Setting guidelines for identifying sustainable transport challenges in medium-sized cities in Indonesia

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August, 2012

Master of Science Thesis
University of Twente
Civil Engineering and Management

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Abstract

In the recent climate change debate much focus is placed on low carbon development. The transportation sector is one of the major contributors to greenhouse gases. Therefore CO_2 mitigation is a key issue in transport planning. On a local level however other transport externalities receive more attention. The use of co-benefits captures the effect on CO_2 emissions from transport measures. The concept of sustainable transport includes low carbon development concerns and these co-benefits.

In the next decades the energy use in the world is expected to further increase, especially in the developing world, and the share of energy uses in transport is also expected to increase. These two developments stress the need for more sustainable transport strategies. In developing such strategies the evaluation of the sustainability of transport systems plays an important role. Medium-sized cities in developing countries are however often not capable of performing such evaluations due to a lack of institutional capacity, knowledge and funding. This research aimed at developing an evaluation framework for medium-sized cities in Indonesia and applying this to the Indonesian cities of Yogyakarta and Surakarta to test the feasibility of identifying sustainable transport goals. The results were used to set guidelines for future evaluations.

The framework applied in this research started with making an initial long-list of possible indicators. Criteria that related to the methodological quality of indicators and the relevance of these indicators to the concept of sustainable transport were used in the Analytic Hierarchy Process (AHP) to select a set of indicators. In the process of selecting indicators stakeholder participation was found to be important. In this research transport experts' judgments were used for selecting the indicator criteria and the surveys for the AHP were conducted among transport experts and users.

Application of this framework in the cities of Yogyakarta and Surakarta has shown that in both cities it was difficult to find the necessary data and that available data was often unreliable. This made it hard to perform a good evaluation of the sustainability of transport systems and the sustainable transport goals. With the growing need for cities to develop sustainable transport strategies it is important that these cities start addressing the issues that hamper the development of such strategies. Evaluation of the sustainability of transport systems is a first step in identifying sustainable transport goals, but is also important in tracking progress.

The data that was available has been used to identify sustainable transport challenges in the two cities. The biggest challenge in both cities is dealing with the increasing motorization of the transport system, which leads to congestion, air pollution and traffic accidents. A second challenge will be to improve the functioning of the local governments. Sustainable transport planning requires that governments share information.

The lessons learned from the application of the evaluation framework in Yogyakarta and Surakarta has been used to develop guidelines for future sustainable transport evaluations in medium-sized cities in Indonesia. These guidelines also apply to cities in other developing countries, when they have to deal with the same issues. The following guidelines can be used as a road map by these cities:

1. Adopt a sustainable transport strategy

Evaluating the sustainability of transport systems is important as input for sustainable transport strategies. The local government that has decided to start developing sustainable transport strategies should have a clear idea about the concept of sustainability and how it applies to transport.

2. Strengthen institutional capacity and knowledge

From literature and this research it became clear that the medium-sized cities in Indonesia do not have the capacity and knowledge at the moment to evaluate the sustainability of transport systems. The use of indicator data is only useful when this is available and reliable. Therefore an important task is to strengthen institutional capacity and knowledge. International organizations can help local governments doing this, but also national knowledge centers can be established, where knowledge and best practices are shared.

3. Choose an evaluation method

The evaluation framework has to specify how the transport system is evaluated. First the context should be established as input for the selection of indicators. In this process stakeholders should be asked to evaluate the set of indicators. The framework should also specify how the data is collected and processed.

4. Choose the right indicators

In the evaluation indicators have to be used to provide information on the sustainability of the transport systems. For the selection of indicators from a long-list criteria have to be used to assess the methodological quality of the indicator. The final set of indicators should be balanced, covering all dimensions of sustainable transport. An indicator set should contain 10-15 indicators to be comprehensible.

5. Standardize the measurement of indicator data

The measurement of indicator data should be standardized temporally and spatially. This will allow making trends that provide useful information. Also the same units should be used, to be able to compare the data. For each of the indicators targets will have to be defined.

6. Structure public participation

Through the whole process of evaluation there should be public participation. This is advocated by many literature sources, but it is not clear how this should be done. As it is difficult to include the public in this process, interest representatives can be asked to join. Examples of such representatives are pedestrian or cycling associations, public transport passenger associations and motorist associations. These associations are more concerned with transport issues and have a better understanding of sustainable transport implications.

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1 Introduction

This chapter sets out the theoretical framework for this research. In view of the global climate change debate countries and cities are encouraged to develop low carbon systems. On a local level other economic, social and environmental issues should also be addressed. The use of co-benefits is important in addressing these local issues and low carbon development. In the field of transportation definitions and evaluation frameworks of sustainable transport are used to integrate these aspects.

1.1 Climate change debate

At the moment it is widely believed that human actions contribute to climate change, which will threaten basic elements of life if no action is taken right now (Parry, Canzaiani, Palutikof, Van der Linden, & Hansen, 2007; Stern, 2007). The increase of greenhouse gases in the atmosphere has lead to a global warming of half a degree since the Industrial Revolution and predictions estimate that the further warming in the next decades will be somewhere between half a degree and three degrees Celsius (Stern, 2007). The main contributor to the increase in greenhouse gases is carbon dioxide, CO_2. Before the Industrial Revolution the amount of CO_2 in the air was 280 ppm, in 2007 it was 430 ppm and estimates show levels of 550 ppm for 2050 if the flow of emissions does not change (Stern, 2007). The flow of CO_2 however is expected to increase, so the level of 550 ppm CO_2 might already be reached in 2035.

Since 2006 half of the world's population lives in cities. These cities are responsible for 75% of the world's energy use and 80% of all greenhouse gas emissions, with the urban transport sector contributing to half of these emissions (UN-HABITAT, 2007). The total amount of people living in cities is expected to double from 2.3 billion in 2005 to 5.3 billion in 2050 (UN-HABITAT, 2009). Much of this growth will be concentrated in Asia. To limit the increase of global warming emission reduction targets have been suggested in the Copenhagen Accord: developed countries have to reduce their emissions 25-40% compared to 1990 levels, developing countries need to reduce their emission levels by 15-30% compared to the business as usual scenario in 2030 (Huizenga & Bakker, 2010). The way transport systems are developed in the next 10 years will determine for a great extent how much emission reductions in transport can be achieved (ADB, 2009; Huizenga & Bakker, 2010). So it is clear that there is a serious need for cities, particularly in Asia, to deal with urban transport in order to meet CO_2 reduction targets.

Many cities are now trying to deal with transport related energy use and greenhouse gas emissions. Through international organizations, multi- and bilateral organizations, research centers, consultancy agencies, national and local authorities low carbon transport solutions are developed. In developing countries funding mechanisms for reducing emissions are available, for example the clean development mechanism (CDM) and nationally appropriate mitigation actions (NAMAs). These funding mechanisms can be used for transport investments if they lead to greenhouse gas reductions. Although not many transport projects, only 0.1% of the total amount of projects, have received a CDM funding, it is expected that through NAMAs there will be more funding for transport projects (Center for Clean Air Policy, 2010). In the beginning of 2010 26 out of the 44 developing countries submitting NAMAs included actions in the transport sector (Dalkmann & Binsted, 2010). However, only three of them were Asian (Indonesia, Mongolia and Singapore). Measuring the effect of a transport project on the emission of CO_2 has been one of the difficulties for receiving CDM funding. Transport NAMAs do not only take emission reduction into account, but also look at co-benefits. Primary co-benefits have an indirect effect on emission reductions, for example reduced traffic congestion, secondary co-benefits are not related to emissions, but do have a positive effect, like for example increased safety and health. Sometimes these co-benefits are decisive in granting the funding, showing the importance of these co-benefits (Huizenga & Bakker, 2010). These co-benefits often are part of a sustainable transport strategy. In the global debate on climate change, transport plays an important role, being one of the main contributors to the production of greenhouse gases, but on a local level other aspects are also important. To capture all relevant issues the concept of sustainable development is applied to the urban transport sector. Using the concept of sustainable transport allows dealing with global, national and local issues. In the next part the concepts of sustainability, sustainable development and its use in transport are further explained.

1.2 Sustainability

The concept of sustainability is widely spread and used and there are many different definitions available. Bell and Morse (1999) define sustainability as:

"...a dynamic balance among three mutually interdependent elements: (1) protection and enhancement of natural ecosystems and resources; (2) economic productivity; and (3) provision of social infrastructure such as jobs, housing, education, medical care and cultural opportunities."

A visual representation of these three elements is given in the following Venn-diagram, Figure 1. These three elements are also frequently referred to as the three pillars or dimensions of sustainability.

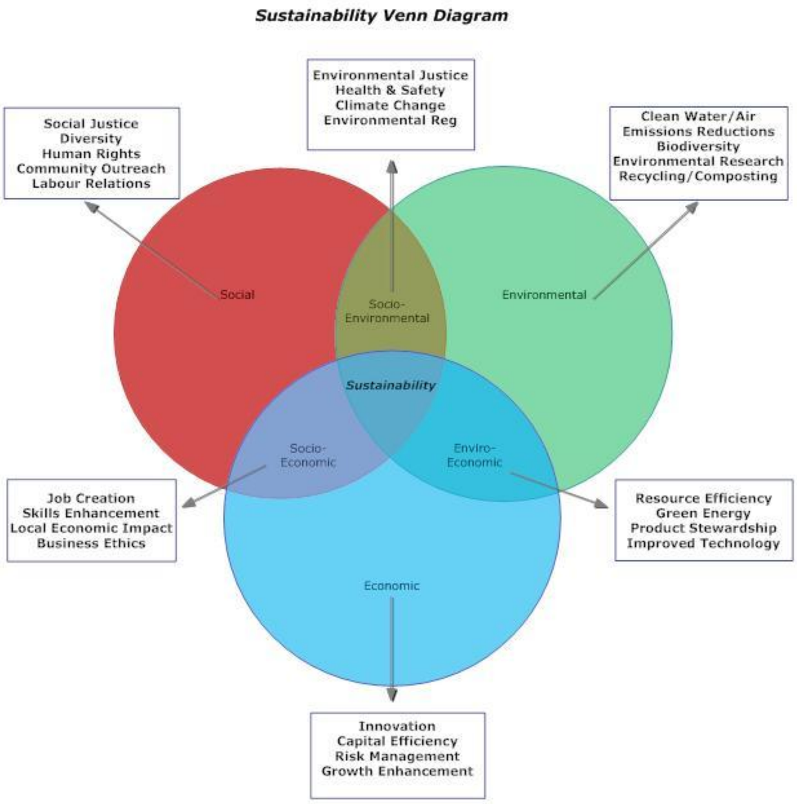


Figure 1 Sustainability Venn diagram (University of Windsor, 2011)

1.2.1 Economic sustainability

The economic pillar focuses on various kinds of capital, this includes man-made, natural, human and social capital (World Bank, 2006). The capital should be 'sustained', meaning that future generations can enjoy similar levels of this capital. Economical growth has been the most important policy goal in the recent history. This is why it has been difficult to find a balance between sustainability and economic growth of countries (Moldan, Janoušková, & Hák, 2012).

1.2.2 Social sustainability

Social sustainability can be defined as "the extent to which social values, social identities, social relationships and social institutions are capable of being maintained into the future" (A. Black, 2004). Social sustainability is linked to both other pillars: "From a social perspective in particular, human well-being cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy" (Torjman, 2000). Despite these definitions, social sustainability remains difficult to define, it is not yet clear what social unsustainability is (Moldan et al., 2012). Moles, Foley, Morrissey, and O'Regan (2008) question what the elements of social sustainability are. Should it involve inequality among people, regions or nations? Also there are many equity impacts to consider and units to measure these impacts (Van Wee & Geurs, 2011). As the concept of sustainability has been broadened over time, more indicators have been developed. This has been particularly the case for the social dimension, where indicators initially focused on poverty measures, but now also include broader quality of life concepts (Lautso et al., 2004). In dealing with social sustainability there should be a clear view on what is included in the concept and what is not.

1.2.3 Environmental sustainability

Environmental sustainability roughly consists of two elements; on the one hand protecting resources and on the other dealing with waste (Goodland, 1995). Sources of raw materials used for human needs should be protected and waste should not exceed the capacity. Environmental sustainability also deals with changes in natural systems, such as the climate system, terrestrial systems and aquatic systems.

1.3 Sustainable development

While sustainability relates to the state of a system, sustainable development aims at developing in a sustainable direction. In the past decades sustainable development has played an important role in policy making. There is not one single definition of what sustainable development exactly is, though the definition provided by the 'Brundtland report' is commonly used:

"Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987)

Adams (2006) argues that the looseness of the definition of sustainable development has been the reason for the widespread acceptance of it. Environmentalists, governments, economic and political planners and business people all use the same definition to promote sometimes very different visions. Grosskurth and Rotmans (2005) say that the definition in the 'Brundtland report' is a political definition of sustainable development, which creates problems for a scientific application of the concept of sustainable development. These problems are normativeness, subjectivity, ambiguity and complexity. The 'Brundtland report' acknowledges the aforementioned criticism:

"Yet in the end, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. We do not pretend that the process is easy or straightforward. Painful choices have to be made. Thus, in the final analysis, sustainable development must rest on political will." (WCED, 1987)

1.4 Sustainable transport

As transport has significant economical, social and environmental impacts it is an important factor in sustainability (Litman, 2008). Gudmundsson and Höjer (1996) discussed how the sustainable development principles can be translated into sustainable transport goals. In their view sustainable development implies four principles which can all be applied to the transport sector:

1. *"To safeguard a natural resource base within critical loads, levels and usage patterns;*
2. *To maintain the option value of a productive capital base for future generations;*
3. *To improve the quality of life for individuals; and*
4. *To secure an equitable distribution of life quality"* (Gudmundsson & Höjer, 1996)

Gudmundsson and Höjer (1996) argue that current mobility patterns are not in accordance with these principles, especially with the first principle as transport does not contribute to the reproduction of natural capital. Furthermore they argue that if sustainable development as a policy goal was seriously adopted it would have large implications for transport policy.

1.4.1 Definition of sustainable transport

As with definitions for sustainability and sustainable development, there are many definitions used for sustainable transport (Jeon & Amekudzi, 2005). The council of EU Ministers of Transport agreed in 2001 on the use of a definition of sustainable transport, based on the definition of the Centre for Sustainable Transport (CST, 2005):

"A sustainable transport system [is] defined as one that:

- *allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;*
- *is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;*
- *limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimising the impact on the use of land and the generation of noise."*

This definition is more comprehensible and concrete than other sustainable transport definitions, it is also reviewed by political mechanisms and accepted by many politicians (RAND Europe et al., 2003). The three elements of sustainability, economy, society and environment can be found in this definition. Bongardt, Schmid, Huizenga, and Litman (2011) added a fourth dimension to this definition, the degree of participation:

"A more sustainable transportation system is one that:

- *is designed in a participatory process, which involves relevant stakeholders in all parts of the society."*

1.4.2 Sustainable transport in developing countries

The 'Brundtland report' (WCED, 1987) made a prediction of the problems that were likely to occur in developing countries. Urbanization is one of the major problems facing these countries. The 'Brundtland report' predicted a growth of population in developing countries with three-quarters of a billion, which would mean that the capacity of urban infrastructure had to increase with 65 percent to maintain the often inadequate conditions. Given that many governments in these developing countries lack power, knowledge, resources and trained personnel, the 'Brundtland report' concludes that developing countries have a major urban crisis in their hands. The situation of developing countries cannot be compared to similar problems in industrialized countries, as in these countries the problem is often one of political and social choice.

More than twenty years after this publication of the 'Brundtland report' the predictions made can be evaluated. Data from the World Bank (2007) shows that in the period of 1990-2005 the urban population in low income countries annually grew with 3.2%. In the same period the annual urban population growth in high income countries was 1.1%. These figures show that urbanization forms a bigger problem in developing countries. Cities in Nigeria already face the crisis predicted in the 'Brundtland report' (Akinbami & Fadare, 1997). The urban transport system is in conflict with urban spatial patterns and the transport system has been found to be unsustainable ecologically, economically and socially. Also Karachi in Pakistan is already in crisis (Qureshi & Lu, 2007), where urban design and transport policies have not been able to provide a holistic approach to urban transport development. Qureshi and Lu also conclude that the transport system is unsustainable environmentally, economically and socially. Many more examples of problems in countries in developing countries can be given, but these two examples show that transport systems in developing countries are already in a sustainable crisis.

In the international conferences on sustainable development organized by the United Nations concerns about sustainable transport have also been expressed. The outcome document of the recent Rio+20 conference, "The Future We Want", contains two paragraphs on sustainable transport, in which the importance of sustainable transport in sustainable development is acknowledged (UN, 2012b). Although the Rio+20 conference overall is seen as a failure to agree on decisive actions, it has been successful for sustainable transport for three reasons (SLoCaT, 2012):

- There is larger agreement on the urgency to act on sustainable transport
- Compared to 1992 and 2002 all stakeholders are better prepared and willing to help implementing sustainable transport
- While Agenda 21 and the Johannesburg Implementation Plan were merely aspirational documents "The Future We Want" describes the need to scale up efforts that have proven to be successful

The importance of developing sustainable transport in developing countries is also acknowledged in the outcome document. This renewed interest in sustainable transport in developing countries has been financially supported by eight multilateral development banks through an investment of $175 billion dollar for the next ten years (ADB, 2012; UN, 2012a).

1.5 Evaluation of sustainable transport

In sustainable transport planning the development of a comprehensive evaluation framework is critical (Bongardt et al., 2011). Bongardt et al. describe several goals of evaluating sustainable transport. One of them is identifying challenges for policy makers and giving direction towards progress in achieving sustainability goals. A second goal is to raise public awareness about the subject of sustainable transportation. Evaluating sustainable transport can also help researchers to better understand impacts of transport policy and planning decisions. A final goal could be to help donors (e.g. multilateral development banks) to make sure that their funds contribute to sustainable projects. The evaluation of sustainable transport is a key issue of this research. The next chapter describes how evaluation is applied.

2 Research design

The previous chapter set out the theoretical framework for this research. In this chapter the research design is described. First from the theoretical framework the scope of this research is given, which leads to the research objective. In the research model the research questions are presented. Finally the research methodology is explained.

2.1 Scope of research

Evaluating sustainable transport in the context of developing cities is not straightforward, as there is no clear consensus on how to define sustainable transport in a local context, but also because there are local constraints which hamper the evaluation. However, in planning processes evaluation is an important aspect. This research focuses on evaluating the sustainability of transport systems in the context of medium-sized cities in Indonesia in order to identify sustainable transport challenges. Why this scope has been chosen will be explained next.

Transport related problems in developed and developing countries are different from each other; the causes, magnitude, and solutions to these problems are often very different. In Brazil a study was carried out to find differences between the perception of sustainable transport of transport planners in four regions in Brazil (da Silva, da Silva Costa, & Macedo, 2008). The results showed that all regions had a different perception of sustainable transport. The differences can be explained by economical, social and cultural differences. Objectives of sustainable transport are likely to differ with context, locality, time, scientific knowledge and global events (Abolina & Zilans, 2002). This was also shown by Marletto and Mameli (2012) for the city size. While smaller cities were more concerned about transport costs, large cities were more concerned about pollution from transport. The objectives in smaller cities are not only different, these cities also deal with problems when implementing sustainable transport. Dimitriou (2006) describes the particular case for medium-sized cities in developing countries. According to Dimitriou medium-sized cities in developing countries have populations of 500,000 to 5,000,000. He identified root problems that particularly apply to these medium-sized cities. These root problems are related to a lack of capacity, knowledge and funding. Together with rising vehicle numbers and increasing populations this causes many transport problems, like congestion, more traffic accidents, too little space for non-motorized transport and negative impacts on the environment. The lack of capacity, knowledge and funding makes it very hard for medium-sized cities to effectively deal with sustainable transport objectives. Evaluating the current state of the transport systems can help to identify sustainable transport challenges. This can be seen as a first step in developing sustainable transport objectives and policy.

The focus of this research is to identify what kind of problems medium-sized cities encounter when they try to evaluate the sustainability of their transport systems and to provide guidelines for tackling these issues. Yogyakarta and Surakarta, two cities on the island of Java, Indonesia, have been chosen as pilot cities. These two cities are selected because they are both medium-sized and face similar transport problems and both cities are already trying to develop sustainable urban transport strategies. Using two cities allows getting a better understanding of the issues involved in evaluating the sustainability of transport systems. Because both cities are quite similar on some aspects it is assumed that the same indicator set can be used for both cities. This also allows comparing them.

2.2 Objective

From the scope of the research follows the research objective, which is formulated as:

The objective of this research is to set guidelines for identifying sustainable transport challenges in the context of medium-sized cities in Indonesia by developing and applying a sustainable transport evaluation framework

First an evaluation framework will be developed that is suitable for Yogyakarta and Surakarta, but that could also be applied to other medium-sized cities in Indonesia and possibly other developing countries. The application of this evaluation framework to these two cities will show if a true evaluation of the sustainability of the transport systems is possible to identify sustainable transport challenges, or, if not, what the problems are. The results will be used to set guidelines for future evaluations in these two cities and in other medium-sized cities in Indonesia and the developing world.

2.3 Research model

The research model describes the structure for the research. First the research questions are described. Sub-questions are used to indicate what kind of information is needed to answer the research questions. Secondly the conceptual model for this research is presented.

2.3.1 Research questions:

1. *Which framework should be used for evaluating the sustainability of the transport systems?*
   Many evaluation frameworks are available for evaluating sustainable transport. The one used in this research should be suitable for use in medium-sized cities in developing countries. Chapter 3 gives an overview of evaluation frameworks and presents the chosen framework for this research.

   Sub-questions:
   a. *What are available evaluation frameworks?*
   b. *Which aspects of the evaluation frameworks are relevant for evaluating sustainable transport in the context of medium-sized Indonesian cities?*
   c. *Which indicators should be used to evaluate sustainable transport?*
   d. *What are criteria for selecting suitable indicators?*

2. *What are sustainable transport problem and policies?*
   In Chapter 4 an overview of sustainable transport will be given to get familiar with the concept and use of sustainable transport. The relation of sustainable transport to the climate change debate is explained. The chapter discusses which policies local governments can adopt to deal with sustainable transport problems. These polcies will be related in next chapters to the chosen indicator set and the sustainable transport policies in Yogyakarta and Surakarta.

