Public-Private Partnerships) of the State of São Paulo, the study was dropped. Aboard the *Expresso Bandeirantes* (as this alternative is named), the passengers would make a train journey at 160 km/h, with only one stop in the city of Jundiaí, reaching the Viracopos International Airport in 50 minutes.

Bullet Train

In 1998, the *Empresa Brasileira de Planejamento de Transportes* (Brazilian Company of Transportation Planning) performed a study on the rail link connecting Rio de Janeiro, São Paulo and Campinas (passengers and cargo), with the purpose to reduce costs, time and pollution, besides the improvement of the access to ports in the region (GEIPOT, 2005).

This study proposes a system of High Speed Trains (TAV), based on the conventional technology of "wheel-rail" contact and the utilization of the lines that are exclusive and protected against noise. The location of the stations joins accessibility criteria (meeting the demands) and characteristics of system performance (maximum speed of 330 km/h). The system was conceived to be integrated with the subway, bus terminal, international airports and railway terminals.

Bus (existing situation)

Currently, there are three options to the road transport by bus:

1. From the International Airport of Cumbica to the Road Terminal of Campinas and from it to the Viracopos Airport.

2. From the Airport of Congonhas to the Road Terminal of Campinas and from it to the Viracopos Airport.

3. Direct connection between airports made by some air companies only to their passengers.

Environmental Impacts

The hierarchies of environmental impacts (fundamental objectives) for the planning, construction and operation stages of the project are presented in Figures 2 to 4.

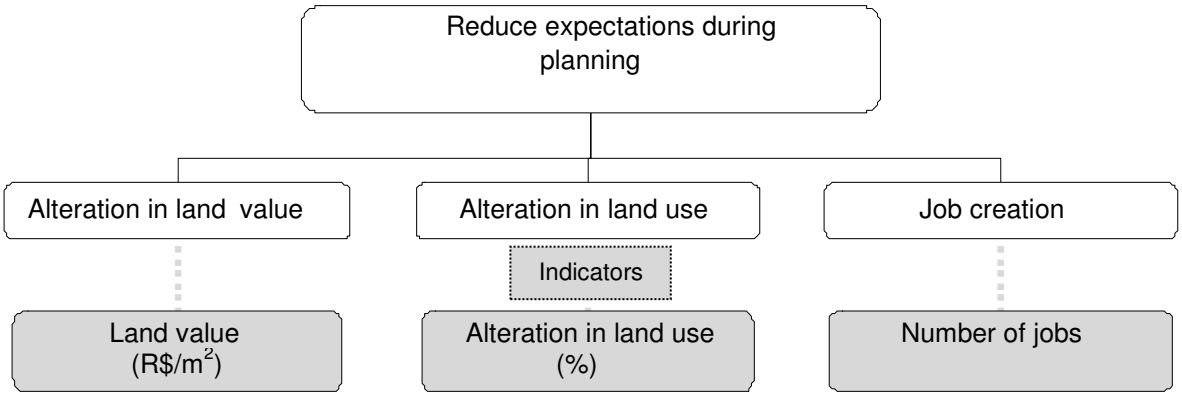

Figure 2 – Hierarchy of environmental impacts and indicators - Planning stage

In Figure 2, the overall objective is to reduce expectations during the planning stage of the railroad connection. The three impacts under the overall objective specify its meaning. Therefore the expectations that should be reduced are alteration in land value and land use and job creation.