3. *What are the sustainable transport challenges for Yogyakarta and Surakarta?*
   The purpose of evaluating the sustainability of transport systems in this research is to identify sustainable transport challenges. By applying the developed evaluation framework to the two pilot cities, Yogyakarta and Surakarta, the challenges these cities face should become clear. Chapter 5 describes the indicator set used for both cities and shows the indicator data. The results for both cities will be compared to see if the differences in indicator data can be related to transport policies in the past.
   Sub-questions:

   a. *Which set of indicators is suitable for Yogyakarta and Surakarta?*
   b. *Which trends do the indicator data show?*
   c. *How can the differences between the two cities be explained?*

4. *What can be learned from the application of the framework to Yogyakarta and Surakarta?*
   The results from the pilot studies will be used to determine if there is a gap between which results were expected and the actual results. In Chapter 6 the causes of this gap will be identified on a strategic level and an operational level. In this chapter there is also feedback on the developed framework.

   Sub-questions:
   a. *What are the issues on a strategic level?*
   b. *What are the issues on an operational level?*
   c. *Are these issues found in other developing countries as well?*
   d. *How did the framework perform?*

5. *Which guidelines follow from the pilot studies?*
   Chapter 7 deals with the question how to close the gap between theory and practice. A number of strategies is proposed to deal with the identified issues in the previous chapter. This is done for the pilot cities, but also with a look at cities in other contexts.

   Sub-questions:
   a. *What are the minimum requirements for evaluating sustainable transport?*
   b. *Do these guidelines also apply to other cities?*

2.3.2 Conceptual model

Evaluation is an important aspect in achieving sustainable transport objectives (Bongardt et al., 2011; CST, 2000). In this research the transport systems of Yogyakarta and Surakarta will be evaluated on a local level, with an evaluation framework designed and applied for their context. Comparing or benchmarking countries or cities in both developed and developing countries does allow to show what country-specific challenges are (Bongardt et al., 2011), but it does not relate to differences in situations. Another reason for evaluating on a local level is the lack of indicator data in many developing countries (Bongardt et al., 2011). This problem is also recognized in Agenda 21; the gap between the availability, quality, coherence, standardization and accessibility of data between developed and developing countries is increasing, which makes it harder for these developing countries to make informed decisions (UN, 1992b).

This research aims at identifying the gap between what Yogyakarta and Surakarta should be able to do and what they currently can do in evaluating their own transport systems. An evaluation framework is built based on the concept of sustainable transport in the context of these two pilot cities. The framework is applied to both cities and the results are used to describe the gap between the desired outcome of such an evaluation and the outcome in reality. The results of this comparison will be used to set guidelines for future evaluations dealing with this gap between theory and practice. The conceptual model of this research is shown in Figure 2.

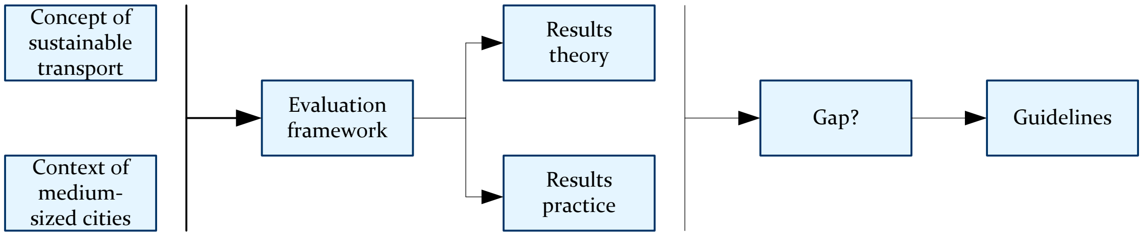


Figure 2 Conceptual model

2.4 Research methodology

The research methodology follows the research questions. So first an idea about the current problems, policies and solutions in sustainable transport is obtained. Then the evaluation framework is built based on a literature study. The aspects relevant for evaluating sustainable transport in medium-sized cities in developing cities will be chosen for the framework. This framework is then applied to the two pilot cities, Yogyakarta and Surakarta. For these cities an indicator set is chosen and indicator data are used to try to identify sustainable transport challenges. The results from applying the evaluation framework to these two cities are used to see if Yogyakarta and Surakarta are capable of identifying challenges. In the discussion of the results operational and strategic issues concerning the evaluation are identified. Also feedback to the used framework is given through the experiences in the two pilot cities. All the results will be used to provide guidelines for future sustainable transport evaluations. All these steps are shown in Figure 3.

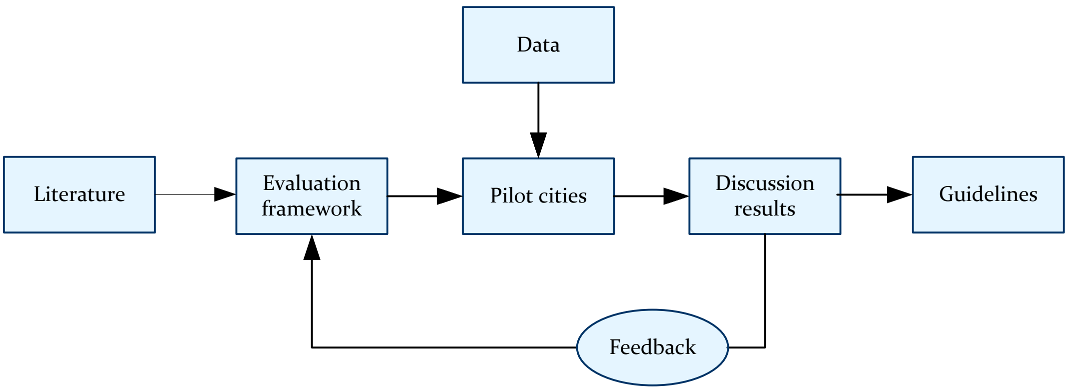


Figure 3 Structural model

3 Evaluation framework

Evaluating the sustainability of transport systems is an important aspect in developing sustainable transport strategies. This evaluation requires a framework in which indicators are used to describe the sustainability of a transport system. In this chapter such a framework is built for medium-sized cities in an Indonesian context.

3.1 Indicators

To measure the impact of transportation on several issues indicators are needed (Bongardt et al., 2011). At the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, Agenda 21 was adopted, in which the development of indicators of sustainable development was promoted (UN, 1992b). This has been the starting point for the development of indicators for sustainable development, including indicators for sustainable transport.

An indicator is a "variable selected and defined to measure progress toward an objective" (Litman, 2008). Indicators can serve several functions: simplification, quantification, benchmarking, comparison and communication. There are indicators that measure progress toward a more sustainable process (outcome) and indicators that measure the results of actions (output) (Bongardt et al., 2011).

Indicators can be used to evaluate if transport systems are becoming more sustainable and if policies achieve the goals they should serve (Gudmundsson, 2001). Indicators tell something about the performance of transportation systems and policies. The use of indicators is attractive, because they are able to capture all the dimensions of sustainable transport and indicators can simplify the complex concept of sustainable transport into small and manageable units of information (Castillo & Pitfield, 2010).

The following part describes the use of indicators in sustainable transport evaluation frameworks. It focuses on the selection process and issues involved with the selection and use of indicators. Finally a selection method is chosen for the evaluation framework that is developed in this research.

3.1.1 Indicator set selection method

It is important that the evaluation framework is scientifically sound and fits the objective of the research, so it should allow evaluating the sustainability of the transport system in its context. Participation from relevant local stakeholders is seen as an important aspect in the framework, to avoid the downfall of too much influence from the researcher in the results and to relate to the contextual perception of sustainable transport. The involvement of local communities in planning processes is advocated in UN's Local Agenda 21 (UN, 1992a). Not only in planning processes, but as well in selecting, collecting and monitoring of indicators should local communities participate (Corbiére-Nicollier, Ferrari, Jemelin, & Jolliet, 2003). At a city level the people who live in the city should be consulted together with the involvement of experts (Lautso et al., 2004). Research has shown that stakeholders can have different perceptions of what sustainable transport is and which indicators should be used to evaluate it (Marletto & Mameli, 2012). While transport users are more concerned about reducing private transport costs, air pollution and traffic accidents, experts are more concerned about improving accessibility of non-motorized transport and public transport, and reducing the consumption of land and public space by urban mobility. The research of Marletto and Mameli also shows that the size of cities and the transport mode used influence the perception of citizens on what sustainable transport issues are.

Many methods in the past have used a top-down approach, an evaluation based on experts' opinions about sustainable transport (Reed, Fraser, & Dougill, 2006). Bottom-up approaches, which are lead by public opinions, have been less popular, but can be integrated in the top-down approach as Reed, Fraser and Dougill have shown. For this research a selection method that integrates the top-down and bottom-up approach, by treating all stakeholders equally, is thought to be best suitable.

Evaluating sustainable transport should be done in relation to the transport goals to be able to evaluate the effects of the transport policy and give direction to future policy (Castillo & Pitfield, 2010). The definition of sustainable transport in the specific situation is critical in the selection of indicators (Jeon & Amekudzi, 2005). Therefore it is important to include the local perception if sustainable transport in the selection of indicators.

Five evaluation frameworks were reviewed for this research, see Table 15 in Appendix A. The advantages and disadvantages of the five frameworks were described and the positive aspects, accounting for the limited time and resources in this research, were used to design the selection method for indicators in the evaluation framework.

The influence of the method of Castillo and Pitfield (2010), ELASTIC, on this research' indicator selection method has been dominant as this method allows to incorporate the local perception of sustainable transport and involves stakeholder input. Aspects from other methods were added to include more stakeholder involvement during the selection procedure. The selection of a set of indicators is done through the Analytic Hierarchy Process (AHP) in which stakeholder input is used to give weights to selection criteria. Figure 4 shows the steps that have to be taken to select the right indicators. The steps will be further explained in the next parts.

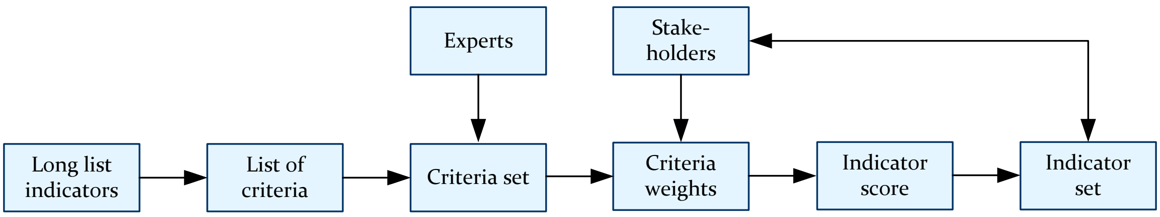


Figure 4 Indicator selection method

3.2 Long-list

To be able to select the appropriate set of indicators for the evaluation of sustainable transport an initial long-list of possible indicators has been made based on literature on indicators and examples of international projects that used sustainable transport indicators. This resulted in a total of 263 indicators. In the following part a description of the used sources is given and a short analysis on the indicators found is provided.

3.2.1 Sources

An overview of the used sources to create a long-list of indicators is presented in Table 16 in the Appendix. In total 12 sources were used, resulting in a total of 263 indicators. For each source the aim of the approach is described and the table shows which aspects of sustainability were addressed by the indicators.

3.2.2 Analysis long-list

The several sources used for the long-list had differing aims, which inherently leads to different indicator sets. For instance some sources may aim at the inclusion of environmental issues in transport evaluation and thus over represent environmental indicators. But by combining all indicators a comprehensive list has been made. A set that is suitable for use in this research.

Another difference that can be noticed is the number of used indicators. This can also partly be explained by the differences in approach. Some reports provide guidelines and may therefore use more indicators as examples, while some of the papers tried to make a set of indicators ready for application. The appropriate size of an indicator set depends on its purpose. For researchers and policy makers more data might seem attractive, for decision makers and the general public a set of 10 to 15 indicators is preferred (Dahl, 2012) to be able to comprehend.

Many of the indicator sets have common indicators, or nearly common indicators. Some of the frequently used indicators are the household consumption for transport, traffic accidents, and emission of greenhouse gases. The way indicators are described and measured shows some gaps. For instance the time that people spend in traffic is described in various ways, see Table 1. While some indicators measure only the time spent in traffic, others measure the congestion delay, average speed, or costs associated with the delay. The question is which indicator should be used in measuring sustainability. With the use of the proposed evaluation method the indicator with the highest methodological quality and relevance to the concept of sustainability will be chosen.

Table 1 Indicators related to travel time

Indicator	Source
Average commute travel time and reliability	Litman (2011b)
Commuting time	Bojković, Anić, and Pejčić-Tarle (2010)
Average total journey time	Kane (2010)
Per capita congestion delay/costs	Litman (2011b)
Social/external cost of transport	Castillo and Pitfield (2010)
Social cost of transport	OECD (1999)
Average time spent in traffic	Haghshenas and Vaziri (2012)
Minutes lost per person or per kilometer per day	CAI Asia (2010)
Average speed of cars/motorcycles in peak hour	UTBI (2006)
Total time spent in traffic	Lautso et al. (2004)

Sometimes the unit used for measuring an indicator differed. The indicator local air quality can be measured by the total emission of local air pollutants, but the amount residents are exposed to is also used. Again the question which measure is the best indicator of sustainability can be asked. Dahl (2012) criticizes the use of unsustainable indicators instead of using indicators that measure sustainability. He argues that a new set of values-based indicators is needed, in which the indicators are scientifically underpinned to earn the confidence of users, who should be involved in selecting the indicators.

Many indicators are related to more than one dimension. Local air pollution damages the environment, but is also harmful to people. Taxes on fuel generate income for the government, but also have effect on the use of non-renewable fuels. The cost of transport for users is sometimes seen as an economical indicator, but other sources have put this under the social dimension. These three examples show that between all dimensions indicators are shared. This does not have to be a problem, as long as it is acknowledged that the indicator does not cover just one dimension. Especially when a set of indicators is chosen this should be taken into account to choose a set that covers all dimensions equally. It is even suggested by Gustavson, Lonergan, and Ruitenbeek (1999) to use indicators that reflect more than one dimension, as this is more efficient.

3.3 Criteria

For the selection of the right indicators criteria are used. By using stakeholder input, through expert judgments and surveys, the concept of sustainable transport is defined in these criteria. These criteria also help finding the indicator that describes the concept of sustainable transport best.

3.3.1 Set of criteria

In the literature many criteria for selecting criteria were found. The criteria that applied to the selection of indicators from a long-list were collected. Criteria were selected in two categories: criteria that relate to the methodological quality of indicators and criteria that relate to the relevance of indicators to the concept of sustainable transport. For the first category a literature study has been performed, which resulted in a long-list of possible criteria, see Table 17 in Appendix C. This initial long-list has been cut down to ten possible criteria, which are listed in Table 2. The criteria for the relevance of an indicator to the concept of sustainable transport were also used by (Castillo & Pitfield, 2010) and originate from the PROSPECTS project (May et al., 2001), which are listed in Table 3. 'Religion' was added as a possible criterion after a first discussion with some experts, as in the Indonesian context this can be an important criterion.

Table 2 Set of methodological criteria

Criterion methodology	Description
Understandable	Indicator is understandable for the general public
Validity	Indicator measures the issue
Useful	Indicator is useful for decision makers
Long-term view	Indicator relates to historical and future information
Measurability	Indicator can be measured theoretically sound, dependable and easily understood
Availability	Data for indicator is easily and regularly available
Transport's impacts isolated	Indicator measures the impact of only transport
Reliability	The quality of the data is reliable
Transparency	Indicator is clearly described in the context, has scientific foundation, and has a robust value
Actionability	Indicator measures factors that can be influenced by policy action

Table 3 Set of relevance criteria

Criterion relevance	Description
Livable streets and neighborhoods	The indicator measures physical, aesthetic and special characteristics
Protection of the environment	The impact of transport on the environment is measured by the indicator
Equity and social inclusion	Indicator measures differences between social, economic and geographical groups
Health and safety	The indicator relates to health and safety issues
Support of a vibrant and efficient economy	The indicator shows effects of transport on the economy
Religion	The indicator measures the impact of transport on religious activities

The relevance criteria cover the three dimensions of sustainability. The methodological criteria make sure that the quality of measuring the indicator is high enough. The criterion 'long-term view' relates to present and future dimension of sustainability. For each of the indicators in the final set data should be collected for the past, present and future, but these criteria cannot guarantee that this will be possible for all indicators. Also differences between social groups should be tried to measure, but these cannot be ensured through these criteria.

3.3.2 Criteria weights

As was done in the research of Castillo and Pitfield (2010) the criteria will be weighed to reflect the perception of sustainable transport. The Analytic Hierarchy Process (AHP) is used to assign weights to the criteria through stakeholder surveys. An explanation of AHP can be found in Appendix D.

A set of five criteria was thought to be the best, as more criteria will lead to too much pair wise comparisons in the surveys (Aull-Hyde, Erdogan, & Duke, 2006). Experts should be asked to rank the criteria and then the highest ranked indicators will be used in the surveys. For the surveys it is important to include all relevant stakeholders to obtain a good idea of the perceptions of each stakeholder about the concept of sustainable transport. In the research of Castillo and Pitfield (2010) only transport academics and planners were included in the survey, but in this research other stakeholders are also considered, including the transport users.

The surveys will be processed and this will result in weights for the criteria per stakeholder group. These results can be analyzed first to see what the differences between the stakeholders are and for the final weights the results have to be aggregated. It is important that only the results from expert stakeholders should be used for the methodological quality of indicators, as other stakeholders do not have enough knowledge to do this. For the criteria that relate to the relevance of an indicator to the concept of sustainable transport the results from all stakeholders can be used, where each stakeholder group has the same weight.

3.4 Indicator set

All indicators in the long list have to be scored on all criteria to reflect how good the indicator scores on the specific criterion, where 0 is the lowest score for indicators that perform very poor and 4 the highest score for a high performance on a criterion. The scores for each criterion are multiplied with the weight of this criterion. This is done for all criteria and the total scores are summed up. In this way each indicator has a score. The list of indicators is then sorted based on the total scores. The 15 indicators with the highest score are selected. When this is done it is important that there are no indicators that measure the same aspect, so there should be a check for overlapping indicators.

When the set of indicators has been made there should be feedback to stakeholders, to inform them on what the results of the survey are. But also to discuss if the chosen set is complete and if the indicator set measures the important aspects of sustainable transport. The feedback could result in some adjustments in the indicator set.

3.5 Indicator data

With the final set of indicators chosen data collection is required to be able to analyze the sustainability of transport systems. For each of the indicators it should be clear what kind of data is needed. This part discusses how data should be collected and how the data needs to be processed and presented.

3.5.1 Collecting

For the collection of indicator data it is important that the indicator is well described, including the relation to sustainable transport. It should be clear what it measures, so the unit of the indicator should be known before collecting data (Litman, 2011b).

In developing countries less indicator data is available. If the necessary data for an indicator is not available, other data that describes the same indicator, but in different units, can also be used. Also in these countries more qualitative data can be used if quantitative data is not available (Center for Clean Air Policy, 2011).

Sustainable development is a direction for policy, therefore evaluating transport systems should measure developments over time. This will allow seeing if this indicator is moving in a sustainable direction or not (Litman, 2011b). Measuring indicator trends can also identify the effectiveness of policy measures. Spatial representation of data can be useful for some indicators, as this will show where major problems occur and which people are affected most. This could for example be done for indicators like local air quality or traffic accidents, if detailed spatial data is available.

3.5.2 Processing

Processing of indicator data is necessary to provide comparable and meaningful results that can be interpreted by policy makers, the general public and other stakeholders (Bongardt et al., 2011). If the indicator data is used to compare two or more cities, like in this research, the data should be comparable. First of all they need the same units, but for some indicators it is also necessary to normalize data. For example, the number of registered motorized vehicles in a city will depend on the number of citizens. So to compare this indicator the data should be normalized for the number of residents.

The results of the evaluation will be used to identify sustainable transport challenges. So these should follow from the presentation of the data. As there are many different indicators used for the evaluation of sustainable transport, there are also many different ways in which results are presented. An overview of some different methods is given and in the end the best suitable one for the context of medium-sized cities in developing countries is chosen.

STPI (CST, 2002)

The sustainable transport performance indicators project (STPI) has been undertaken by the Centre for Sustainable Transport (CST) in Canada. The focus of this project has been on selecting the right indicators, but in the third report indicator data is also presented. Most of the data is presented in graphs, showing trends over time. Tables and charts are also used, when better suitable. In the summary of the results on all indicators smiley faces are used to indicate what the direction of progress is (positive, neutral or negative). This feature has been adapted from the TERM 2001 reporting (European Environment Agency, 2001).

OECD evaluation framework (OECD, 1999)
The OECD framework is designed to reveal trends and phenomena that need further attention or action. It focuses on the relation between transport and the environment. The selected indicators are presented separately, using different presentation methods; tables, graphs, charts. These are used to show changes over time, but also to compare countries.

PROPOLIS (Lautso et al., 2004)
PROPOLIS is a research project within the Fifth Framework Programme of the European Commission and is used to evaluate the effect of policy options on the sustainability of transport systems on a city level. The PROPOLIS approach uses a set of indicators for each of the three dimensions of sustainability and one additional set of background indicators. For the economic dimension a cost-benefit analysis is used, for the other two dimensions a multi-criteria analysis. To the indicators of the social and environmental dimension weights are assigned, which in the model is done through AHP. The results of PROPOLIS are scales per dimension. To be able to aggregate the indicator data per dimension and compare scenario outcomes, PROPOLIS uses upper and lower limits for indicator values and it normalizes all indicators through indicator functions. This results in a maximum and a minimum score for each dimension. The analysis of scenarios shows if the score is moving towards the maximum or minimum.

PROPOLIS uses a sophisticated approach to present indexed scales for each of the three dimensions of sustainability. The calculations used need a high quality and availability of indicator data, but also transport models.

PSUTA (CAI Asia, 2010)
The Partnership for sustainable urban transport in Asia (PSUTA) is an initiative of CAI-Asia in response of the fast motorization in Asian cities. The partners of PSUTA have developed a strategic framework for sustainable transport, which analyzes urban transport challenges. For three cities (Hanoi, Pune, Xian) indicators have been developed to help the local decision makers to better understand the current sustainability, or the lack of it, and help develop more structured and quantified transport policy. Indicator data is presented in tables and graphs, showing trends over time. In the end the major findings for the three cities are qualitatively described per sustainability pillar (safety, clean air, social, access and social sustainability, economic, overall).

SUMMA (RAND Europe et al., 2005)
SUMMA (SUstainable Mobility, policy Measures and Assessment) was designed to assist policy makers, in Europe, in making trade-offs and develop sustainable transport policy. SUMMA provides a model that calculates the effects of possible policy measures. The results are presented in tables that contain the indicators and the chosen policy measures. Colors indicate if the policy measure will have a positive (green), neutral (yellow) or negative effect (red) compared to a base scenario.