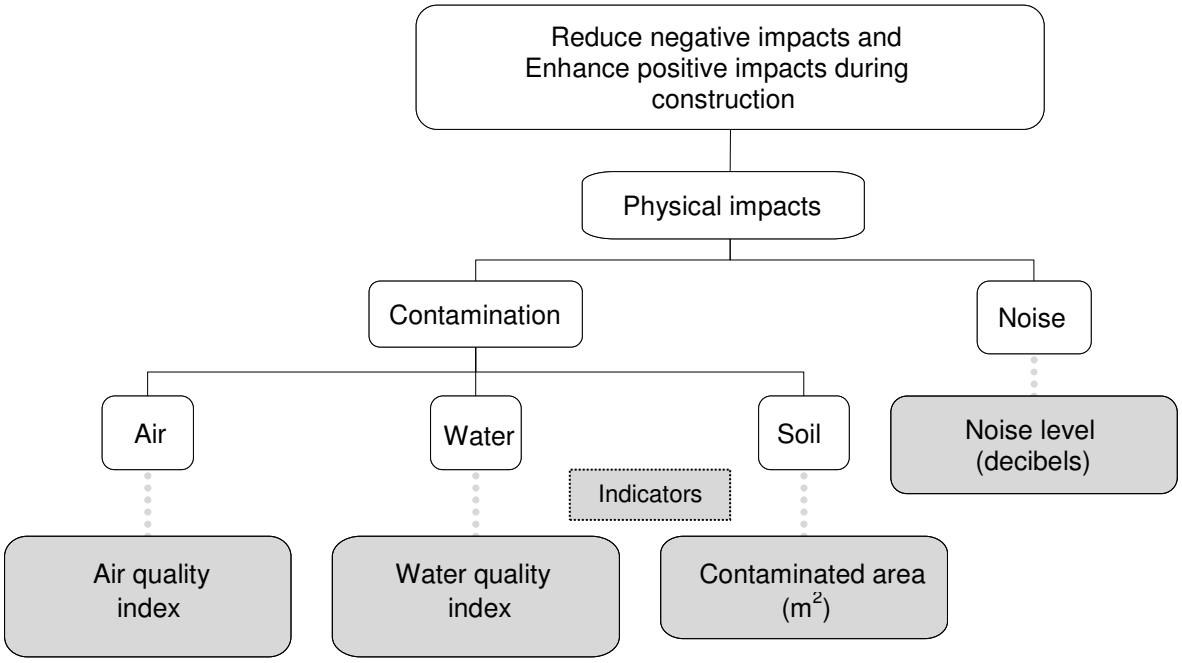

Figure 3a – Hierarchy of environmental impacts and indicators – Construction stage

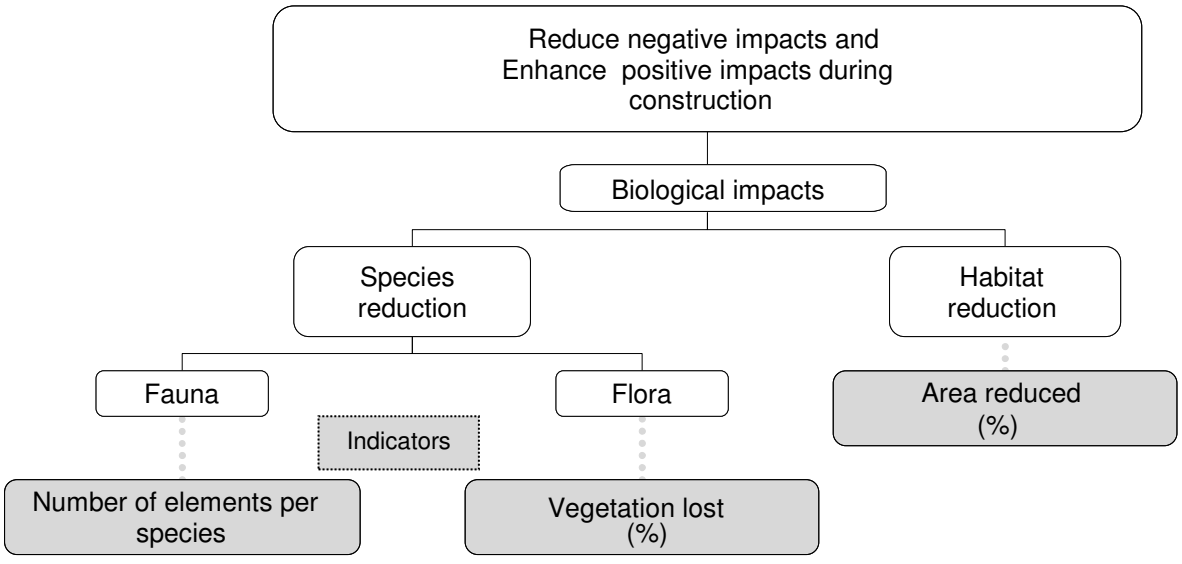

Figure 3b – Hierarchy of environmental impacts and indicators – Construction stage