TERM (European Environment Agency, 2011)
The Transport and environment reporting mechanism (TERM) was set up to enable policy makers to monitor progress of their integration policies and the environmental performance of transport on the targets set in the Transport White Paper from 2001. With the launch of the new White Paper in 2011 has been updated. TERM uses graphs, diagrams, charts, tables and maps to present the results.

UTBI (UTBI, 2006)

The Urban transport benchmarking initiative (UTBI) aims at providing a useful context to policy makers and comparing the participating cities. Most of the results for the indicators are presented in bar diagrams. Some graphs are used to show relations between indicators.

3.5.3 Presentation of indicator data

From the previous examples it is clear that there is not a single best method to present the results of a transport evaluation. Some methods use aggregated data others just present values. For the evaluation framework that is developed in this research it is important that the presentation of the results match the purpose. The results from this evaluation framework will be used to identify sustainable transport challenges in medium-sized cities in the context of developing countries. In the selection of indicators public participation was considered important, so results should be easily interpretable for both policy makers and other stakeholders. These two aspects will determine which presentation method is the best for this evaluation framework.

When sustainable transport is considered as a direction for policy the trends of indicators should show if this indicator is developing in a sustainable direction. So data for several years is necessary to evaluate the direction of development. On the other hand it is also relevant to see if the indicator currently is at a sustainable level, this will help identifying the transport challenges.

If sufficient data is available about the indicator and about the targets for the indicator, a scale can be used. Using a scale will show to what degree targets are achieved. But as it is assumed that in medium-sized cities in developing countries data is less available it will be hard to make good scales. Therefore for this evaluation framework an indication of the direction of indicator development will be used. This can either be positive when the indicator is moving in a sustainable direction, negative for the opposite or neutral when there is not much development. For the current situation the same will be done. This requires that an idea about what sustainable or unsustainable values for indicators are should be obtained. Colors will be used to present the scores of all indicators, green for positive scores, red for negative and yellow for neutral.

Trends show the development of an indicator over time. Data from several years is needed to make good trends that give useful information. Data from 5-10 years will at least be necessary to make a trend that describes recent developments. If more years are used this will even provide more information. The trends can be related to policies that have been implemented in the past to explain why the indicator developed in a certain way.

In many researches the data from indicators is aggregated in an index or several indices. This makes it possible to present the results of a study in a few figures, so scores are fast interpretable. Indices can also be used to compare cities, regions or countries and make rankings. This is however susceptible to errors and might lead to the illusion that the index covers the complete concept of sustainability (Morse & Fraser, 2005). The data that is used in this framework will not be aggregated into one composite index. A first reason is that the data availability is too limited. The use of indices requires high quality data, which in the context of medium-sized cities in developing countries probably is not available. A second reason is that presenting the data in a disaggregated form is better interpretable for transport users and other stakeholders. Presenting the data in their original form gives a lot of information that would be lost if the data would have been aggregated.

4 Sustainable transport overview

In this research an indicator set is chosen to evaluate the sustainability of the transport systems in Yogyakarta and Surakarta. To be able to see if these indicators also relate to possible sustainable transport policies, this chapter presents an overview of policies which can be adopted by local governments. The overview is also used to evaluate the transport policies of both cities.

This chapter follows the structure of the first chapter and starts with a discussion on the contribution of transport to greenhouse gases, followed by a discussion on co-benefits. The use of the ASIF model is explained with respect to low carbon development and the use of co-benefits. Special attention is given to sustainable transport problems in developing countries as this is the focus of this research. Then the overview of possible sustainable transport policies is presented.

4.1 Transportation's contribution to climate change

Chapter 1 already briefly discussed the climate change debate and the role transport plays in the GHG emissions. The challenge for the next decade will be to mitigate GHG emissions from transport and particularly CO_2 emissions. At the moment transport contributes to 19% of the global energy use and to almost 25% of the energy related CO_2 emissions and is expected to reach 50% in 2030 and 80% in 2050 (IEA, 2009). These figures show the importance of the transport sector in the climate change debate and the need for low carbon development.

To achieve the CO_2 mitigation as discussed in Chapter 1 the transport sector will have to change. Studies have been carried out that calculated the possible reduction in CO_2 emissions from transport. The study of Schipper, Ng, Gould, and Deakin (2010) developed two scenarios and calculated what CO_2 reductions are possible for 2050. In the first scenario, called 'Globalization', there is strong international cooperation to decrease CO_2 emissions, which leads to innovations in vehicle technology and stricter standards. In this scenario CO_2 emissions are 72% less in North America and 54% in South America in 2050 compared to a business as usual scenario. The second scenario, called 'Glocalization', is based on local concerns for reducing transportation problems. This concern will lower distances traveled and shifts travel to less CO_2 intensive modes. In this scenario reductions of respectively 78% and 34% can be reached. These scenarios show that emissions can be decreased, but they require a comprehensive set of complementary policies in the next years.

Much of the increase in CO_2 emissions from transport will take place in Asian countries (EIA, 2011). Measuring the emission levels in these countries is important to understand why levels are increasing and how they can be reduced, but lack of availability of data makes it hard to analyze current levels or make predictions for the future (Schipper, Fabian, & Leather, 2009). The data that is available is often only the information from fuel sales. From these figures CO_2 emissions can be calculated through a top-down method, but it is better to use a bottom-up approach, as a top-down approach does not reveal impacts of transport or CO_2 focused policies. The International Environmental Agency developed the ASIF model to calculate CO_2 emissions from transport. In this model greenhouse gases (G) are a product of travel activity (A), the mode structure (S), the fuel intensity per mode (I) and the carbon content of the fuel (F) (IEA, 2009). Using this model it is possible to measure the effect of single policy measures on the emission of CO_2 and also the effect of co-benefits can be measured using this model (Schipper et al., 2009). Data availability in Asian countries however is still limited, Schipper et al. (2009) argue that governments need to address more structural funding to data collection and they should not rely on project based data or foreign assistance in collecting data. As discussed in Chapter 1 co-benefits can be important on a local scale and can be decisive in receiving funding. Co-benefits are often part of sustainable transport policies. The problems and solutions related to sustainable transport in developing countries are discussed next.

4.2 Sustainable transport problems in developing countries

Although both developed and developing countries are facing sustainable transport problems, these problems and the possible solutions are not the same (ADB, 2009). Huizenga (2009) appoints the differences between developed and developing countries:

Developed countries:

- High baseline
- Low growth
- High private transport share
- Many four-wheelers
- Good data availability
- Strong institutional capacity
- Market failure

Developing countries:

- Low baseline
- High growth
- High PT and NMT shares
- Many two-wheelers (Asia)
- Limited data availability
- Weak institutional capacity
- Market absence and failure

Gakenheimer and Dimitriou (2011) add to the characteristics of developing countries that in cities personal trip patterns are changing fast, land use densities are declining, many vehicle technologies are obstructing each other which makes integration difficult, infrastructure is inadequate in many places, freight logistics are changing, and there are too little efforts to deal with local pollution. This mixture of characteristics creates problems on all the dimensions of sustainability. These problems include congestion, traffic accidents, damage to the environment, both locally and globally, and diminishing oil reserves (Banister, 2005; W. R. Black, 2010; Zusman, Srinivasan, & Dhakal, 2012).

Because motorization levels in developing countries are still relatively low compared to developed countries it is possible to leapfrog the high individual car dependency, high energy use and the low transport efficiency experienced in many developed countries (ADB, 2009). The ADB uses the Avoid, Shift, Improve (ASI) approach to develop sustainable transport solutions:

- *"Avoid or reduce travel demand, which could be achieved through better integration of land use and transport planning;*
- *Shifting travel to, or keeping the modal share of the most efficient mode, which in most cases will be either non-motorized transport or public transport; and*
- *Improving existing forms of motorized transport through technological improvements and innovations to make engines and fuels less carbon intensive"* (ADB, 2009)

The ADB considers this approach to be the most feasible way to mitigate GHG emissions in developing countries in the future and realize the co-benefits of a sustainable low-carbon transport system in a short period, but the success is highly dependent on the policy instruments that can be put in place in the next few years. The ASI approach is strongly linked to the ASIF model. The avoidance of travel is corresponds with the activity, the modal shift with the mode structure and the improvement of existing motorized transport with the fuel intensity per mode and carbon intensiveness of fuels.

4.3 Sustainable transport policies

Sustainable transport has been on the agenda of local governments for some time. This has resulted in many solutions to the problems mentioned before. The solutions cover various areas, from land use development to technological solutions. Table 4 gives an overview of possible policies local governments can adopt to develop sustainable transport systems. The policies have been grouped using the ASI approach. A comprehensive set of different measures is necessary to be successful at making transport systems more sustainable (Banister, 2005; W. R. Black, 2010; Zusman et al., 2012).

Table 4 Overview of sustainable transport policies

Driver	Changes to the driver	Policies
Avoid	Avoid urban sprawl	Creating regional systems of cities
		Promoting compact cities and smart growth
		Mixed use developments
	Reduce necessity of trips	IT-based communications and services to reduce transportation needs
		Home delivery of goods
		Transport optimization
Shift	Improve public transport	Public transport capacity investment
		Public transport subsidy
		Promotion of rail-based mass rapid transit
		Promoting bus rapid transit (BRT)
		Improving bus routes and services
		Using community vehicles
		Development at public transport nodes
		Demand responsive transport
		Park and ride
	Improve non-motorized transport	Promoting special lanes for pedestrians and cyclists
		Car-free zones
		Traffic calming
		Cycle subsidy
	Reduce ownership and use of automobiles	Number plate bidding systems
		Promoting car sharing
		Regulating entrance to city centers (number plate regulation)
		Road capacity restraints and reductions
		Parking policy

		High occupancy vehicle lanes
		Road pricing to control vehicle use
		Travel awareness initiatives for wise use of automobiles
		Peak congestion avoidance
		Company work hours policy
Improve	Reduce emissions from conventional fuel vehicles (including hybrids)	Vehicle emission standards and inspection/maintenance systems
		Vehicle fuel standards
		Greening fuel taxes
		Promoting high efficiency vehicles
		Intelligent transport systems (ITS)
	Introduce alternative fuel vehicles (bio-fuel, CNG, LPG, EV, fuel cells)	Promoting alternative fuel vehicles

Sources: Banister (2005), W. R. Black (2010), Zusman et al. (2012)

Implementation of sustainable policies is not an easy task. Although Table 4 gives a nice overview of possible solutions, it depends on the local context which set of policies should be implemented and how these should be implemented. Also for some of the policies it is not clear if they have a positive effect on sustainability. For example the effects of integrated land use and transport planning are not unambiguous (Wegener & Fürst, 1999). In a review of empirical studies on the interaction between land use and transport Wegener and Fürst found some factors that influence the travel demand. Neighborhood design can lead to shorter trips and higher shares for non-motorized transport and public transport. High residential and employment density have positive effects on the use of public transport. High densities lead to shorter trips in some studies, but in other studies this relation was not found. Wegener and Fürst conclude that land use policies that increase densities of mixed land use can only be effective if they are accompanied by car restrictive measures, making the car more expensive or slower.

Another example of a policy that is difficult to implement is Bus Rapid Transit (BRT). In recent years BRT has been a popular policy in many cities across the world, but often the BRT systems failed (Wright, 2011). Often cities believed that BRT would solve all their transport problems, but these cities did not implement the system right. Wright describes some of the most often made mistakes:

1. System designed around a technology, not the customer
2. System designed around the existing operators, not the customer
3. Too little investment in the planning process
4. No competitive tendering of planning consultants
5. Too few full-time staff dedicated to planning the system
6. First phase is too limited in scope
7. No reorganization of existing bus routes
8. No reorganization of existing regulatory structures
9. Allowing all existing bus operators to use busway infrastructure
10. No competitive tendering of bus operators

11. No independent concession for fare collection
12. Public sector procurement of vehicles
13. No provision of feeder services or direct services into residential areas
14. System built on low-demand corridor(s) to make construction easier
15. No provision of safe and quality access for pedestrians to stations
16. No provision for integration with other transport modes
17. No integration of BRT plan with land use planning
18. Under sizing vehicles and/or infrastructure for the given demand
19. Too few doorways in vehicles or station to facilitate rapid boarding and alighting
20. No communications plan, marketing campaign, or system branding to explain or promote the new system

These two examples of policies show that implementing sustainable transport policies is not a straightforward task. It involves a good understanding of the situation, a comprehensive view on solutions and knowledge about the implementation of policies.

5 Pilot studies

This chapter seeks to evaluate the feasibility of applying the sustainable transport evaluation framework to medium-sized cities in an Indonesian context. The results of applying the evaluation framework to the cities of Yogyakarta and Surakarta are presented. First selection criteria are selected for the indicators. Surveys have been used to give weights to these criteria and select an indicator set. The data for these indicators has been collected and evaluated. The results for both cities are compared and transport challenges are identified.

5.1 Study area

The cities of Yogyakarta and Surakarta have been chosen for the pilot studies. Both cities are located centrally on the island of Java in Indonesia. Yogyakarta is part of the Special Province of Yogyakarta, Surakarta is a city in the much larger province of Central Java. Both cities were part of the ancient Mataram kingdom, of which Yogyakarta was the capital. In both cities there still is a sultan, who resides in his palace (Kraton). Yogyakarta is after Bali the most visited tourist place in Indonesia, most people visit the city for the temples of Borobudur and Prambanan. Yogyakarta and Surakarta are also known for their Javanese culture; the dances, the puppet shows and the batik painting.

The study areas are the city areas of Yogyakarta and Surakarta, see Figure 5 and Figure 6. These areas have been chosen because these are the most populated areas, they are of comparable size and data is available for this area. The total urban area is larger than these city areas, as it stretches out into some of the adjacent regencies. These regencies are much larger than the city area and are largely rural. For the complete urban areas of both cities data is not collected, only for the city area and the regencies. Therefore using the total urban area for the pilot studies is not possible.

The size of the area of Yogyakarta City is 32.5 km^2, while Surakarta is a bit larger with 44.1 km^2. Population numbers in 2010 were respectively 468,342 and 530,282, which comes down to densities of respectively 14,411 inhabitants/km^2 and 12,025 inhabitants/km^2. For Yogyakarta the actual number of people living in the city area is probably higher as there are many students living in Yogyakarta who are still registered at their parents' address. The developments in population (Figure 7) show that the increase in Yogyakarta has been higher (19%) then in Surakarta (6%) in the period of 2003 to 2010. The development of the gross regional domestic product per capita show opposite trends (Figure 8); in Surakarta the GRDP grew with 29% in the period of 2003 to 2009, in Yogyakarta the growth was 11% for the same period.

Although both cities are comparable on a number of aspects, it is expected that differences in transport policies in the past have lead to different transport systems. The use of indicators in the evaluation should identify if the transport policies in both cities have lead to different outcomes.

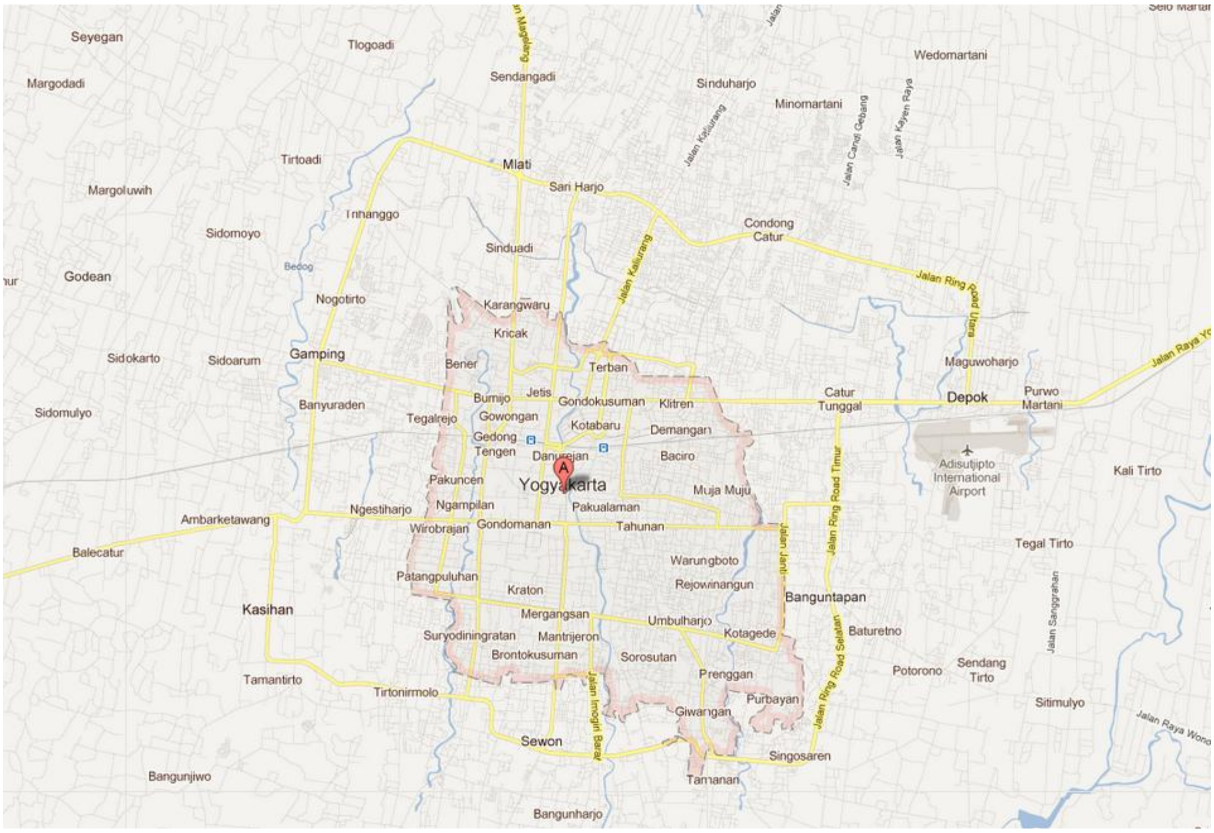


Figure 5 City of Yogyakarta area

Source: Google maps (2012)

Figure 6 City of Surakarta area

Source: Google maps (2012)

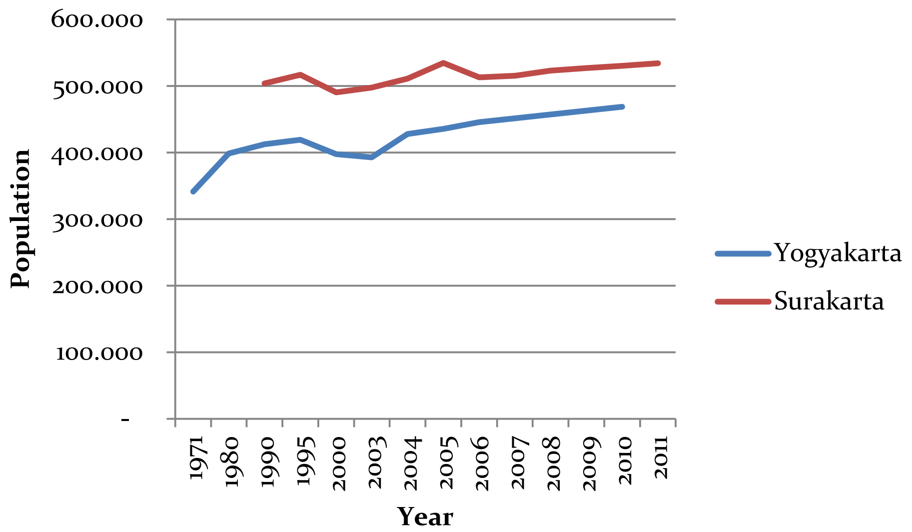


Figure 7 Population Yogyakarta and Surakarta

Surakarta 2009-2011 based on 0.7% growth (CDIA, 2011f)
Sources: CDIA (2011b), CDIA (2011f),BPS Kota Yogyakarta (2007), Tatralok (2010)

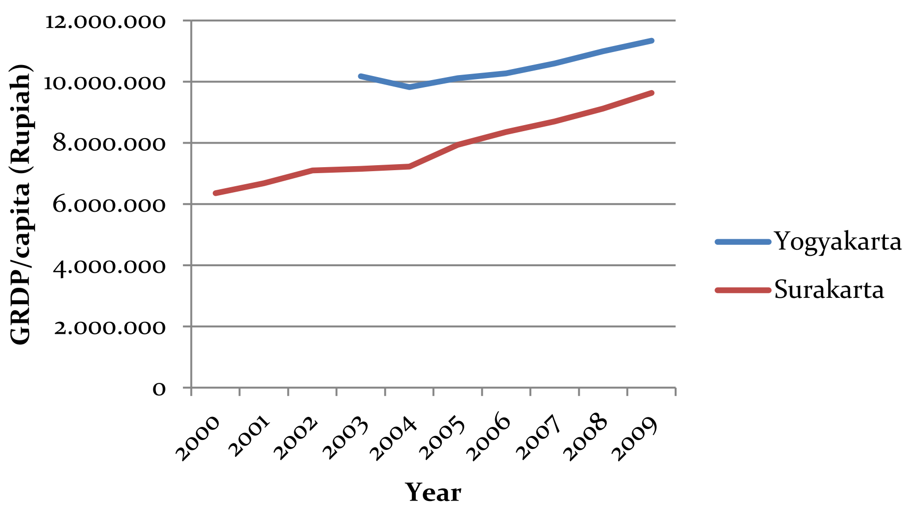


Figure 8 GRDP per capita in Yogyakarta and Surakarta

Sources: Bappeda Kota Yogyakarta (2006), CDIA (2011b), CDIA (2011f)

5.2 Indicator selection

The first step in the evaluation framework deals with selecting an indicator set that is suitable for the context. First the selection criteria are selected based on expert judgments and then surveys are used give weight to these criteria. By rating the long-list of indicators on each of the criteria a ranking of indicators is developed. The highest scoring indicators are chosen for evaluation of the sustainability of the transport systems in Yogyakarta and Surakarta.

5.2.1 Set of criteria

Five experts from PUSTRAL, the research center for transport and logistics studies at the Gadjah Mada University, were asked to rank the criteria from both categories. A Borda-count was used to aggregate the judgments from the experts. In a Borda-count people have to rank a set of alternatives (n). The highest ranked alternative receives a score of n, the second score n-1 and so on. The scores for each of the individual judgments are summed and a final ranking is made. The results from the experts of PUSTRAL were used to select the five criteria from each set with the highest ranking (in bold), see Table 5 and Table 6.

Table 5 Ranking of initial set of methodological criteria

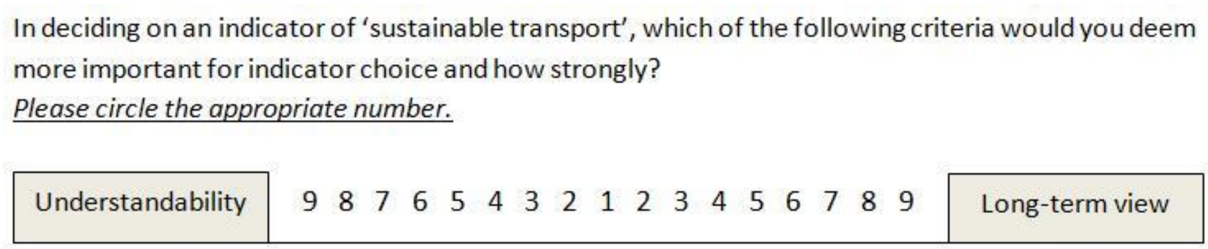
Criterion methodology	Description	Rank (1-10)
Understandable	**Indicator is understandable for the general public**	**1**
Long-term view	**Indicator relates to historical and future data**	**2**
Measurability	**Indicator can be measured theoretically sound, dependable and easily understood**	**3**
Actionability	**Indicator measures factors that can be influenced by policy action**	**4**
Validity	**Indicator measures the issue**	**5**
Transparency	Indicator is clearly described in the context, has scientific foundation, and has a robust value	6
Reliability	The quality of the data is reliable	7
Useful	Indicator is useful for decision makers	8
Availability	Data for indicator is easily and regularly available	9
Transport's impacts isolated	Indicator measures the impact of only transport	10

Table 6 Ranking of initial set of relevance criteria

Criterion relevance	Description	Rank (1-6)
Equity and social inclusion	**Indicator measures differences between social, economic and geographical groups**	**1**
Livable streets and neighborhoods	**The indicator measures physical, aesthetic and special characteristics**	**2**
Support of a vibrant and efficient economy	**The indicator shows effects of transport on the economy**	**2**
Protection of the environment	**The impact of transport on the environment is measured by the indicator**	**4**
Health and safety	**The indicator relates to health and safety issues**	**5**
Religion	The indicator measures the impact of transport on religious activities	6

5.2.2 Survey design

The surveys were constructed in the same way as Castillo and Pitfield (2010) did. First an introduction was given into the research and then it was explained how to rate the pair wise comparisons of the criteria. These criteria were described at the beginning of the survey. Figure 9 gives an example of such a pair wise comparison, the complete survey can be found in Appendix E. The survey was translated into Bahasa Indonesia.


In deciding on an indicator of 'sustainable transport', which of the following criteria would you deem more important for indicator choice and how strongly?
Please circle the appropriate number.

Understandability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Long-term view

Figure 9 Example of questioning

For the survey five stakeholder groups were identified as the most important: transport academics, transport decision makers, transport planners, transport operators and transport users. Castillo and Pitfield (2010) only used the transport academics and planners in their research, so the approach used in this research should give a better view on the perception of all relevant stakeholders. The number of respondents for the methodological criteria was 34 academics and 38 planners, for the relevance criteria respectively 30 and 39. This research aimed at having similar numbers of respondents.

Transport academics are researchers in the field of transport. In Yogyakarta they can be found in the many universities. Transport planners work at the municipalities of Yogyakarta and Surakarta and are involved in making transport plans. In Yogyakarta and Surakarta transport academics also assist in the development of transport plans, which makes a distinction between the two difficult. The decision makers also work in the local government, they decide on new transport policies. Transport operators are the directors of bus companies in both cities. The group of transport users consists of all the persons that use the transport system, which is of course everybody. Therefore the survey sample should be representative for this group, covering all ages and all modes.

Two types of surveys were made; a hardcopy survey for the transport users and an online survey (in Survey Monkey) for the other stakeholders. The user survey was conducted by two paid students of the Gadjah Mada University, they collected 40 responses. The profile of the respondents is given in Appendix F. Most respondents were younger than 30 and probably student. This is a bias, as the group of respondents is not a good representation of the total group of transport users. The modal split of the respondents does seem to reflect the total modal split of all transport users and also the gender of respondents was divided. For the other four stakeholder groups the e-mail database of PUSTRAL was used. Although many e-mail addresses were available for transport academics and planners, it was harder to find addresses for transport decision makers and operators. Efforts had been made to collect more addresses through the Organda (organization of transport operators) of Yogyakarta and Surakarta, but without success. Because of the low response rate and few available e-mail addresses for the decision makers and operators it was decided to make a new stakeholder group: the transport experts, in which the results for the transport academics and planners are combined. To collect more responses the researchers at PUSTRAL were also asked to fill in the survey. In total 18 responses from experts were used, 5 from transport academics, 5 from transport planners and 8 from PUSTRAL researchers. The transport experts were asked to give judgments about both the methodological criteria and the relevance criteria, surveys from the transport users were only used for the relevance criteria.

The research of Marletto and Mameli (2012) has shown that transport experts and citizens choose different indicators to measure the sustainability of transport systems. Based on these results it is also expected that this research will show differences between the two stakeholder groups. Marletto and Mameli found that transport users choose indicators that are related to the negative externalities of transport, like traffic accidents and pollution, and expenditures on private transport. These are all indicators that affect the citizens personally. The transport experts chose indicators that describe the quality of transport modes (walkability, cyclability and quality of public transport) and the space used for transport. These indicators are all much more related to the transport system itself. So for the case of Yogyakarta and Surakarta it is expected that the transport users will give more weight to the criteria that relate to transport externalities that influence their lives. Based on the research of Marletto and Mameli this will probably be the 'protection of the environment' and 'health and safety'. Transport experts are expected to be more interested in the quality of modes. Walkability and cyclability are related to the criterion 'livable streets and neighborhoods', so it is expected that the experts will give more weight to this criterion. The differences in weights for the criteria will lead to different indicator sets per stakeholder. The indicator sets for both stakeholders will be compared and are used to reflect on the expected outcomes as described in this part.

5.2.3 Survey results

The responses were processed in Excel spreadsheets, which applied the AHP calculations to the judgments made by the respondents. For each respondent the consistency in their judgments was calculated, using the consistency ratio (CR). Although a CR of less than 0.1 is considered to be very consistent by Saaty (2003), it is not clear from literature how consistent individual judgments should be in order to be useful for aggregated judgments. Apostolou and Hassell (1993) show that inconsistent individual judgments do not have a significant influence on the final outcome. Aull-Hyde et al. (2006) show that as the number of alternatives used increases, the number of individual judgments needed to obtain a consistent matrix decreases. For a 5x5 matrix 25 random individual matrices will lead to a consistent aggregated matrix. Both researches do not say when an individual judgment is too inconsistent and focus only on the CR value of the aggregated matrix, as long as this is less than 0.1 they are satisfied. In the research of Castillo and Pitfield (2010) it is not clear how they dealt with inconsistent judgment, but their results suggest that all judgments were used.

Inconsistent judgments do have an influence on the final weightings, even though they might not be significant, so a threshold is needed to decide on which judgments should not be used. Alonso and Lamata (2006) say that sometimes CR's higher than 0.1 can be used depending on the situation, but they do not say which CR's are acceptable for individual judgments. Therefore in this research, individual judgments with a CR higher than 0.5 were considered to be too inconsistent, because these judgments are closer to the average inconsistent judgment than to the optimal consistent judgment, so these were excluded from the aggregated judgments.

The influence of the inconsistent judgments is demonstrated here.
Table 7 shows the number of judgments per CR class for the transport experts and users. Both stakeholders make inconsistent judgments. Table 8 and Table 9 show what the influence of these judgments on the aggregated weights is. From these tables it can be concluded that excluding the judgments with a CR higher than 0.5 will lead to other results, which probably represent the stakeholder group better.

Table 7 Number of inconsistent judgments per CR class

	Expert judgments		User judgements
CR	**Methodology**	**Relevance**	**Relevance**
0-0.1	2	4	11
0.1-0.2	9	5	13
0.2-0.3	2	0	1
0.3-0.4	0	4	4
0.4-0.5	3	1	1
0.5-1	2	4	4
>1	0	0	6

Table 8 Influence of inconsistent judgments on weightings for transport experts

	Methodology			Relevance		
Criterion	**All**	**CR <0.5**	**CR >0.5**	**All**	**CR <0.5**	**CR >0.5**
1	0.21	0.20	0.22	0.22	0.20	0.26
2	0.14	0.13	0.29	0.17	0.21	0.09
3	0.15	0.15	0.15	0.19	0.18	0.19
4	0.34	0.35	0.25	0.25	0.25	0.23
5	0.15	0.16	0.10	0.17	0.15	0.24

Table 9 Influence of inconsistent judgments on weightings for transport users

	Relevance		
Criterion	**All**	**CR <0.5**	**CR >0.5**
1	0.15	0.13	0.20
2	0.19	0.20	0.16
3	0.22	0.22	0.16
4	0.25	0.28	0.24
5	0.19	0.18	0.24

The results for both stakeholders are shown in

Table 10, Table 11 and Table 12. A complete overview of the weights for all stakeholders, including the initial stakeholder groups, is given in Table 19 in Appendix G. For the combined weights the geometric mean of the final matrices of both stakeholders was used, giving both stakeholders equal importance. In these tables it can be seen that there are some differences in the judgments of the transport experts and the transport users; health and safety is for both the most important criterion, but the importance of other criteria is not the same. The results of Castillo and Pitfield (2010), see Table 20 in Appendix G, show generally the same weights for the relevance criteria for the experts, but the difference between the methodological quality and relevance to sustainable transport is much smaller (respectively 0.48 and 0.52). The results for the methodological criteria cannot be compared as Castillo and Pitfield (2010) used different criteria.

Table 10 Weights for methodological criteria

	Transport experts
Understandability	0.20 (2)
Long-term view	0.13 (5)
Measurability	0.15 (4)
Actionability	0.35 (1)
Validity	0.16 (3)

Table 11 Weights for relevance criteria

	Transport experts	Transport users	Combined
Livable streets and neighborhoods	0.20 (3)	0.13 (5)	0.16 (5)
Protection of the environment	0.21 (2)	0.20 (3)	0.21 (2)
Equity and social inclusion	0.18 (4)	0.22 (2)	0.20 (3)
Health and safety	0.25 (1)	0.28 (1)	0.27 (1)
Support of vibrant and efficient economy	0.15 (5)	0.18 (4)	0.17 (4)

Table 12 Weights for methodology and relevance

	Transport experts
Methodology	0.26 (2)
Relevance	0.74 (1)

Initially it was the intention to use five stakeholder groups to reflect the complete spectrum of transport stakeholders, but because of the low number of responses in some of the groups only two stakeholder groups were used; the transport experts and transport users. In the initial situation each stakeholder would have had an equal weight in the final weights. Now only the experts and users were used. The weights for the relevance criteria were aggregated with equal importance for the transport experts and users.

All indicators have been scored on each criterion with a rating from 0-4, where 0 equals to extremely poor performance of the indicator on the criterion and 4 outstanding performance. This resulted in an initial ranking, but as this initial rating was done by one person (the researcher), it was due to subjectivity; therefore the 50 unique indicators with the highest score were rated again with Deni Prasetio MSc, a researcher at PUSTRAL, to avoid too much subjectivity. In this second rating some scores were adjusted. Complete objectivity is never possible in these kinds of ratings, it is subject to the perceptions of the people who rate the indicators. This is a weak point of applying AHP to find a suitable indicator set. Evaluating the outcome of the rating with stakeholders can decrease the influence of the assessor.

5.2.4 Final set

From the final list of ranked indicators the top 15 unique indicators have been selected, these are presented in Table 13. Unique indicators are those indicators that do not conflict with higher rated indicators. For example the indicator 'Walkability and cyclability' was not included as this indicator conflicts with the 'Length of cycling and walking paths'. A point of discussion in the research of (Castillo & Pitfield, 2010) was that there was an overrepresentation of economic indicators, which might lead to a biased view on the sustainability of the transport system. Table 13 shows which dimensions of transportation sustainability are covered. This is based on the original sources of the indicators and a personal assessment. Most indicators relate to social sustainability (8), but the economic (6) and environmental (6) dimensions are also represented with sufficient indicators. The governmental dimension is covered by four indicators. This is however sufficient as the governmental dimension is not as broad as the other dimensions, so it needs less indicators to describe it. The differences in the number of indicators per dimension can be seen as a representation of the stakeholders' weights (Castillo & Pitfield, 2010). On the other hand it is possible that some indicators will always score high. Comparing this indicator set with sets that are based upon different weights will show if other indicators will be chosen. In the next part this is illustrated.

Table 13 Final set of indicators

Rank	Indicator	Unit	Score	Dimension
1	Length of cycling and walking paths	km (as % of total)	2.35	ECO/ SOC
2	Clearly defined goals, objectives and indicators	Availability of goals, objectives and indicators	2.28	GOV
3	Quality of open space	Index (base=100)	2.24	ENV/SOC
4	Justice of exposure to air pollution	Justice index	2.20	ENV/SOC
5	Justice of exposure to noise	Justice index	2.20	ENV/SOC
6	Share of non-motorized individual transport	Modal split (%)	2.09	ECO/ENV/SOC
7	Car and bicycle ownership	Number of cars and bicycles per 1,000 citizens	2.10	ECO/ENV/SOC
8	Transport emissions - CO2, NOx, VOC, CO etc. and emissions intensities	Emissions: % of total, per mode Intensity: per capita, vkt, GDP	2.10	ENV
9	People killed in road accidents	Deaths per million and per vkt	2.06	ECO/SOC
10	Transport investment costs	Euro/capita, % of budget	2.03	ECO
11	Availability of planning information and documents	Availability of planning information and documents	1.95	GOV
12	Traffic injuries	Injuries per million and per vkt	1.95	ECO/SOC
13	Basic road safety law, licensing, traffic enforcement	Availability of laws, licensing, enforcement	1.90	GOV
14	Road network	Length, density, speeds,	1.90	ENV

		VCR		
15	Public participation in transport planning	Portion of population involved, moment of participation	1.90	GOV

Now the indicators have been selected the influence of the stakeholders can also be seen. For each of the stakeholders, transport experts and users, the same selection of the 15 highest ranked indicators has been made, see Table 21 and Table 22 in Appendix H. Most indicators in Table 13 are also part of the indicator sets for both stakeholders, for the experts' indicator set only one indicator is different; 'Destinations accessible by people with disabilities and low income' instead of 'public participation'. For the users' set three indicators were substituted; 'Public awareness of transport sustainability issues', 'Structure of road fuel prices in real terms (by type of fuel) and taxation' and 'Destinations accessible by people with disabilities and low income' instead of 'Traffic injuries', 'Road network' and 'Basic road safety law, licensing, traffic enforcement'. This shows that different perceptions about sustainable transport can lead to different indicator sets using the method in this research. These differences can be explained by the weights that were assigned to the criteria. Transport experts assigned more weight 'Livable streets and neighborhoods', while transport users assigned more weight to 'Equity and social inclusion' and in general on the methodological criteria.

The indicator sets for both stakeholders reflect to some extent the expected indicators, as described before. The transport experts indeed gave more weight to 'livable streets and neighborhoods' and transport users valued 'health and safety' higher. This does however not lead to completely other indicator sets. Only two indicators differ in the indicator sets of both stakeholders. In the set for transport users 'structure of fuel prices' and 'public awareness of transport sustainability issues' were chosen. From the research of Marletto and Mameli (2012) it was expected that transport users would choose indicators that relate to expenditures on private transport, but the research did not show that citizens want to be involved. It is also notable that the indicator 'traffic injuries' was not included in the transport users' indicator set. For the transport experts it was expected that indicators that reflect transport modes would be selected. The indicator 'Walkability and cyclability' did score high, but an indicator related to public transport quality was not selected. Also in the final set public transport is not directly covered by one of the indicators. The reason for this is that public transport indicators did not score high on the criteria as many of the effects of public transport are indirect. So although there are some differences between the two stakeholder groups, this does not result in large differences in the indicators chosen. A more direct method of selecting indicators would probably lead to more differences, but the use of AHP will lead to sets of indicators that are much alike. This is also demonstrated in the next part.

Now the results for both stakeholders have been discussed the next question is if assigning weights to the criteria through stakeholder participation and AHP has been useful. Do the indicators reflect the context of Yogyakarta and Surakarta, or would the same process without weights have given similar results? To be able to give answer to this question an indicator set has been developed for a situation in which all criteria weights are equal, see Table 23 in Appendix H. In this set there are three indicators substituted, two of which were also used in the user set. A new indicator is 'Transit affordability'. It is notable to see that only in this indicator set an indicator relating directly to public transport is used.

So assigning weights to the criteria does not lead to completely different indicator sets, but minor changes can be seen. For the evaluation of sustainable transport in the context of a specific city or region it means that most indicators will be the same, because some indicators are very strong. These strong indicators score on most of the criteria, while other indicators that score very high on one criterion will have a lower total score. In this way indicators that describe several aspects of sustainable transport will be chosen in the indicator set, which according to Gustavson et al. (1999) is positive.

Including other stakeholders, like the transport decision makers and operators, would have given a more complete view on differences in perception between all stakeholders. Especially on a local scale, as in Yogyakarta and Surakarta, these differences can be important to recognize, as transport is mainly influenced by government alone.

Another issue with the rating of the indicators is the 'Long-term view' criterion. When an indicator scores low on this criterion, because there is no data available, it will cause a lower final rating, decreasing the chance of being chosen in the final set. Increasing the availability on an indicator makes it more attractive, so for the government this can indicate which indicators should be measured. In this case the 'Long-term view' criterion did not have much weight in the final score, mainly because the methodological criteria had a low weight, so the influence of this criterion was low. One indicator could have been chosen if it had scored a 3 or 4 on the criterion 'Long-term view'; 'Portion of destinations accessible by people with disabilities or low income'. Information on this indicator is hardly available, but if the government would start measuring it, the indicator might become valuable in the future.

5.2.5 Relation to overview sustainable transport policies

The indicators in the final set will be used to identify challenges. These challenges should be used to develop sustainable transport policies. The indicators should also relate to the possible sustainable transport policies in order to track progress. In Chapter 4 an overview of sustainable transport policies, which can be adopted by local governments, has been given. In this overview the ASI (Avoid, Shift and Improve) approach has been used to group policies. Here the relation of the indicators to each of those groups will be given.

Policies that relate to the avoidance of travel activities are based on the avoidance of urban sprawl through better land use planning and the reduction of the need to travel through the use of telecommunications. There is not a direct indicator for urban sprawl or the need to travel, neither is there for land use planning or telecommunications. The number of vehicles on the streets is measured, this is however not a good measure for the avoidance of travel as it is not clear if trips are substituted.

Most of the policies listed in Table 4 in Chapter 4 relate to modal shifts. Improving public transport and non-motorized transport are one side of the policies, the other is to reduce the use of the car, which should be done simultaneously. There is not an indicator that measures the quality of public transport, but there are indicators that are related to vehicle ownership and modal split. From these indicators the changes in public transport, non-motorized transport and private motorized transport can be seen.

The last group of policies aims at improving engine technology and fuels. Again there is not a direct indicator that can measure developments on these policies. The goal of these policies however, the reduction of air pollution, can be measured through two of the indicators. So the outcome of the policies can be measured.

Some of the indicators are not related to the ASI approach. These include the governmental indicators and some of the more social indicators, like for example traffic deaths and injuries. The governmental indicators do not measure aspects of the traditional three dimensions of sustainability, but in this research it has been argued that the governmental dimension should be included as well. The ASI approach is not related to governmental aspects. Traffic accidents however are typical examples of unsustainable transport, but Table 4 in Chapter 4 did not include policies directly aimed at improving traffic safety. Most of those policies aim at reducing the use of the car. Safety is indirectly included in some of the policies, like for example in the promotion of special pedestrian lanes and cycling lanes. So the chosen indicator set does have a relation to the possible policies discussed in Chapter 4, but sometimes relations between the outcomes of policies and the indicators are indirect.

5.3 Indicator data

For each of the fifteen indicators the associated data has been searched. In Appendix I the indicator data is presented. First the sources of the indicator are given, followed by a short description on the indicator and the appropriate units, which builds on the information in the original sources of the indicators. The units are chosen in order to allow a comparison between Yogyakarta and Surakarta. For some of the indicators it was found that data did not exist or was not available to use in this research, therefore a short piece is written about this for each indicator. Finally the collected data on the indicators is presented.

As the units are derived from their original sources, not all indicators have the same kind of units. Most of the indicators are absolute. Relative indicators using scales were hard to compute, so for these indicators often absolute values were used as well.

The data is first used to make a comparison between the two cities. For the convenience of making this comparison the data for both cities is presented together when most suitable. Secondly an assessment of the sustainability score of each indicator is made. This is done for the trend the indicator has shown in recent years and the current state. The scores for the two cities are presented using colors, where green represents a positive result, red for a negative one and yellow neutral. Grey is used to indicate that too little data was available to make a judgment. To decide which color should be given targets and references are used. It would have been best to use either targets or references, but these were not available for all indicators. Also some references are national, others international. Again, this was done as it was not possible to use one of them. So for each of the individual indicators it had to be decided what the scored color would be. The choice for a color is explained for each of the indicators. In the future when cities like Yogyakarta and Surakarta want to adopt a sustainable transport evaluation method, they should decide on using either targets or references for their indicators. The use of targets allows tracking progress towards these predetermined targets.

5.4 Overview results

The final scores for each of the indicators are summarized in Table 14. This table shows that for many of the indicators not enough data was available to be able to give scores for trends on indicators and current states. For some indicators scores could be made, although data was limited. The current state of the transport systems in both cities only has neutral and negative scores on sustainability. This leads to the conclusion that in both cities the transport systems are not sustainable at the moment. Trends based on the indicators show positive as well as neutral and negative developments. Two of those positive trends in both cities are related to governmental indicators; "Clearly defined transport goals, objectives and indicator" and "Public participation". Although these judgments were based on limited data, the indicators show that the local governments in both cities are aware of sustainable transport issues.

Many of the negative scores can be attributed to the motorization in both cities. In recent years the presence of the car has been more and more dominant and both cities are not yet successful in stopping this trend. The increase in the use of motorized vehicles has a negative effect on the air quality and traffic safety.

The units for the indicators were chosen based on their original sources and the available data in both cities. It is however possible that the use of other indicators could have resulted in different colors. Also the mixing use of national and international references and targets can lead to biases in the assessment of scores. The use of international references and targets will lead to more negative judgments. In this research it was not possible to choose targets or references on the same level, but in future evaluations this should be done together with the determination of the units that will be used.