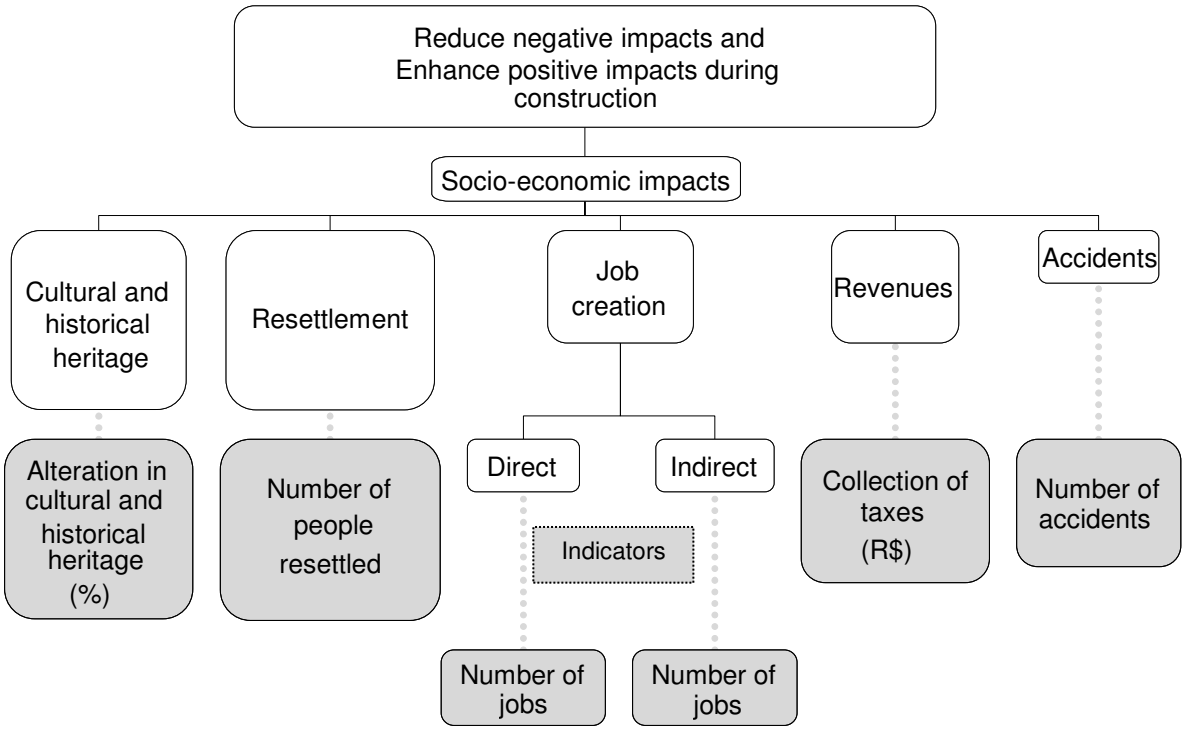

Figure 3c – Hierarchy of environmental impacts and indicators – Construction stage

During the construction stage, the overall objective is to reduce negative impacts and enhance positive impacts. The environmental impacts were divided into physical, biological and socio-economic impacts. Physical impacts (Figure 3a) were specified as air, water and soil contamination and noise. Biological impacts (Figure 3b) include species reduction (fauna and flora) and habitat reduction. Socio-economic impacts (Figure 3c) were broken into cultural and historical heritage, resettlement, job creation (direct and indirect jobs), revenues and accidents.

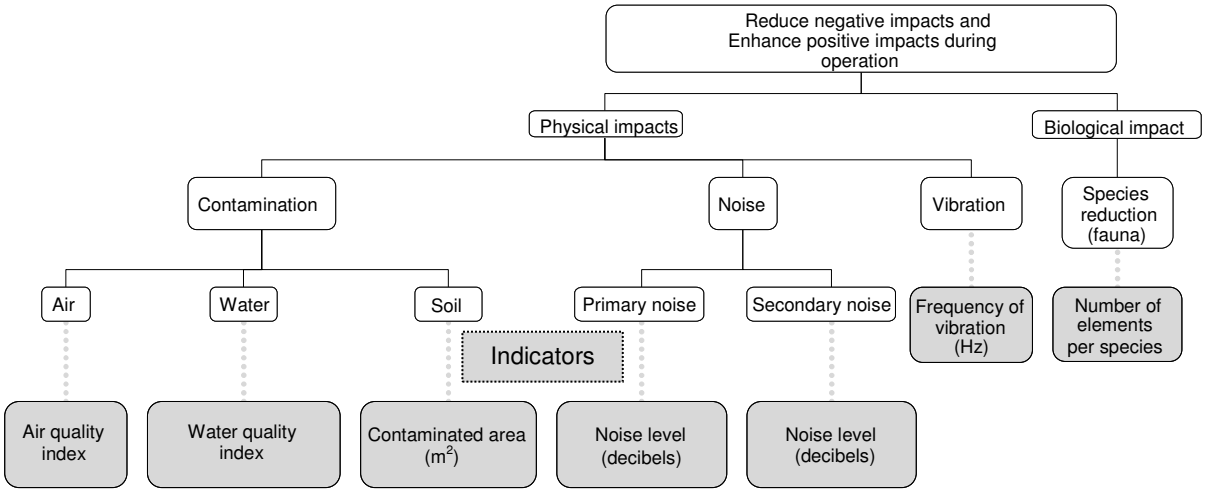

Figure 4a – Hierarchy of environmental impacts and indicators – Operation stage

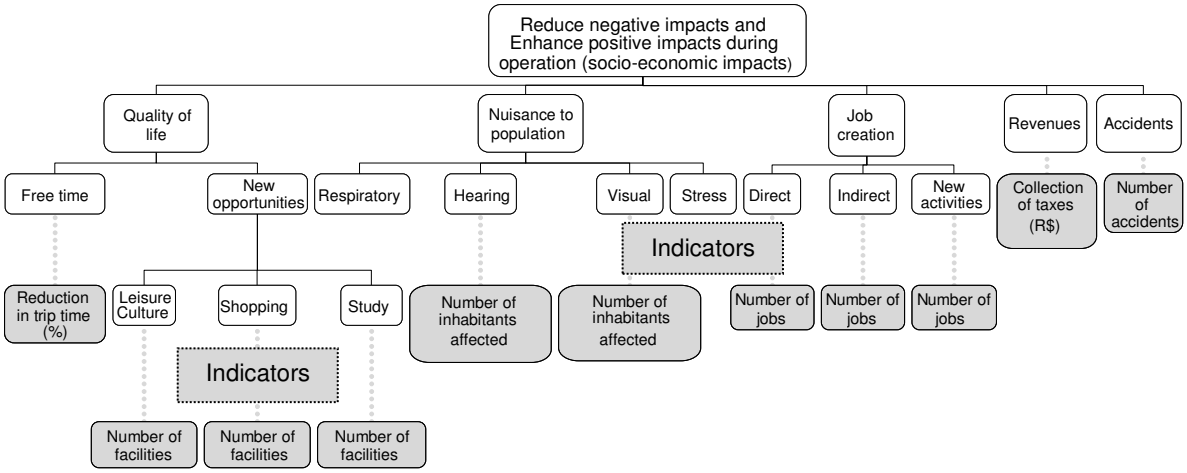

Figure 4b – Hierarchy of environmental impacts and indicators – Operation stage

During the operation stage, the environmental impacts were also divided into physical, biological and socio-economic impacts. Physical impacts (Figure 4a) were specified as air, water and soil contamination, noise and vibration. The biological impact of concern is species reduction (Figure 4a). Socio-economic impacts (Figure 4b) were broken into quality of life (free time, leisure and culture, shopping and study opportunities), nuisance to population (respiratory, hearing, visual and stress problems), job creation, revenues and accidents.

Environmental Indicators

The environmental indicators (attributes) suggested to represent the environmental impacts are indicated in Figures 2 to 4. Most of indicators are measured with quantitative scales. The air and water quality indicators are measured with indices that have been defined by the state environmental agency (CETESB, 2009; CETESB, 2010).

CONCLUSION

In order to support the environmental impact assessment process, a multi-criteria approach to identify the environmental impacts which need to be investigated in depth is proposed. The methodological framework used is the Multiple Criteria Decision Aid (MCDA) which consists of three interacting phases: structuring, evaluation of the alternatives and recommendation.

The paper emphasizes the structuring phase which encompasses the following activities: characterizing the decision-making context and the project, identifying and structuring the fundamental objectives of the stakeholders, and selecting the attributes. In the EIA process, the environmental impacts correspond to the fundamental objectives and the attributes can be considered as environmental indicators.

The multi-criteria approach is applied to identify the environmental impacts of the railroad connection between the city of São Paulo and the Viracopos International Airport in the State of São Paulo, Brazil.

The structuring shows the complexity of the studied problem. The decision-making context is characterized by several actors, with different interests and concerns. The environmental impacts associated with the planning, construction and operation stages of the project were identified. Then they were detailed and structured in different hierarchies, thus revealing the wide range of important impacts involved in the railroad connection.

The paper demonstrates that the Multiple Criteria Decision Aid methodology can be formally integrated into the EIA process to help identify and structure the environmental impacts and the corresponding environmental indicators.

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