The results from this evaluation are used to compare both cities and relate the differences to transport policies in the past. This is done in the next parts

Table 14 Indicator scores

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Walking and cycling paths				
Clearly defined transport goals, objectives and indicators				
Quality of open space				
Justice of exposure to air pollution				
Justice of exposure to noise				
Vehicle ownership				
Transport emissions				
Share of non-motorized transport				
Traffic fatalities				
Local government expenditures on transportation				
Availability of planning information and documents				
Traffic injuries				
Basic road safety law, licensing and traffic enforcement				
Length and density of road network				
Public participation				

5.5 Comparison of Yogyakarta and Surakarta

Yogyakarta and Surakarta are two cities that are quite similar. Based on the evaluation of their transport systems it can be concluded that they experience the same developments, many of the indicators show the same trends and current situations. However some indicators do show differences between the two cities. The indicators that show similar trends and current situations will be described first and then the differences between the two cities will be discussed.

Asian cities are known for the fast motorization that is occurring the last years. Yogyakarta and Surakarta are no exception. Both cities show fast increases in the number of motorized vehicles, particularly the motorcycle is popular. Motorcycles are cheap and can be paid off with loans. This makes a motorcycle a good alternative for bicycles and public transport.

Both cities also show the same developments on a governmental level. They are trying to change the way in which they develop their transport systems. This could already be seen in the transport plans the cities developed themselves and later in the assistance of CDIA in both cities. From a business-as-usual method of planning they try to include sustainable goals in transport planning. Public participation is also part of a more sustainable way of planning and both cities seem to acknowledge this, although it is not clear if there are already structured sessions.

One of the differences between the two cities has to do with non-motorized transport. The indicators show that in Yogyakarta non-motorized transport has a larger modal share and there have been more investments to improve cycling. On the other hand since some years in Surakarta is improving facilities for pedestrians. It seems that both cities focus on different forms of non-motorized transport.

Another difference is the current conditions on roads. In Yogyakarta VCR's are higher than one on many major roads and speeds are dropping. In Surakarta the transport system is not that congested yet, but predictions for the next decades show that this city is moving in the same direction.

The most recent measured emission levels show that in Surakarta more standards are exceeded than in Yogyakarta, respectively four and one. It would be expected that Yogyakarta would have higher emission levels due to the higher traffic loads. Maybe the worse air quality in Surakarta is caused by other sources as well, like industry. Another possibility would be that this data is not reliable enough and that actual emission levels are different, but this cannot be underpinned.

5.6 Transport developments in the past

The state of the transport systems in Yogyakarta and Surakarta is the result of policies that have been carried out in the past and other developments. Relating the trends and current scores of both cities to a historic perspective can explain why the indicators developed in certain direction.

Before 2008 the cities of Yogyakarta and Surakarta did not have to make their own transport plans. Until then it was part of the regional plan. A summary of the developments in both cities since the late 70's based on an interview with dr. Heru Sutomo, chairman of the board of researchers at PUSTRAL, is given next.

5.6.1 History of transport developments in Yogyakarta and Surakarta

This part describes the developments in transport planning in both cities, focusing on the differences between the two cities. The nature of both cities is very different, Yogyakarta being the city of education and tourism and Surakarta being an industrial city.

Both cities started with organized public transport late 70's or early 80's, before this time there were pick-up trucks carrying people around town. In Yogyakarta the Bus Kota (city bus) was introduced, while in Surakarta a double decker bus operated, the latter being a prestigious gift from the first lady at that time. The double decker was used by many people, but costs were too high, so service ended after a few years. At this time Surakarta also introduced the Bus Kota, being inspired by its success in Yogyakarta. Besides the Bus Kota there were also many Angkots (some kind of paratransit) running in Surakarta, something that Yogyakarta has always been able to avoid on a large scale. This can be explained by the fact that Surakarta is much more influenced by its neighboring cities than Yogyakarta, being part of the Special Province of Yogyakarta and therefore making its own plans. In both cities the Bus Kota was a success and routes were expanded. The modal share for the bus in Yogyakarta was higher, because here many students used the bus. The highest model shares were during the crisis of 1997-2003, after the crisis the modal shares decreased. In Yogyakarta this decrease was higher, which led to the introduction of TransJogja in 2007 to give a new impulse to the public transport sector. Meanwhile Surakarta also introduced its own new bus system, BatikSoloTrans (BST), an attempt to create a bus rapid transport system.

The development of non-motorized transport in both cities can be explained by cultural and social issues. People in Yogyakarta generally are more practical, less ceremonial and higher educated, which explains why cycling was, and still is, more popular in this city. In Surakarta people are more concerned with status and elegance, so here people favor the use of cars. In Surakarta also becaks are used by many people, especially to go to markets. In Yogyakarta people also used to do this, but the prices for becaks have increased due to the tourism, which makes the becak too expensive for many locals. In recent years there has been a change of mind about the use of non-motorized transport, mainly walking, due to the new mayor, who started his first office in 2005. He is an advocate of walking and has implemented some improvements in the infrastructure for pedestrians. His ideas are very popular among the citizens and he has been elected for a second term. Although Yogyakarta has always been the city of cycling, it has turned out to be hard to implement new plans. Decision making takes a long time, due to bad communication and hesitation, as people sometimes fear the opinion of the sultan, who as the governor of the province has to approve all plans. An example of this slow decision making is the pedestrianization of Malioboro Street, which has been in planning since 1999, when a Swiss consultant presented his plans. He also asked the public about their opinion and two-third approved his plans, but until now nothing has been done. Another reason for this is that many on-street shops and the parking is controlled by mafia and they used to have a lot of power, since they supported the former mayor.

5.7 Relation transport policy and comparison both cities

Since the late nineties Indonesia started decentralizing governmental tasks. Since then local governments had to develop more policies, including transport policy. First this was done on a regional scale, but since 2008 these cities have to make their own transport plans. Yogyakarta and Surakarta are still struggling with making new plans, due to a lack of capacity and knowledge. In the transport sector both cities were not successful in slowing down the motorization process. Efforts have been made to introduce bus rapid transit systems (BRT), but in both cities these are not as successful as hoped. Wright (2011) describes this phenomenon of cities that that implement BRT unsuccessfully. He sums up 20 of the most common BRT planning errors. Most of these errors also apply to Yogyakarta and Surakarta. Besides the investments in BRT there are not many other transport investments that could qualify as being sustainable. Yogyakarta has made some efforts in creating cycling facilities, but these do not really work when there are no cycling lanes. Surakarta has invested in pedestrian facilities, but here too should have been invested in good walking paths as well. It seems as if both cities are struggling with making effective policy. The example of the pedestrianization of Malioboro Street is a good example of a sustainable plan that is not implemented. In the mean time the motorization continues and the pressure on the transport system increases. So the influence of the market on the transport sector is higher than the influence of the government and transport policies in the past in both cities have not been able to move developments in a sustainable direction.

In 2011 both cities were assisted by CDIA in developing a sustainable urban transport strategy. In this strategy the strengthening of institutional capacity is also one of the objectives. It is important that this will succeed because in the future Yogyakarta and Surakarta will have to develop new transport plans and they cannot always rely on the support of external organizations. For cities like Yogyakarta and Surakarta it is important to share experiences through a national or even international network. In this way knowledge about sustainable transport is spread and local policy makers can benefit from the successes and mistakes from other cities. The strengthened capacity and knowledge of local policy makers will probably have a positive effect on the indicators that are related to the government.

The strategies developed by CDIA focus on the improvement of the BRT systems in both cities. With some adjustments made to the routing, the ticketing and accessibility it is expected that people will change modes; from the car to the bus. If this will happen it will have a positive effect on many of the indicators.

The importance of non-motorized transport is acknowledged in the CDIA reports, but most focus is on the development of BRT. While non-motorized transport is a key issue in developing more sustainable transport. It is the mode that is accessible for everyone and it serves as a feeder for public transport. So the indicators concerning the walking and cycling paths, the vehicle ownership and modal share are interesting to monitor in the next years.

5.7.1 Relation to overview sustainable transport policies

In this part the policies of both cities are compared to the overview of possible policies, as presented in Table 4, to see if they cover all aspects. First the transport policies of Yogyakarta are discussed and thereafter those of Surakarta.

In 2008 the Master Plan Transportation (Bappeda Kota Yogyakarta, 2008) was completed, the first transport policy plan the City of Yogyakarta had to develop. The Master Plan shows the ambition of the local government to implement sustainable transport policies. A variety of policies is discussed, ranging from the pedestrianization of areas, constructing cycling lanes and bus improvements. In the elaboration on these policies examples from other cities are used. A translation to the context of Yogyakarta is not always made. Compared to the overview of possible policies, the policies in the Master Plan only aim at modal shift. Avoiding travel activities through better land use planning or telecommunications is not included. Also technological innovations to improve engines and fuels are not mentioned. The policies in the Master Plan do not show a comprehensive approach to sustainable transport, because it is not clear how policies can support each other. In 2011 CDIA completed a study on sustainable urban transport in Yogyakarta (CDIA, 2011d). Although the goal of this study was to develop a sustainable urban transport strategy, only improvements for TransJogja, the local BRT system, are recommended. The implementation of the improvements is much more detailed described than in the Master Plan, but supporting policies are not included in the report. The role of non-motorized transport remains largely neglected.

For Surakarta almost the same observations are made. The Tatralok (Tatralok, 2010) contains many policies to improve non-motorized transport, public transport and motorized private transport. It even proposes the introduction of a monorail. Also road pricing systems are mentioned. As discussed in Chapter 4 a comprehensive set of policies is necessary for effective sustainable transport development. The policies in the Tatralok aim at improving all modes, but this will not lead to a modal shift. The avoidance of travel and improvement of technologies is, like in Yogyakarta, not included in the set of policies. The report of CDIA (CDIA, 2011e) for Surakarta does show some differences compared to the one for Yogyakarta. It does include policies that support improvements in the BatikSoloTrans, Surakarta's BRT system.

5.8 Transport challenges

The purpose of applying the evaluation framework to Yogyakarta and Surakarta was to identify sustainable transport challenges. 15 indicators have been selected and data for these indicators was collected. For most of the indicators there was not sufficient data available, or data was not reliable. So identifying transport challenges based on these indicators is harder then when all the necessary data would have been available. Nevertheless some challenges can be identified.

The biggest challenge both cities face is slowing down or even stopping the motorization of the transport system. The modal split of non-motorized transport and public transport are very low. Both cities have tried to implement a BRT system, but so far these have not been successful. More supporting policies are needed to realize a modal shift from the private car to public transport. In Chapter 4 some of those possible supporting policies have been discussed. Also avoidance of travel activities can be a solution to the rising motorization in both cities. This will require integrated land use and transport planning and investments in telecommunications as an alternative for travelling.

A second challenge has to deal with the functioning of the government. The policy making process should be more transparent, including public participation and providing information on policy plans. This will also allow all citizens to be part of the planning process and identify transport issues they think are important.

Other challenges include improving traffic safety, the quality of open space and the reduction of air pollution. These challenges are however related to the motorization in both cities. So in dealing with higher volumes of motorized traffic the focus should not only be on modal shifts towards more sustainable modes, but also on increasing safety and limiting other negative effects from motorized vehicles. Sustainable transport policies relating to the improvement of vehicle technology can play an important role in dealing with these challenges.

The identification of sustainable transport challenges in this research has been hampered by the lack of available and reliable data. The question is if more and better data would have given the opportunity to identify more challenges. The use of more information would have given better information on the development of indicators over time. This would also show which indicators are getting worse the fastest and should receive most attention. Looking at the indicators for Yogyakarta and Surakarta dealing with the motorization of the transport system would still be an important challenge, but other challenges might be identified as well.

The results from this evaluation should also be the input for discussions with stakeholders on what they think are the most important sustainable transport challenges. The indicators give an indication of how the transport system is developing. Using a set of 15 indicators provides a tool that is clear and easy to understand. The indicators can also be used to monitor progress.
The approach used by CDIA was somewhat different. In the first phases of the project in Yogyakarta and Surakarta a lot of information was collected, but it is not clear how the urban transport strategy follows from it. Also targets for the used indicators are not used. This makes evaluating the effectiveness of the measures difficult.

6 Discussion results

The evaluation framework has been applied to the cities of Yogyakarta and Surakarta to see if it is possible to identify sustainable transport challenges using this framework. This chapter deals with the problems and issues that were found in applying the framework. This is done on an operational and strategic level. This chapter also gives feedback on the functioning of the framework.

6.1 Operational issues

From Table 14 it is immediately clear that there was not enough information to evaluate all the indicators properly. For some indicators data was too unreliable to make conclusions. The numbers on traffic deaths and injuries in Yogyakarta showed values that seemed to be too low compared to Surakarta and average values for Asian cities. Also for some indicators the data was not complete. For example the numbers on 'Vehicle ownership' and 'Share of non-motorized transport' did not give enough reliable information on the number of bicycles and the use of it. For many indicators it was impossible to evaluate the trend, because data was often only available for one or two years. This makes it hard to say if these cities are developing in a sustainable direction. The quality of the used data is also an issue. This became particularly clear for the air quality in Yogyakarta. Many sources were available, but the values, units and standards were not consistent.

The total urban areas of Yogyakarta and Surakarta are larger than the city region, but data is only collected for the city region and the regencies of the province. This makes it hard or even impossible to evaluate the total urban transportation system. Much of the urban growth takes place outside the city regions, but the effect of this growth on the transportation system cannot be measured properly.

Collecting the data also was a problem. Agencies, like for example the environment agency, present all the collected data for each year in annual reports. All these reports have to be read to find the right data. Sometimes data for one indicator was used in one year, but not in the next. There is not an easy way to discover if the data does exist. Even the agencies themselves do not exactly know what they measured.

The operational issues can be summed up as follows:

- Data measurement is not standardized and structured
- Measured data is unreliable
- Data is not available for the total urban area
- All the data from one agency is presented in annual reports

It is interesting to see that many of the criteria for selecting indicators that deal with these issues were not selected by the experts. Maybe this is also a reflection of how the local government is concerned about data collection. To be able to make a good evaluation of more and better indicator data is necessary. So the criteria 'reliability' and 'availability' should be given more importance. The weight of these criteria should not depend on the results of AHP, as they are too important. The framework in this research had been designed to incorporate stakeholder involvement in all decisions, but it turns out that this does not lead to best outcome.

6.2 Strategic issues

In some cases the necessary data did exist, but could not be used in this research. This was for example the case for 'Local government expenditures on transportation', the information is available at the local governments, but for this research it could not be accessed. Also information on traffic enforcement had been requested at the police, but the requested information was not given. The two indicators that measure exposure to air pollution and noise need the use of a transport model to calculate emissions spatially. Both cities use traffic models for traffic load predictions, but not for other purposes. Maybe these models can be used in the future to calculate the negative effects of transport, but for this research it was not possible.

At the moment there is not much cooperation between local agencies. The transport agency and the environment agency could for example work together to develop policies to mitigate transport emissions and measure the progress. The transport agency has traffic models that can be used to predict future emission levels, the environment agency on the other hand measures current concentrations and tries to meet the standards. Through more integration between the agencies a more holistic view on sustainable problems can be obtained and thus more effective policy can be made.

Another issue is the inefficient and slow functioning of the governance structure, which can be illustrated by requesting information from the police. Collecting data from the police, but also other agencies, is difficult. First official letters have to be sent, then a visit has to be made to the office and in the end no data is received. The example of the police data also showed that data is not stored centrally. Each police office in the city collects its own data, but this is not stored in a central database. So accessing this data, or even knowing what data exists, is very hard.

The strategic issues are:

- No cooperation between agencies
- The governance structure
- Decentralized data storage

6.3 Feedback on evaluation framework

In this part feedback is given on the evaluation framework used in this research. First personal experiences about the functioning of the framework are described. Secondly the results from a feedback session with stakeholders are given.

6.3.1 Discussion of evaluation method

The evaluation framework has been applied to Yogyakarta and Surakarta. Issues in collecting data have already been discussed, but the functioning of the designed framework itself can also be discussed. The framework was designed for medium-sized cities in developing countries, the question is if the framework has appeared to be appropriate. This question will be answered here.

The framework starts with a long-list of possible indicators and used a set of selection criteria to assess which indicators are best. The set of criteria was selected by experts. Using AHP weights were assigned to these weights. Using AHP might not be the best method. It does allow showing differences in perception between stakeholders, but the surveys might be too difficult and might be too far away from sustainable transport goals. AHP was chosen because it limits the influence of the researcher in the selection of indicators, but the rating of indicators on the criteria still has to be done by the researcher. This problem can be overcome by using more stakeholder input in the final selection of indicators, something that in this research was not done. Alternatives for AHP should however be considered, as it was also shown in this report that a few indicators will always score high when using AHP and thus a set of indicators suitable for a local context will always contain many of the same indicators.

In collecting the data for indicators it was found that some indicators required several data sources and processing, like for example the indicators that measure justice of exposure to air pollution and noise. The data for these indicators was not available. In the future to anticipate to this problem the long-list should contain only indicators that are easy and cost-effective to measure and still are reliable and provide useful information.

Originally transport academics and experts were used in the ELASTIC method. In this research other relevant stakeholders were added, including transport users, as it was found in literature that public participation is important in developing sustainable transport strategies and evaluating the sustainability of transport systems. Experiences during this research however showed that the public often is not aware of what sustainable transport is, let alone how it should be evaluated.

Sustainability also deals with future generations and differences between social groups. The applied framework did not show the effects of transport developments on future generations. Limited data was available on predicted values for indicators. Taking future generations into account requires more sophisticated frameworks and modeling, something which is not available in cities like Yogyakarta and Surakarta at the moment. For these cities the priority at the moment should be at measuring developments and the current state of the transport system and monitor progress toward sustainable transport. The selected indicators also did not show differences between social groups for the same reasons.

6.3.2 Feedback session

In the framework used to evaluate the sustainability of the transport systems of Yogyakarta and Surakarta stakeholder involvement was considered to be very important. First stakeholders were used to assign weights to the indicator selection criteria. From the initial five stakeholder groups only two groups were left over, because the number of responses was too low. The two stakeholder groups that were used are the transport experts and transport users.

After selecting the indicator set and collecting some of the indicator data feedback sessions were organized for both stakeholder groups. The purpose of these feedback sessions was to show where the surveys were used for, but also to receive feedback from the stakeholders on the process and the results. Unfortunately the feedback session for transport users was canceled twice, because the number of attendants was too low.

During the feedback session with experts, the attendants were asked to think about which indicators are relevant for evaluating the sustainability of the transport systems of Yogyakarta and Surakarta. In the beginning they were struggling with this task, but after some encouragement and examples they started naming possible indicators. There was a strong focus on using the three dimensions of sustainability and the indicators should relate to these dimensions. One example of mentioned indicators is; an indicator that relates to the inclusion of elderly (social), an indicator that relates to multi-modal transport (environment) and an indicator that relates to income and costs of the public bus (economic).

In the end the attendants were asked to give feedback on the used framework, starting with the survey. The use of AHP was not unfamiliar, so they had no problems with filling in the survey. They understood the next steps in selecting the indicators, but were concerned about the level of indicators, as this is not the same for all indicators. Some indicators describe just one little element, while others contain much richer information. And some indicators measure the outcome, while others measure output. The issue of availability of indicator data was also addressed as a possible problem. Finally they hoped that this research will be able to give direction to future policy.

6.3.3 Evaluation of ELASTIC

The application of an indicator selection method based on ELASTIC (Castillo & Pitfield, 2010) turned out not to be successful in this research for several reasons. The main reason is that finding data for all the selected indicators was not possible, which hampers the total evaluation. The use of AHP to select a set of indicators suitable for a local context may not have been the best method. In this research it has been demonstrated that some indicators will always score high in AHP, because they score points on all criteria, and thus end up in the final set. Castillo and Pitfield claimed that ELASTIC was suitable for selecting indicators for specific contexts, but the results of this research show otherwise. The results of ELASTIC identify indicators that score on all dimensions of sustainability. So indicators that measure just one dimension of sustainability are less likely to be chosen. Although Gustavson et al. (1999) say that indicators that cover all dimension should be used, feedback from the stakeholders shows that it is preferred to select indicators that measure aspects of one dimension and make indicator sets for the three dimensions.

The paper Castillo and Pitfield wrote on ELASTIC does not elaborate on how to deal with inconsistent judgments in AHP. In general a consistency ratio (CR) of less than 0.1 is considered to be consistent (Saaty, 2003), but it is not clear if all judgments should fulfill this demand when they are aggregated into one final judgment. The surveys conducted in this research show that most judgments have a CR higher than 0.1. Because it was not clear how ELASTIC deals with inconsistent judgments a threshold of 0.5 was chosen in this research for the individual judgments.

ELASTIC is designed to use stakeholder judgments to select indicators. The method should lead to an objectively chosen indicator set, but in the end all indicators have to be rated against the criteria. This is something that is done by the researchers themselves. This rating is decisive for the final selection of indicators, so the method is not completely objective. Also in the final set some decisions have to be made to avoid doubling effects of indicators.

Castillo and Pitfield also say that the results of ELASTIC are based on the sustainable transport goals, but a direct relation to these goals is not made. Only criteria are used to shape the context in which the method is applied. So the indicators are also not directly related to the sustainable transport goals and strategies.

6.3.4 Alternative indicator selection methods

The issues concerned with the use of AHP in an indicator selection method based on ELASTIC raise the question if alternative selection methods are better suitable for application in the context of medium-sized cities in Indonesia. In the development of an indicator selection method five frameworks were considered in this research (Table 15 in Appendix A). Throughout this whole research stakeholder participation was seen as an important aspect of the evaluation of sustainable transport, including the selection of indicators. It is however difficult to include all stakeholders and receive good input from them. This is particularly the case for transport users, or the general public, when they are not familiar with the subject. Depending more on expert involvement can benefit the quality if the indicator selection and thus the evaluation. The method described by and Reed et al. (2006) may be a good alternative for ELASTIC, see Figure 10. This method is based on best practices and is designed to evaluate sustainability on a local scale. It also incorporates stakeholder involvement. In this approach more influence is given to experts; they lead the selection of indicators. User groups are used to evaluate the chosen indicators. The development of sustainable goals and strategies is part of this method. The method can be adopted by local governments to develop sustainable goals and strategies and choose the right indicators for them in an adaptive learning process, where strategies can be adjusted to meet the set goals. To identify sustainable transport challenges indicators should also be input for the specification of sustainable transport goals and the development of strategies. So after step 1 and 2, first steps 5 to 10 should be taken to establish the context. Once the goals and strategies have been formulated a new set of indicators should be chosen that is capable of monitoring progress.

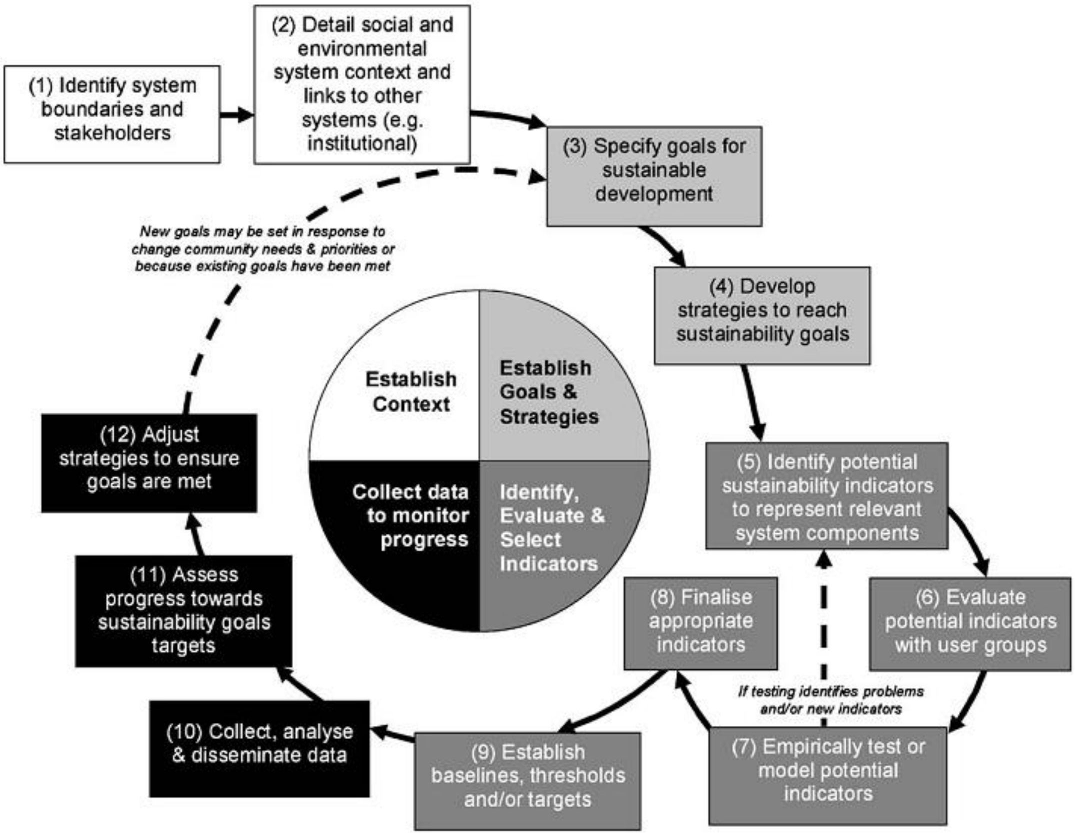


Figure 10 Adaptive learning process for sustainability indicator development and application (Reed et al., 2006)

Although this method is designed for use by local communities, it can also be applied on a city level. The user groups can be substituted by other groups. A solution to the problem of including the public in the selection process is to invite representative groups. In Yogyakarta for example cycling, environmental and other groups can be asked to evaluate the indicator set. These groups have a strong opinion on specific subjects related to sustainable transport and probably have a better understanding of the relation between the indicator and transport.

7 Guidelines

Based on the evaluation framework that has been developed in this research and the experiences gained from applying it to the cities of Yogyakarta and Surakarta in this chapter guidelines are formulated for medium-sized cities in developing countries that try to identify sustainable transport challenges in order to make informed decisions and provide evidence based policy.

7.1 Goal

Identifying sustainable transport challenges for medium-sized cities in Indonesia was the goal of the evaluation framework that has been developed in this research. On a local level cities in many developing countries are experiencing the negative effects of increasing population combined with the motorization of the transport system. In a response these cities are trying to develop sustainable urban transport strategies. On a global level more concern is given to mitigating carbon emissions in order to alleviate climate change. Through multilateral organizations and governments funding is available for low-carbon development. For cities in developing countries this funding is essential in changing their transport systems. In granting funding to these cities co-benefits are often decisive. The co-benefits are positive results from transport investments that contribute to sustainable transport goals.

While many of the large cities in the developing countries already have an acknowledged sustainable transport problem, many medium-sized cities are also facing sustainable transport problems. These cities however often have less capacity, knowledge and funding to develop their transport systems in a sustainable way. Copying successful sustainable transport solutions from other cities will not work, without knowing what the current situation is in a city. The first step these cities have to take is to define what sustainable transport means to them and what the sustainable transport challenges in their cities are. The use of a sustainable transport evaluation framework can assist in developing a perception on sustainable transport and identifying the local sustainable transport challenges. The use of indicators will help to develop evidence based transport policies, monitor progress and provide accountability.

7.2 Strategies

Medium-sized cities in developing countries and the transport problems they face are not similar, but many of the issues in developing sustainable transport strategies are. Therefore a generic set of guidelines can be made for these cities, based on the results of the case studies in Yogyakarta and Surakarta. The guidelines describe strategies to deal with the issues that arise when sustainable transport strategies are tried to be made. Experiences from applying the framework to the cities of Yogyakarta and Surakarta have identified the issues these two cities face when evaluating their transport systems. These issues are used to provide guidelines, which together form a road map for local governments to identify sustainable transport challenges, so the guidelines should be adopted in the presented order.

7.2.1 Sustainable transport strategy

The first thing cities should do is to decide to develop a sustainable transport strategy. This means that these cities should start making comprehensive policies that lead to a more sustainable transport system. This might sound like an unnecessary guideline, but few cities really adopt comprehensive sustainable transport strategies. Most cities develop strategies aimed at solving specific problems, like for example congestion. Sustainability however entails a much wider view on the total transport system and will also lead to a wider variety of policy measures. These policies should relate to the three dimensions of sustainability. As has been shown in this research, the concept of sustainability is not straightforward. This is most likely also the reason that many cities develop project-based transport plans, addressing only some of the most important transport issues. So here a gap between the literature and reality can be found. But as this research is built on the idea that sustainable transport will receive more attention in the future it is assumed that also the medium-sized cities in the developing world will have to start developing sustainable transport strategies , as is already happening in many cities, and the sooner they start with this the more they will benefit from it.

7.2.2 Institutional capacity and knowledge

Adopting sustainable transport strategies requires sufficient institutional capacity and knowledge, as the concept of sustainability requires a comprehensive insight. The pilot studies revealed some institutional issues that hamper the implementation of sustainable transport strategies. Although the issues in other medium-sized cities in other countries might be different, it is likely that they will have some of the same. Evaluation of sustainable transport and the development of sustainable transport strategies require a local government that is functioning well. Agencies should cooperate and there should be an integrated approach towards sustainable goals to get the most out of the sustainable policies. This requires sufficient knowledge and capacity, something that in many medium-sized cities is not available. These cities should benefit from each others' experiences. On a national or even international level there can be knowledge sharing. This can be lead by the national government, or otherwise by some of the cities that already have developed capacity and knowledge. Also some international organizations are involved in collecting and sharing experiences of cities around the world, like for example EMBARQ and SLoCaT. If cities are adopting sustainable urban transport strategies, they should know what the relation of transport with other fields is. So a holistic view on sustainable development should be present.

During the literature study and the indicator selection it was found that transparency in the planning process is important. As sustainable transport is closely related to the users of the system, these users should also be involved in processes. A transparent planning process allows stakeholders to see what the local government is actually doing and also the results of implemented measures can be tracked. This specific part of improving local governmental processes will also be discussed in some of the next guidelines.

7.2.3 Evaluation method

This guideline prescribes the use of an evaluation method to identify sustainable transport challenges and develop evidence-based policies. In this research an evaluation method based on ELASTIC (Castillo & Pitfield, 2010) has been used. This method turned out to be not ideal for the selection of indicators and evaluating the sustainability of transport systems in a local context. The use of AHP can be used to identify which indicators are strongly related to the concept of sustainability, but adjustment to the local context is difficult. Therefore it is suggested to choose a different evaluation method, which is capable of including the local context into the indicator. In the previous chapter the method described by Reed et al. (2006) is mentioned as a good alternative. In this method first the context is defined. In the previous the chapter it has been suggested to include the use of indicators as well in this phase. The context is input for the formulation of sustainable transport goals and objectives and subsequently experts choose a suitable indicator set to monitor progress on the strategies. This set is evaluated with some relevant stakeholders and might be adjusted. Which indicators should be used and how much indicators are needed in a set is discussed in the next guideline.

After the indicator set has been chosen, baselines, thresholds or targets should be established. This is something the local government should do. In the next steps of the method data is collected and analyzed. The results of the analysis are input for new strategies to meet sustainable transport strategies. The evaluation method described by Reed et al. (2006) is an adaptive learning process in which strategies and indicators can be updated. So this method goes further than just identifying sustainable transport strategies, it includes the whole planning process. This makes it suitable for local governments to adopt. There are however still some choices to make in the method. More guidelines are needed to deal with these choices.

7.2.4 Indicators

Indicators play an important role in the evaluation of transport systems and choosing the right indicators is necessary to provide useful information. Indicator criteria can be used to select a set of indicators. In this research methodological and relevance criteria were used to select an indicator set. The use of relevance criteria led to the selection of those indicators that score on all aspects of sustainability. Although Gudmundsson and Höjer (1996) argued that this is positive, it makes it harder to evaluate each of the dimensions of sustainability. In the feedback session with the experts it was found that indicators that are related to only one dimension of sustainability are preferred. So a set of indicators for each of the three dimensions should be chosen. A total set of 10 to 15 indicators is considered to be the right size (Dahl, 2012). This size allows containing enough information about sustainability, but still being communicable. So this would mean that for each of the dimensions 3 to 5 indicators should be used.

The indicator set used in this research also included indicators that relate to the functioning of the local government. Although this is not part of the three dimensions of sustainability, it does form an important aspect. A good functioning government is a condition for developing sustainable strategies. Using indicators to measure the functioning of a government gives insight in governmental processes. This makes the government more accountable and should also provide more chances for the public to get involved in planning processes. The role of public participation is explained in one of the following guidelines.

Methodological criteria should be used to assess the quality of indicators. In this report an overview of such criteria has been given. Local experts should choose which criteria to use and also score indicators on these indicators. In choosing the right methodological criteria the availability and reliability of indicators should receive much attention, as it turned out that this was a problem in Yogyakarta and Surakarta. In this research the ELASTIC method has been used to choose an indicator set. Through the use of AHP weights were attained to criteria and a long-list of indicators was scored on these criteria. The use of AHP is suitable to use when a ranking of indicators must be made and to aggregate the judgments of several persons. If however indicators are used that should relate to only one dimension of sustainability, a long-list of potential indicators should be made first for each of the dimensions. Other selection methods can also be used, but these will also include the use of methodological criteria to test the suitability of an indicator.

Although the availability and reliability of data is an important aspect, this does not mean that indicators for which data is not available should not be included in a final set. Local governments can start measuring new indicators, when these can provide useful information and are relatively easy and cost-effective to measure.

7.2.5 Indicator data

This research has shown that in the pilot cities, Yogyakarta and Surakarta, not a lot of data was available and the reliability of data was questionable. It is assumed that other medium-sized cities in Indonesia cope with the same problems. The local experts in these cities should choose those indicators that can be measured reliably. This might also mean that these cities have to start measuring new indicators, when these indicators provide useful information in relation to the sustainable goals and strategies. Measuring all the indicators from the chosen set should be standardized. This means that measurements should be done at the same time, location and circumstances. This will make it possible to interpret the data. Also the same units should be used for the data. This will avoid biases in the reporting of data and targets.

For each of the indicator targets should be defined. These targets should be realistic within the scope of the sustainable transport goals and strategies. Trends can be made based on data measurements through time. Evaluating these trends in relation to the targets set will show if the transport system is developing the desired sustainable direction.

7.2.6 Public participation

Based on many literature sources the evaluation framework used in this research incorporated public participation through surveys. The idea is that sustainability is closely related to people and thus these people should get involved in planning processes, including the selection of indicators and identifying sustainable transport challenges. It is however not easy to effectively let the public involve in these processes. The surveys used in this research did not reveal the true perceptions of the public about sustainable transport issues. Other forms of participation are needed.

In the establishment of the context of the sustainability of transport systems surveys can be used to ask the public about their opinion on several transport issues. For the selection of indicators more intensive forms of participation are necessary, because here surveys will not provide enough information. In the evaluation method proposed by Reed et al. (2006) first experts choose indicators, which are then evaluated by relevant stakeholders. This should also include the public. Representative organizations can be asked to join workshops in which the indicators in relation to the concept of sustainability are evaluated. In such workshops new issues might arise. Organizations that can be included are for example pedestrian or cycling associations, public transport passenger associations and motorist associations. But also organizations that are involved in guarding the environment can provide useful input. These organizations have a better feeling with the concept of sustainability, the relation with transport and can be accessed easier.

7.3 Summary guidelines

Based on the results and experiences of this research a set of guidelines has been developed, which should help medium-sized cities in Indonesia to identify sustainable transport challenges. These guidelines are listed below, starting with the guideline with the highest priority:

1. Adopt a sustainable transport strategy
2. Strengthen institutional capacity and knowledge
3. Choose an evaluation method
4. Choose the right indicators
5. Standardize the measurement of indicator data
6. Structure public participation

Conclusion

The objective of this research has been to set guidelines for evaluating the sustainability of transport systems in the context of medium-sized cities in Indonesia in order to be able to identify sustainable transport challenges. In this research an evaluation framework has been developed and applied to the cities of Yogyakarta and Surakarta. The conclusions that can be drawn from the experiences of applying this framework are discussed next. Secondly the feasibility of applying this framework to Yogyakarta and Surakarta is discussed and finally the guidelines for the evaluation of the sustainability of transport systems in medium-sized cities in Indonesia are presented.

Sustainable transport evaluation framework

A sustainable transport evaluation framework can help local governments to identify sustainable transport challenges and in later stages it can be used to track progress towards goals. In this research it was found that the use of the concept sustainability has both benefits as well as disadvantages. Because the concept does not have one single definition it can be used in many ways. It can capture global climate debate issues as well as local issues. The looseness of the definition of sustainability however also presents problems, when the term is used for policies or projects that are not really that sustainable. Implementation of sustainability in transport planning should involve a clear idea of the concept and what it should include. This should also be the starting point for the use of sustainable transport evaluation frameworks.

In this research a number of evaluation frameworks were reviewed and from literature important aspects were found. Most of the frameworks use criteria for the selection of indicators. These criteria were often related to the methodological quality of the indicators. There were however some differences in the application of these criteria in the indicator selection, particularly regarding the involvement of stakeholders. Based on a literature research the involvement of relevant stakeholders, including the public, was considered to be an important aspect of a successful evaluation framework. Also the use of indicators that relate to the local perception of sustainable transport was seen as an important aspect. These aspects have led to the use of ELASTIC as the basis for the evaluation framework applied in this research.

ELASTIC has been designed to develop a set of sustainable transport indicators in a local context, with the involvement of several stakeholders. The Analytic Hierarchy Process (AHP) is used to assign weights to criteria based on stakeholder judgments. Application of an evaluation framework based on ELASTIC in this research, however showed that the framework is not suitable for selecting indicator sets for local contexts. The use of several criteria that measure the relevance of an indicator the concept of sustainability will lead to the selection of those indicators that perform on all criteria. In this way the assignment of weights to the indicators will not have a lot of influence on the final set, as was demonstrated in this research. Also the use of ELASTIC will not lead to a balanced set of indicators that cover all dimensions of sustainability. This does not mean that ELASTIC cannot be useful in future evaluations, but it should not be used to find a local set of indicators. It can be used to identify indicators that score high on methodological quality and aspects of sustainability, but more direct input is necessary to develop a final set of indicators that is suitable for local contexts.

Feasibility of evaluating the sustainability of the transport systems of Yogyakarta and Surakarta

Evaluating the current sustainability of transport systems is an important starting point for cities to base their sustainable transport strategy upon. The evaluation framework applied in this research has been designed to identify sustainable transport challenges in the context of medium-sized cities in Indonesia. The sustainable transport problems in medium-sized cities in developing countries receive less attention than those in the larger cities. The problems are however increasing and there is a need for sustainable transport strategies. The local governments in these cities often have less capacity, knowledge and funding to deal with the sustainable transport issues. Therefore this research focused on the evaluation of sustainable transport in the medium-sized cities in Indonesia, to test how feasible evaluating the sustainability of the transport systems is at the moment. Yogyakarta and Surakarta have been used as pilot studies for applying the framework and identifying the sustainable transport challenges.

In both cities the framework could not fully be applied, there was a lack of data availability and the data that has been collected was unreliable. The findings from the two cities confirm that data availability is a problem, which was already found in literature, but they also confirm that institutional capacity and knowledge is weak. These conclusions may not be new, but they do show that despite many efforts since the acknowledgement of the importance of sustainable transport evaluations, the medium-sized cities in Indonesia, and probably other developing countries too, are still not ready for evaluating their own transport systems. This also poses problems for the development of effective sustainable transport strategies. With an increasing need for sustainable transport strategies guidelines are required for these cities to help them deal with evaluation issues.

Guidelines for future sustainable transport evaluations

The evaluation of the transport systems of Yogyakarta and Surakarta was hampered by some strategic and operational issues. Guidelines have been developed to assist local governments in medium-sized cities in Indonesia to deal with these issues. These guidelines provide a road map for the local governments to start evaluating the sustainability of their transport systems as first step in developing more evidence-based, effective sustainable transport strategies. Each of the guidelines is briefly explained:

1. Adopt a sustainable transport strategy

   Evaluating the sustainability of transport systems is important as input for sustainable transport strategies. The local government that has decided to start developing sustainable transport strategies should have a clear idea about the concept of sustainability and how it applies to transport.

2. Strengthen institutional capacity and knowledge

   From literature and this research it became clear that the medium-sized cities in Indonesia do not have the capacity and knowledge at the moment to evaluate the sustainability of transport systems. The use of indicator data is only useful when this is available and reliable. Therefore an important task is to strengthen institutional capacity and knowledge. International organizations can help local governments doing this, but also national knowledge centers can be established, where knowledge and best practices are shared.

3. Choose an evaluation method

The evaluation framework has to specify how the transport system is evaluated. First the context should be established as input for the selection of indicators. In this process stakeholders should be asked to evaluate the set of indicators. The framework should also specify how the data is collected and processed.

4. Choose the right indicators

In the evaluation indicators have to be used to provide information on the sustainability of the transport systems. For the selection of indicators from a long-list criteria have to be used to assess the methodological quality of the indicator. The final set of indicators should be balanced, covering all dimensions of sustainable transport. An indicator set should contain 10-15 indicators to be comprehensible.

5. Standardize the measurement of indicator data

The measurement of indicator data should be standardized temporally and spatially. This will allow making trends that provide useful information. Also the same units should be used, to be able to compare the data. For each of the indicators targets will have to be defined.

6. Structure public participation

Through the whole process of evaluation there should be public participation. This is advocated by many literature sources, but it is not clear how this should be done. As it is difficult to include the public in this process, interest representatives can be asked to join. Examples of such representatives are pedestrian or cycling associations, public transport passenger associations and motorist associations. These associations are more concerned with transport issues and have a better understanding of sustainable transport implications.

These guidelines have been developed specifically for medium-sized cities in an Indonesian context, but they are also transferable to medium-sized cities in other developing countries. Most of these cities will also face the same issues, relating to a lack of capacity, knowledge and funding. In these cities transport problems are expected to increase, so starting to develop sustainable transport strategies will be more and more important. Through international organizations there is already a lot of attention and funding for these problems, but the local governments will also have to start addressing the problems. Researches like this one will remain important in finding solutions and giving guidance to governments.

References

Abolina, K., & Zilans, A. (2002). Evaluation of urban sustainability in specific sectors in Latvia. *Environment, Development and Sustainability, 4*, 299-314.

Adams, W. M. (2006). The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century Report of the IUCN Renowned Thinkers Meeting, 29-31 January 2006.

ADB. (2009). Rethinking transport and climate change *ADB Sustainable development working paper series*.

ADB. (2012). $175 billion to scale up support for transport announced at Rio+20 Retrieved July 19, 2012, from http://www.adb.org/news/175-billion-scale-support-transport-announced-rio20

Akinbami, J. F. K., & Fadare, S. O. (1997). Strategies for sustainable urban and transport development in Nigeria. *Transport Policy, 4*(4), 237-245. doi: 10.1016/s0967-070x(97)00022-x

Alonso, J. A., & Lamata, M. T. (2006). Consistency in the Analytic Hierarchy Process, a new approach. *International Journal of Uncertainty, Fuzziness, and Knowledge-Based Systems, 14*(4), 445-459.

Apostolou, B., & Hassell, J. M. (1993). An empirical examination of the sensitivity of the Analytic Hierarchy Process to departures from recommended consistency ratios. *Mathematical and Computer Modelling, 17*, 163-170.

Aull-Hyde, R., Erdogan, S., & Duke, J. M. (2006). An experiment on the consistency of aggregated comparison matrices in AHP. *European Journal of Operational Research, 171*(1), 290-295. doi: 10.1016/j.ejor.2004.06.037

Australian Government. (2010). Local government infrastructure Retrieved August 14, 2012, from http://www.regional.gov.au/local/publications/reports/2002_2003/C4.aspx

Banister, D. (2005). *Unsustainable transport - City transport in the new century*. Oxfordshire: Routledge.

Bappeda Kota Yogyakarta. (2006). Kerjasama pemerintah swasta untuk proyek infrastruktur transportasi perkotaan proyek percontohan Kota Yogyakarta - Tahap I: Studi dan seleksi proyek kerjasama pemerintah swasta untuk pembangunan infrastruktur transportasi Malioboro.

Bappeda Kota Yogyakarta. (2008). Penyusunan master plan transportasi Kota Yogyakarta.

Bell, S., & Morse, S. (1999). *Sustainability indicators: measuring the immeasurable*. London: Earthscan.

Belton, V. (1986). A comparison of the analyitic hierarchy process and a simple multi-attribute value function. *European Journal of Operational Research, 26*, 7-21.

Black, A. (2004). *The quest for sustainable, healthy communities*. Paper presented at the NSW council on Environmental Education, Sydney, Australia.

Black, W. R. (2010). *Sustainable transportation: problems and solutions*. New York: The Guilford Press.

BLH. (2009). Hasil pengukuran kualitas udara ambien. In BLH (Ed.).

BLH. (2011). Kualitas udara ambien Kota Yogyakarta Provinsi DIY tahun data 2011. In BLH (Ed.).

BLH. (2012). Pemantauan kualitas udara ambien Kota Yogyakarta tahun 2009-2011. In BLH (Ed.).

Bojković, N., Anić, I., & Pejčić-Tarle, S. (2010). One solution for cross-country transport-sustainability evaluation using a modified ELECTRE method. *Ecological Economics, 69*(5), 1176-1186. doi: 10.1016/j.ecolecon.2010.01.006

Bongardt, D., Schmid, D., Huizenga, C., & Litman, T. (2011). Sustainable Transport Evaluation - Developing Practical Tools for Evaluation in the Context of the CSD Process Eschborn: United Nations Commission on Sustainable Development.
BPS Kota Surakarta. (2010). Surakarta dalam angka tahun 2010.
BPS Kota Yogyakarta. (2007). Kota Yogyakarta dalam angka 2006/2007.
BPS Kota Yogyakarta. (2009). Kota Yogyakarta dalam angka 2009.
CAI Asia. (2010). Sustainable urban transport in Asia. Making the vision a reality.
Castillo, H., & Pitfield, D. E. (2010). ELASTIC – A methodological framework for identifying and selecting sustainable transport indicators. *Transportation Research Part D: Transport and Environment, 15*(4), 179-188. doi: 10.1016/j.trd.2009.09.002
CDIA. (2010). Pre-feasibility report in urban transport for Surakarta, Inception report: Cities Development Initiative for Asia.
CDIA. (2011a). Informal public transportation networks in three Indonesian cities: Cities Development Initiative for Asia.
CDIA. (2011b). Pre-feasibility study in urban transport Yogyakarta, Indonesia, Interim report: Cities Development Initiative for Asia.
CDIA. (2011c). Pre-feasibility study in urban transport, Yogyakarta, Indonesia, Draft final report - appendices: Cities Development Initiative for Asia.
CDIA. (2011d). Pre-feasibility study in urban transport, Yogyakarta, Indonesia, Final report: Cities Development Initiative for Asia.
CDIA. (2011e). Pre-feasibility study on urban transport for Surakarta, Final report: Cities Development Initiative for Asia.
CDIA. (2011f). Pre-feasibility study on urban transport for Surakarta, Interim report: Cities Development Initiative for Asia.
CDIA. (2011g). Pre-feasibility study on urban transport for Surakarta, Interim report - Appendices: Cities Development Initiative for Asia.
Center for Clean Air Policy. (2010). Transport NAMAs: A proposed framework. Washington, DC: Center for Clean Air Policy.
Center for Clean Air Policy. (2011). Report 2: Data Selection *Data and capacity needs for transportation NAMAs*. Washington, DC: Center for Clean Air Policy.
Corbiére-Nicollier, T., Ferrari, Y., Jemelin, C., & Jolliet, O. (2003). Assessing sustainability: An assessment framework to evaluate Agenda 21 actions at the local level. *International Journal of Sustainable Development & World Ecology, 10*(3), 225-237. doi: 10.1080/13504500309469801
CST. (2000). Sustainable transportation performance indicators - brief review of some relevant worldwide activity and development of an initial long list of indicators. Toronto: Centre for Sustainable Transport.
CST. (2002). Sustainable transportation performance indicators project - Report on phase 3. Toronto: Centre for Sustainable Transportation.
CST. (2005). Defining Sustainable Transport: Centre for Sustainable Transport.
da Silva, A. N. R., da Silva Costa, M., & Macedo, M. H. (2008). Multiple views of sustainable urban mobility: The case of Brazil. *Transport Policy, 15*(6), 350-360. doi: 10.1016/j.tranpol.2008.12.003
Dahl, A. L. (2012). Achievements and gaps in indicators for sustainability. *Ecological Indicators, 17*, 14-19. doi: 10.1016/j.ecolind.2011.04.032
Dalkmann, H., & Binsted, A. (2010). Copenhagen Accord NAMA submissions: implications for the transport sector: Bridging the gap.
Dimitriou, H. T. (2006). Towards a generic sustainable urban transport strategy for middle-sized cities in Asia: Lessons from Ningbo, Kanpur and Solo. *Habitat International, 30*(4), 1082-1099. doi: 10.1016/j.habitatint.2006.02.001
Dishub Surakarta. (2012). Gelar uji emisi gratis Retrieved April 27, 2012, from http://dishub-surakarta.com/article/92843/dishubkominfo-surakarta---gelar-uji-emisi-gratis.html

Doody, D. G., Kearney, P., Barry, J., Moles, R., & O'Regan, B. (2009). Evaluation of the Q-method as a method of public participation in the selection of sustainable development indicators. *Ecological Indicators, 9*(6), 1129-1137. doi: 10.1016/j.ecolind.2008.12.011

Dyer, R. F., & Forman, E. H. (1992). Group decision support with the Analytic Hierarchy Process. *Decision Support Systems, 8*, 99-124.

EIA. (2011). International energy outlook 2011: U.S. Energy Information Administration.

European Commission (2012). Air quality standards Retrieved April 27, 2012, from http://ec.europa.eu/environment/air/quality/standards.htm

European Environment Agency. (2001). TERM 2001: Indicators tracking transport and environment integration in the European Union.

European Environment Agency. (2011). Laying the foundation for greener transport. TERM 2011: transport indicators tracking progress towards environmental targets in Europe.

Gakenheimer, R., & Dimitriou, H. T. (2011). Chapter 1: Introduction. In H. T. Dimitriou & R. Gakenheimer (Eds.), *Urban transport in the developing world*. Cheltenham: Edward Elgar Publishing Limited.

Goodland, R. (1995). The concept of environmental sustainability. *Annual Review of Ecology and Sytematics, 26*, 1-24.

Grosskurth, J., & Rotmans, J. (2005). The Scene Model: Getting A Grip On Sustainable Development In Policy Making. *Environment, Development and Sustainability, 7*(1), 135-151. doi: 10.1007/s10668-003-4810-0

Gudmundsson, H. (2001). Indicators and performance measures for Transportation, Environment and Sustainability in North America. Report from a German Marshall Fund Fellowship 2000 individual study tour October 2000. *Research Notes from NERI No. 148*: Ministry of Environment and Energy National Environmental Research Institute.

Gudmundsson, H., & Höjer, M. (1996). Sustainable development principles and their implications for transport. *Ecological Economics, 19*(3), 269-282. doi: 10.1016/s0921-8009(96)00045-6

Gustavson, K. R., Lonergan, S. C., & Ruitenbeek, H. J. (1999). Selection and modeling of sustainable development indicators, a case study of the Fraser River Basin. *Ecological Economics, 28*, 117-132.

Haghshenas, H., & Vaziri, M. (2012). Urban sustainable transportation indicators for global comparison. *Ecological Indicators, 15*(1), 115-121. doi: 10.1016/j.ecolind.2011.09.010

Huizenga, C. (2009). *REST description and outreach.* Paper presented at the Presented at Transport week: Freight and passenger railway transport, 9-13 May 2009, Sao Paolo

Huizenga, C., & Bakker, S. (2010). Applicability of post 2012 climate instruments to the transport sector: ADB, IDB, SLoCaT.

IEA. (2009). Transport, energy and CO_2: Moving toward sustainability.

Jeon, C. M., & Amekudzi, A. (2005). Addressing sustainability in transportation systems: Definitions, indicators, and metrics. *Journal of Infrastructure Systems, 11*(10), 31-50. doi: 10.1061//asce/1076-0342/2005/11:1/31

Jibi. (2011). Car free day di Yogya belum bisa rutin Retrieved June 2, 2011, from http://www.bisnis-jateng.com/index.php/2011/06/car-free-day-di-yogya-belum-bisa-rutin/

Joumard, R., & Gudmundsson, H. (Eds.). (2010). *Indicators of environmental sustainability in transport*: Les collections de l'INRETS.

Kane. (2010). Sustainable transport indicators for Cape Town, South Africa, Advocay, negotiation and partnership in transport planning practice. *Natural Resource Forum, 34*, 289-302.

Kenworthy, J. (2011). Chapter 4: An international comparative perspective on fast-rising motorization and automobile dependence. In H. T. Dimitriou & R. Gakenheimer (Eds.), *Urban transport in the developing world*. Cheltenham: Edward Elgar Publishing Limited.

Kota Surakarta. (2011). Khusus retribusi parkir.
Kota Yogyakarta. (2009). Parkir di tepi jalan umum Retrieved June 2, 2012, from http://www.jogjakota.go.id/index/extra.detail/1657/parkir-di-tepi-jalan-umum.html
Kota Yogyakarta. (2012a). Lampiran II peraturan daerah Kota Yogyakarta.
Kota Yogyakarta. (2012b). Rencana pembangunan jangka menengah daerah Kota Yogyakarta tahun 2012-2016.
Lautso, K., Spiekermann, K., Wegener, M., Sheppard, I., Steadman, P., Martino, A., . . . Gayda, S. (2004). PROPOLIS: Planning and research of policies for land use and transport for increasing urban sustainability. Final report. Helsinki.
Litman, T. (2008). Sustainable Transportation Indicators: A Recommended Research Program For Developing Sustainable Transportation Indicators and Data: Sustainable Transportation Indicators Subcommittee of the Transportation Research Board.
Litman, T. (2011a). Developing Indicators for Comprehensive and Sustainable Transport Planning: Victoria Transport Policy Institute.
Litman, T. (2011b). Well Measured - Developing Indicators for Sustainable and Livable Transport Planning Victoria Transport Policy Institute.
Marletto, G., & Mameli, F. (2012). A participative procedure to select indicators of policies for sustainable urban mobility. Outcomes of a national test.: Munich Personal RePCe Archive.
Mascarenhas, A., Coelho, P., Subtil, E., & Ramos, T. B. (2010). The role of common local indicators in regional sustainability assessment. *Ecological Indicators, 10*(3), 646-656. doi: 10.1016/j.ecolind.2009.11.003
May, T., Jarvi-Nykanen, T., Minken, H., Ramjerdi, F., Matthews, B., & Monzón, A. (2001). Cities' decision making requirements - PROSPECTS Deliverable No. 1: Institute of Transport Studies, University of Leeds, Leeds.
Moldan, B., Janoušková, S., & Hák, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. *Ecological Indicators, 17*, 4-13. doi: 10.1016/j.ecolind.2011.04.033
Moles, R., Foley, W., Morrissey, J., & O'Regan, B. (2008). Practical appraisal of sustainable development—Methodologies for sustainability measurement at settlement level. *Environmental Impact Assessment Review, 28*(2-3), 144-165. doi: 10.1016/j.eiar.2007.06.003
Morse, S., & Fraser, E. D. G. (2005). Making ‘dirty’ nations look clean? The nation state and the problem of selecting and weighting indices as tools for measuring progress towards sustainability. *Geoforum, 36*(5), 625-640. doi: 10.1016/j.geoforum.2004.10.005
Munier, N. (2011). Methodology to select a set of urban sustainability indicators to measure the state of the city, and performance assessment. *Ecological Indicators, 11*(5), 1020-1026. doi: 10.1016/j.ecolind.2011.01.006
OECD. (1999). Indicators for the integration of environmental concerns into transport policies.
Parry, M., Canzaiani, O., Palutikof, J., Van der Linden, P., & Hansen, C. (2007). *Climate change 2007: Impacts, adptation and vulnerability*. Cambridge: Cambridge University Press.
Pemerintah Kota Yogyakarta dinas perhubungan. (2003). Studi pola jaringan transportasi jalan Kota Yogyakarta.
PUSTRAL. (2006). Organizational, operational and financial reform on urban public transport industry (case: Yogyakarta Province).
Qureshi, I. A., & Lu, H. (2007). Urban Transport and Sustainable Transport Strategies: A Case Study of Karachi, Pakistan. *Tsinghua Science & Technology, 12*(3), 309-317. doi: 10.1016/s1007-0214(07)70046-9
RAND Europe, Kessel + Partner, Gaia Group, Institut für Energiewirtschaft und Rationelle Energieanwendung, Transport & Mobility Leuven, Study Group Synergo/Econcept, & SUDOP PRAHA a.s. (2003). SUMMA: Deliverable 2 of Workpackage 1: Setting the Context for Defining Sustainable Transport and Mobility.

RAND Europe, Kessel + Partner, Gaia Group, Institut für Energiewirtschaft und Rationelle Energieanwendung, Transport & Mobility Leuven, Study Group Synergo/Econcept, & SUDOP PRAHA a.s. (2005). SUMMA: Final pubishable report.

Reed, M. S., Fraser, E. D. G., & Dougill, A. J. (2006). An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics, 59*(4), 406-418. doi: 10.1016/j.ecolecon.2005.11.008

Saaty, T. L. (2001). The seven pillars of the Analytic Hierarchy Process. In T. L. Saaty & L. G. Vargas (Eds.), *Models, methods, concepts & applications of the Analytic Hierarchy Process*. Norwell, Massachusetts: Kluwer Academic Publishers.

Saaty, T. L. (2003). How to make a decision: the Analytic Hierarchy Process. *European Journal of Operational Research, 48*, 9-26.

Saaty, T. L. (2008). Decision making with the Analytic Hierarchy Process. *Int. J. Service Sciences, 1*(1), 83-98.

Schipper, L., Fabian, H., & Leather, J. (2009). Transport and carbon dioxide emissions: Forecasts, option analysis, and evaluation *ADB Sustainable development working paper series* (Vol. 9): ADB.

Schipper, L., Ng, W. S., Gould, B., & Deakin, E. (2010). "Carbon in motion 2050" for North America and Latin America: University of California at Berkely.

SLoCaT. (2010). Sustainable, Low Carbon Transport. Definition, Goals, Objectives and Performance Indicators.: Partnership on Sustainable Low Carbon Transport.

SLoCaT. (2012). Building on the Rio+20 momentum for sustainable transport.

Sry. (2011). Pencemaran udara di solo akibat emisi kendaraan bermotor Retrieved June 2, 2012, from http://www.wonogiripos.com/2011/solo/70-pencemaran-udara-di-solo-akibat-emisi-kendaraan-bermotor-106039

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge: Cambridge University Press.

Surakarta, D. (2012). Solo car free day Retrieved June 2, 2012, from http://dishub-surakarta.com/page/21469/solo-car-free-day.html

Tatralok. (2010). Studi Tatralok Kota Surakarta.

Torjman, S. (2000). The social dimension of sustainable development: Caledon Institute of Social Policy.

Umwelt Bundes Amt. (2004). Quality targets and indicators for sustainable mobility.

UN-HABITAT. (2007). Climate change, statement by Brian Williams, Chief Energy and Transport Section, Nairobi, Kenia, during UN commission on Sustainable Development Retrieved July 4, 2012, from http://www.unhabitat.org/content.asp?cid=4756&catid=356&typeid=8

UN-HABITAT. (2009). State of the world's cities report 2008/2009: Harmonious cities, Report. New York.

UN. (1992a). Local Agenda 21, Chapter 28: Local authorities' initiatives in support of Agenda 21 Retrieved February 2, 2012, from http://www.un.org/esa/dsd/agenda21/res_agenda21_28.shtml

UN. (1992b). Local Agenda 21, Chapter 40: Information fo decision-making Retrieved February 2, 2012, from http://www.un.org/esa/dsd/agenda21/res_agenda21_40.shtml

UN. (2012a). Commitment to sustainable transport Retrieved July 19, 2012, from http://www.uncsd2012.org/index.php?page=view&type=1006&menu=153&nr=290

UN. (2012b). *The future we want.* Paper presented at the Rio+20, Rio de Janeiro.

United States Environmental protection agency. (2011). National ambient air quality standards (NAAQS) Retrieved April 27, 2012, from http://www.epa.gov/air/criteria.html

University of Windsor. (2011). Sustainability Venn Diagram Retrieved December 12, 2011, from http://www.uwindsor.ca/sustainability/system/files/survey.jpg

UTBI. (2006). Common Indicator Report: European Commission.

Van Wee, B., & Geurs, K. T. (2011). Discussing equity and social exclusion in accessibility evaluations. *European Journal of Transport and Infrastructure Research, 11*(4), 350-367.
WCED. (1987). Our common future: report of the World Commission on Environment and Development.
Wegener, M., & Fürst, F. (1999). Land-use and transport interactions: State of the art *Berichte aus dem Institut für Raumplanung*: Universität Dortmund.
WHO. (2009). Global status report on road safety: Time for action. Geneva: World Helath Organization.
World Bank. (2006). Where is the wealth of the nations? Measuring the capital for the 21st century. Wahington D.C.: The World Bank.
World Bank. (2007). World Development Indicators 3.10: Worldbank.
Wright, L. (2011). Chapter 15: Bus rapid transit: a review of recent advances. In H. T. Dimitriou & R. Gakenheimer (Eds.), *Urban transport in the developing world*. Cheltenham: Edward Elgar Publishing Limited.
Zusman, E., Srinivasan, A., & Dhakal, S. (2012). *Low carbon transport in Asia: strategies for optimizing co-benefits*. Abingdon: Earthscan.

Appendices

A. Evaluation frameworks

Table 15 List of evaluation frameworks

Method	Description	Who	How	When	+/-
ELASTIC (Castillo & Pitfield, 2010)	Using weighted goals, criteria and ST objectives to select indicators.	Transport planners and academics used to assign weights. (Top-down)	Surveys	Before selection of indicators	+ weights + early involvement stakeholders - no public participation
Q-Method (Doody, Kearney, Barry, Moles, & O'Regan, 2009)	Using q-method to select indicators combining top-down and bottom-up	Experts and the public	Focus groups	Experts in early stage, public in development of final indicators	+ expert and public participation - q-method not transparent - focus groups are time consuming
Mascarenhas, Coelho, Subtil, and Ramos (2010)	Based on local strategies and goals and public participation indicators are selected	Public	Workshops and surveys	At indicator selection at development (twice)	+ public participation - no expert participation in selecting indicators - workshops are time consuming
Munier (2011)	Transport goals and urban setting are input for indicator selection together with some criteria	Committee	Not clear, no significant role	Used to create the framework for selecting the initial indicators	+ based on setting - no public participation
Reed et al. (2006)	Based on goals and strategies potential indicators are selected, which are evaluated with user groups.	All relevant stakeholders	User groups	Indicator selection (evaluation)	+ thinks of all relevant stakeholders - user groups can be time consuming

B. Indicator sources

Table 16 Overview of indicator sources

[x] = aspect is covered [o] = aspect is partly covered [ ] = aspect is not covered	
Bojković 2010 (Bojković et al., 2010)	
Type of source	Journal paper
Aim of approach	Cross-country evaluation of sustainable transport
Number of indicators	16
Aspects included	[x] Economic [x] Social [x] Environmental [ ] Governance, planning and participation
Partnership for sustainable transport in Asia, PSUTA (CAI Asia, 2010)	
Type of source	Report
Aim of approach	Raise awareness on sustainable urban transport and encourage cities and governments to intensify efforts to improve the sustainability of their transport systems
Number of indicators	9
Aspects included	[x] Economic [x] Social [x] Environmental [o] Governance, planning and participation
Castillo 2010 (Castillo & Pitfield, 2010)	
Type of source	Journal paper
Aim of approach	Present a method for selecting indicators
Number of indicators	20[1]
Aspects included	[x] Economic [x] Social [x] Environmental [x] Governance, planning and participation
Sustainable transportation performance indicators, STPI (CST, 2002)	
Type of source	Report
Aim of approach	Measure progress towards sustainable transport
Number of indicators	15
Aspects included	[ ] Economic [x] Social [x] Environmental [o] Governance, planning and participation
Hagshenas 2012 (Haghshenas & Vaziri, 2012)	
Type of source	Journal paper
Aim of approach	Develop a set of indicators for global comparison
Number of indicators	9
Aspects included	[x] Economic [x] Social [x] Environmental

[1] Top 15 indicators are used for evaluation in paper

	[ ] Governance, planning and participation
Kane 2010 (Kane, 2010)	
Type of source	Journal paper
Aim of approach	Describe the adoption of a set of indicators for Cape Town, South Africa
Number of indicators	18
Aspects included	[x] Economic [x] Social [x] Environmental [o] Governance, planning and participation
Litman 2011 (Litman, 2011b) (related to Sustainable low-carbon transport, SLoCaT (SLoCaT, 2010))	
Type of source	Report
Aim of approach	Provide an overview of practices and provide guidelines for selecting indicators
Number of indicators	64[2]
Aspects included	[x] Economic [x] Social [x] Environmental [x] Governance, planning and participation
OECD 1999 (OECD, 1999)	
Type of source	Report
Aim of approach	Integrating environmental concerns in transport planning
Number of indicators	32
Aspects included	[x] Economic [x] Social [x] Environmental [ ] Governance, planning and participation
PROPOLIS 2004 (Lautso et al., 2004)	
Type of source	Report
Aim of approach	Research, develop and test integrated land use and transport policies, tools and comprehensive assessment methodologies in order to de-fine sustainable long-term urban strategies and to demonstrate their effects in European cities
Number of indicators	35[3]
Aspects included	[x] Economic [x] Social [x] Environmental [ ] Governance, planning and participation
Transport and environment reporting mechanism, TERM (European Environment Agency, 2011)	
Type of source	Report
Aim of approach	Measure the progress towards environmental European targets
Number of indicators	11[4]
Aspects included	[o] Economic

[2] Key sustainable transport indicators and recommended indicators
[3] Background indicators not counted (nor used)
[4] Core indicators

	[ ] Social [x] Environmental [ ] Governance, planning and participation
UBA 2005 (Umwelt Bundes Amt, 2004)	
Type of source	Report
Aim of approach	Provide guidelines for local authorities
Number of indicators	9
Aspects included	[ ] Economic [x] Social [o] Environmental [ ] Governance, planning and participation
Urban transport benchmarking initiative (UTBI, 2006)	
Type of source	Report
Aim of approach	Provide a context and enable comparisons for participating cities
Number of indicators	25
Aspects included	[x] Economic [x] Social [x] Environmental [ ] Governance, planning and participation

C. Methodological criteria

Table 17 List of methodological criteria

Criteria methodology	Source
Reflect more than one system or dimension	Gustavson et al. (1999)
Comprehensive (and balanced)	Litman (2011a)
Understandable	
Useful	
Right level of analysis (eg. Air quality)	
Relevance to community	Hart (1997) in Litman (2011a)
Understandable	
Developed, accepted and used by community?	
Long-term view of community	
Link different areas of the community	
Reliable, accessible, timely and accurate data	
Local impacts → global impacts	
Measurability	Castillo and Pitfield (2010)
Ease of availability	
Speed of availability	
Interpretability	
Transport's impacts isolated	
Measure sustainability instead of unsustainability	Dahl (2012)
Validity (measure the issue)	Joumard and Gudmundsson (2010)
Reliability (same value when repeated)	
Sensitivity (reveal changes in factor of interest)	
Measurability (straight-forward and inexpensive to measure)	
Data availability	
Ethical concerns (fundamental rights and consistent with morals, beliefs or values)	
Transparency (feasible to understand and reproduce)	
Interpretability (intuitive and unambiguous reading)	
Target relevance (measure performance)	
Actionability (measure factors that can be changed or influenced)	

D. Analytic Hierarchy Process

When making a decision it can be difficult to choose the factors that are important for making this decision. The Analytic Hierarchy Process (AHP) is a multi-criteria decision making approach, that arranges goals, criteria, alternatives and stakeholders in a hierarchy (Saaty, 2001, 2003, 2008). This serves two purposes. It gives an overview of the complexity of the relationships concerned with the situation and it helps the decision maker to assess the importance of issues on all levels (Saaty, 2003). AHP is a widely used method for decision making in all kind of fields and is also suitable for group decisions (Belton, 1986; Dyer & Forman, 1992; Saaty, 2001).

The principles of AHP will be shortly explained here, for a more detailed explanation see the work of Saaty (Saaty, 2001, 2003, 2008), which is used in the following explanation. AHP generally works according to three principles:

1. Decomposition of the problem into a hierarchy
2. Comparative judgments
3. Synthesis of priorities

In the first step all elements of the problem are structured in a hierarchy, see Figure 11.

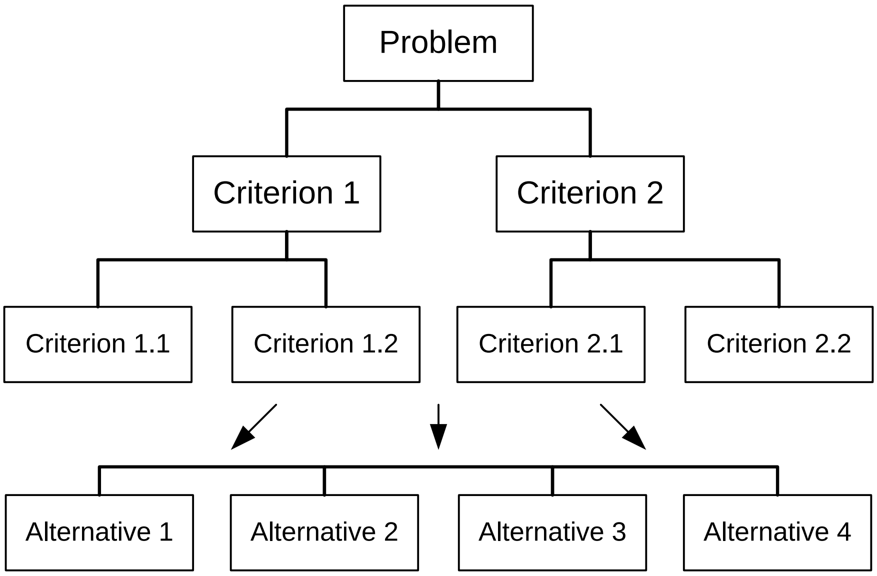


Figure 11 Example of AHP hierarchy

A certain problem might have criteria, sub-criteria and a set of alternatives to choose from. In step two the elements on each level are judged by pairwise comparisons. A common way to compare two elements pairwise is to ask which element is favored and by how much. A frequently used scale for such questions is 1-9, as explained in Table 18.

Table 18 The fundamental scale of AHP (adopted from Saaty (2003))

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong or demonstrated importance	An element is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	

In step three these judgments are translated in the rankings. First the judgments are put in a matrix, using reciprocal values for the opposite combinations. So if criterion 1 is favored over criterion 2 four times, criterion 2 in relation to criterion 1 will receive a value of ¼. When the matrix is filled in all values are normalized, so they can be compared. As people will always give subjective judgments there will be inconsistencies in the matrix. By squaring the matrix a couple of times, these inconsistencies are leveled. From the final matrix the weights can be calculated by dividing the row totals by the total sum of the matrix.

	A	B	C	Weights
A	1	3	1/5	0.23
B	1/3	1	1/6	0.16
C	5	6	1	0.61

Figure 12 Example of an AHP matrix

To measure the consistency of the matrix the principal eigenvector (λ_{max}) is used to calculate the consistency index (*CI*):

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Where *n* is the number of elements. The value of *CI* is compared to the average consistency of random reciprocal matrices resulting in the consistency ratio (*CR*). Matrices with consistency ratios of 0.1 and less are considered to be highly consistent. In the given example of Figure 12 the λ_{max} is 3.094, *CI* is 0.047 and *CR* is 0.081. This indicates that the judgments are consistent.

AHP and individual judgments

There are several ways to aggregate the judgments of individuals. The right way to aggregate depends on the situation. If all individuals have the same objective the geometric mean for all judgments has to be calculated. In cases that some individuals or (sub-)groups have different objectives the outcomes for the priorities can be averaged. If some individuals are more important, their judgments have to be raised to the power of their priority of importance and then the geometric mean is formed.

E. Survey

Survey Sustainable Transport Indicators

Time to complete survey: approximately 5 minutes

Introduction

This survey is used to find the best indicators of sustainable transport in Jogja and Solo. Most research on indicators has focused on Western countries or metropolitan areas in developing countries. Less is known about the concept of sustainable transport in medium-sized cities in developing countries. This research builds on the idea that the concept of sustainable transport depends on the local context. This context is defined by the stakeholders. Therefore input from these stakeholders is needed, to give weights to the criteria for selecting the best indicators. The stakeholders included in this research are: decision makers, transport planners, transport operators, transport academics and transport users. Results will be used to evaluate the transport systems of Yogyakarta and Surakarta and compare both cities. Recommendations will be given with respect to policy measures in the past and future policy.

This research is conducted as part of the master thesis of Guido Nijenhuis, student from the University of Twente, the Netherlands, in cooperation with the Center for Transport Studies (PUSTRAL), University of Gadja Mada, Yogyakarta, Indonesia.

Survey

Please read all the information carefully and answer all questions.

In this survey you will be presented pairs of criteria, which will be used for selecting sustainable transport indicators. Please indicate which criterion in each pair presented you think is more important and indicate how much more you favor this criterion, using the values below.

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong or demonstrated importance	An element is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	

Part 1: Methodology

Used concepts	Description
Understandability	Indicator is understandable for the general public
Long-term view	Indicator relates to historical and future information
Measurability	Indicator can be measured theoretically sound, dependable and easily understood
Actionability	Indicator measures factors that can be influenced by policy action
Validity	Indicator measures the issue

In deciding on an indicator of 'sustainable transport', which of the following criteria would you deem more important for indicator choice and how strongly?
Please circle the appropriate number.

Understandability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Long-term view
Measurability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Actionability
Validity	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Understandability
Long-term view	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Measurability
Actionability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Validity
Understandability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Measurability
Validity	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Long-term view
Understandability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Actionability
Measurability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Validity

Actionability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Long-term view

Part 2: Relevance

Used concepts	Description
Livable streets and neighborhoods	The indicator measures physical, aesthetic and special characteristics
Protection of the environment	The impact of transport on the environment is measured by the indicator
Equity and social inclusion	Indicator measures differences between social, economic and geographical groups
Health and safety	The indicator relates to health and safety issues
Support of a vibrant and efficient economy	The indicator shows effects of transport on the economy

If you were seeking to assess the overall sustainability of a transport system based on its performance on given sustainability objectives, which of the following sustainable transport objectives would you deem more important to your decision, and how strongly?
Please circle the appropriate number.

Livable streets and neighborhoods	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Protection of the environment
Equity and social inclusion	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Health and safety
Support of vibrant and efficient economy	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Livable streets and neighborhoods
Protection of the environment	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Equity and social inclusion
Health and safety	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Support of a vibrant and efficient economy
Livable streets and neighborhoods	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Equity and social inclusion

Support of a vibrant and efficient economy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Protection of the environment
Livable streets and neighborhoods	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Health and safety
Equity and social inclusion	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Support of a vibrant and efficient economy
Health and safety	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Protection of the environment

Part 3 Methodology vs. Relevance

Used concepts	Description
Methodological Quality	Relates to the criteria in part 1: Understandability, long-term view, measurability, actionability, validity
Relevance to Sustainable Transport	Relates to the criteria in part 2: Livable streets, environment, equity, health, economy

If you were asked to choose a sustainable transport indicator based on either its **Methodological Quality** or its **Relevance to Sustainable Transport** which of these two criteria would you deem more important to your selection and how strongly so?
Please circle the appropriate number.

Methodological Quality	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Relevance to Sustainable Transport

Final remark

After selecting the indicators feedback will be given to stakeholders that participated in the survey. The results of the research will be presented and feedback from stakeholders on these results is highly appreciated. Would you like to take part in a feedback session on the results?

☐ Yes, e-mail:…….

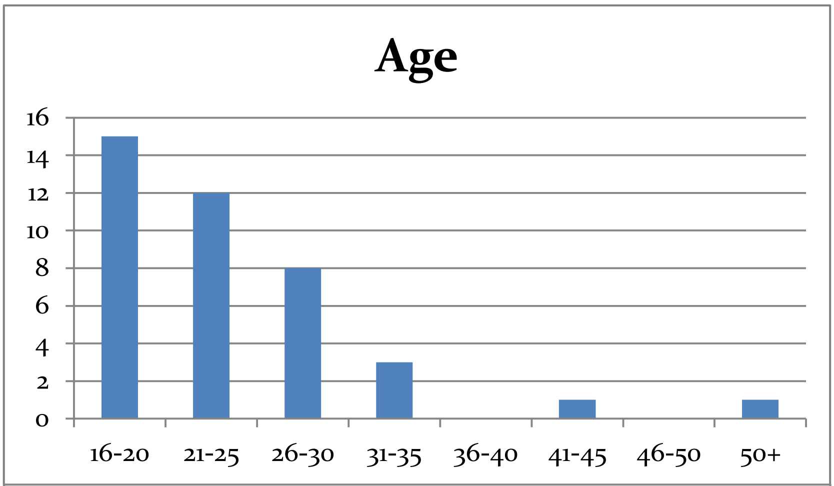
☐ No

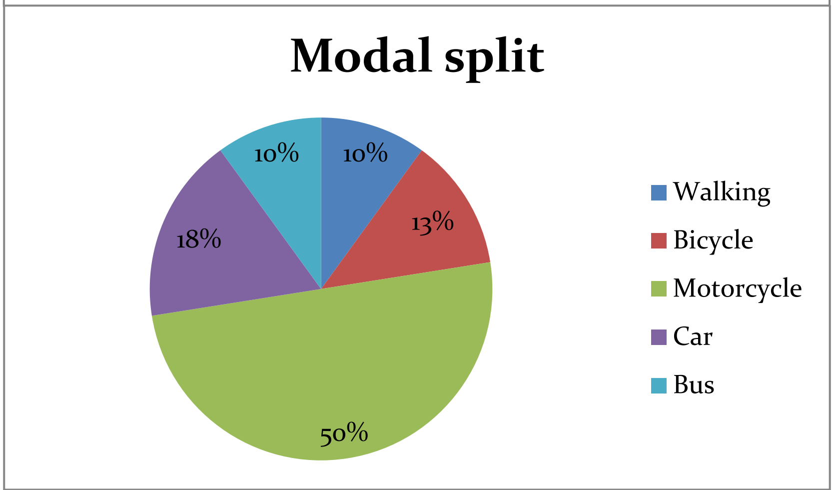
This is the end of the survey. Thank you for your cooperation.

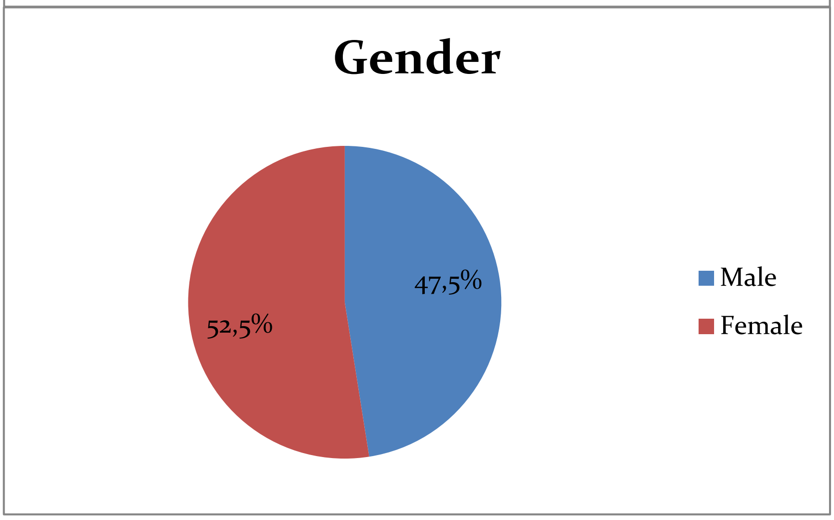
F. Analysis respondents

Analysis of sample transport users

To see if the sample of the transport users is representative for the total population a few questions about the respondent were included. Two students from Gadjah Mada University conducted the survey. They were instructed to cinduct the survey on a location where a mixed group of people can be found. Malioboro Street and the supermarket on the campus of Gadjah Mada were considered to be two suitable places. The two students however only conducted the survey on the campus. Therefore most respondents were student, which explains the age of most respondents (average 24 years). All 40 responses were used in the results shown here.







G. AHP results

Table 19 Weights and standard deviations for all stakeholders for judgments with CR <0.5

Stakeholder	Academic		Decision maker		Planner		Operator		User		PUSTRAL		Expert	
	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.
Methodology	(N=5)		(N=2)		(N=5)		(N=1)		(N=29)*		(N=6)		(N=16)	
Understandability	0.30	0.19	0.42	0.31	0.12	0.04	0.14	-	0.14	0.10	0.21	0.06	0.20	0.13
Long-term view	0.16	0.23	0.11	0.28	0.09	0.11	0.19	-	0.17	0.08	0.14	0.12	0.13	0.15
Measurability	0.13	0.10	0.12	0.02	0.17	0.09	0.32	-	0.26	0.11	0.15	0.06	0.15	0.08
Actionability	0.31	0.02	0.23	0.09	0.44	0.20	0.34	-	0.19	0.11	0.30	0.17	0.35	0.16
Validity	0.10	0.09	0.13	0.15	0.17	0.17	0.01	-	0.24	0.13	0.20	0.16	0.16	0.14
Relevance	(N=3)		(N=2)		(N=4)		(N=1)		(N=30)		(N=7)		(N=14)	
Livable streets and neighborhoods	0.17	0.09	0.13	0.03	0.19	0.11	0.46	-	0.13	0.08	0.22	0.11	0.20	0.10
Protection of the environment	0.17	0.10	0.26	0.38	0.26	0.23	0.10	-	0.20	0.12	0.20	0.10	0.21	0.14
Equity and social inclusion	0.23	0.05	0.13	0.10	0.15	0.07	0.11	-	0.22	0.09	0.18	0.07	0.18	0.07
Health and safety	0.19	0.04	0.32	0.07	0.29	0.16	0.24	-	0.28	0.08	0.26	0.15	0.25	0.13
Support of vibrant and efficient economy	0.24	0.15	0.15	0.38	0.12	0.09	0.10	-	0.18	0.09	0.15	0.07	0.15	0.10
Methodology vs. Relevance	(N=5)		(N=3)		(N=5)		(N=1)		(N=40)*		(N=8)		(N=18)	
Methodology	0.22	0.16	0.19	0.09	0.22	0.26	0.90	-	0.34	0.18	0.27	0.17	0.26	0.19
Relevance	0.78	0.16	0.81	0.09	0.78	0.26	0.10	-	0.66	0.18	0.73	0.17	0.74	0.19

*Transport user judgments about methodological criteria were not used for selecting indicators

Table 20 Weights and standard deviations Castillo and Pitfield (2010)

Stakeholder	Academic		Planner		Combined	
	Weight	St. dev.	Weight	St. dev.	Weight	St. dev.
Methodology	(N=30)		(N=39)		(N=69)	
Measurability	0.22 (3)	0.15	0.22 (2)	0.11	0.22 (3)	0.13
Ease of availability	0.14 (4)	0.11	0.14 (4)	0.10	0.14 (4)	0.10
Speed of availability	0.07 (5)	0.03	0.07 (5)	0.08	0.07 (5)	0.06
Interpretability	0.31 (1)	0.18	0.35 (1)	0.14	0.34 (1)	0.16
Isolatability	0.26 (2)	0.16	0.21 (3)	0.13	0.23 (2)	0.14
Relevance	(N=30)		(N=39)		(N=69)	
Livable streets and neighborhoods	0.16 (4)	0.10	0.15 (5)	0.08	0.16 (5)	0.09
Protection of the environment	0.24 (2)	0.17	0.17 (3)	0.15	0.20 (2)	0.16
Equity and social inclusion	0.17 (3)	0.11	0.16 (4)	0.09	0.17 (3)	0.10
Health and safety	0.28 (1)	0.18	0.33 (1)	0.17	0.31 (1)	0.17
Support of vibrant and efficient economy	0.14 (5)	0.12	0.19 (2)	0.13	0.17 (3)	0.13
Methodology vs. Relevance	(N=30)		(N=39)		(N=69)	
Methodology	0.47 (2)	0.26	0.49 (2)	0.22	0.48 (2)	0.24
Relevance	0.53 (1)	0.26	0.51 (1)	0.22	0.52 (1)	0.24

H. Indicator sets

Table 21 Indicator set for transport experts

Rank	Indicator	Unit	Score
1	Length of cycling and walking paths	km (as % of total)	2.34
2	Clearly defined goals, objectives and indicators	Availability of goals, objectives and indicators	2.26
3	Quality of open space	index (base=100)	2.21
4	Justice of exposure to air pollution	justice index	2.18
5	Justice of exposure to noise	justice index	2.18
6	Share of non-motorized transport	%	2.09
7	Car and bicycle ownership per 1,000 population	Number of cars and bicycles per 1,000 population	2.04
8	Transport emissions - CO2, Nox, VOC, CO etc. (share in total, by mode) and emissions intensities (per capita, per vehicle km, per GDP)	% total/mode, intensity (per capita, vkt, GDP)	2.04
9	Transport cost	monetary value, or % of budget	1.96
10	People killed in road accidents	Deaths per million	1.93
11	Road network: length and density	km, vehicles/km	1.89
12	Basic road safety law, licensing, traffic enforcement (governance)	Availability of laws, licensing, enforcement	1.86
13	Availability of planning information and documents	Availability of planning information and documents	1.86
14	Traffic injuries	Injuries per million	1.85
15	Destinations accessible by people with disabilities and low income	%	1.85

Table 22 Indicator set for transport users

Rank	Indicator	Unit	Score
1	Length of cycling and walking paths	km (as % of total)	2.32
2	Clearly defined goals, objectives and indicators	Availability of goals, objectives and indicators	2.31
3	Justice of exposure to air pollution	justice index	2.24
4	Car and bicycle ownership per 1,000 population	Number of cars and bicycles per 1,000 population	2.21
5	Justice of exposure to noise	justice index	2.21
6	Share of non-motorized individual transport	%	2.19
7	Transport cost	monetary value, or % of budget	2.18
8	People killed in road accidents	Deaths per million	2.13
9	Transport emissions - CO2, Nox, VOC, CO etc. (share in total, by mode) and emissions intensities (per capita, per vehicle km, per GDP)	% total/mode, intensity (per capita, vkt, GDP)	2.11
10	Quality of open space	index (base=100)	2.11
11	Availability of planning information and documents	Availability of planning information and documents	2.08
12	Portion of population engaged in planning decisions	%	2.02
13	Public awareness of transport sustainability issues	awareness, % involved, communication?	2.02
	Structure of road fuel prices in real terms (by type of fuel) and taxation	monetary value	2.01
15	Destinations accessible by people with disabilities and low income	%	1.97

Table 23 Indicator set for equal criteria weights

Rank	Indicator	Unit	Score
1	Transport investment costs	Euro/capita	2.50
	Length of cycling and walking paths	km (as % of total)	2.50
	Availability of planning information and documents	Availability of planning information and documents	2.50
4	Car and bicycle ownership per 1,000 population	Number of cars and bicycles per 1,000 population	2.40
	People killed in road accidents	Deaths per million	2.40
	Clearly defined goals, objectives and indicators	Availability of goals, objectives and indicators	2.40
	Structure of road fuel prices in real terms (by type of fuel) and taxation	monetary values	2.30
	Share of non-motorized individual transport	%	2.30
	Quality of open space	index (base=100)	2.30
	Portion of population engaged in planning decisions	%	2.30
	Public awareness of transport sustainability issues	awareness, % involved, communication?	2.30
12	Traffic injuries	injuries per million	2.20
	Transit affordability	ticket cost, compare to GDP	2.20
	Transport emissions - CO2, Nox, VOC, CO etc. (share in total, by mode) and emissions intensities (per capita, per vehicle km, per GDP)	% total/mode, intensity (per capita, vkt, GDP)	2.20
	Basic road safety law, licensing, traffic enforcement (governance)	Availability of laws, licensing, enforcement	2.20

I. Indicator data

Indicator: Walking and cycling paths (including quality)

Indicator source(s):

- Castillo and Pitfield (2010)
- Litman (2011b)

Description indicator:
For public transport it is important that stations and stops are accessible by foot or bicycle. Also people that do not have enough money to travel with motorized private or public transport depend on walking and cycling. ‘Walking and cycling paths’ measures the quantity of paths as a percentage of the total urban road network. Because in Yogyakarta and Surakarta the walking and cycling paths are often used for other purposes (parking, food stalls) the quality of the paths also needs to be measured.

Unit(s):
Total length of walking and cycling paths in kilometer and as a percentage of the total urban road network.
For the quality of the walking and cycling paths the number of on-street parked vehicles and stalls can be used and a visual assessment of the quality of paths.

Availability:
Information on the length of walking and cycling paths and lanes was not available for both cities. For Yogyakarta the suggested alternative routes for cyclists and the signs to these routes were found. For both cities an indication of on-street activities on the major roads was found.

Yogyakarta
In Yogyakarta some improvements have been made for cycling, see Figure 13. There are signs that direct cyclists to routes with less motorized traffic. Also on major intersections space is reserved for cyclists waiting for the traffic lights. The location of the signs and the cycling route is shown in Figure 14. It must be noted that on these routes the number of motorized vehicles is lower and that most of the time there are no cycling paths.

Figure 13 Cycling facilities in Yogyakarta

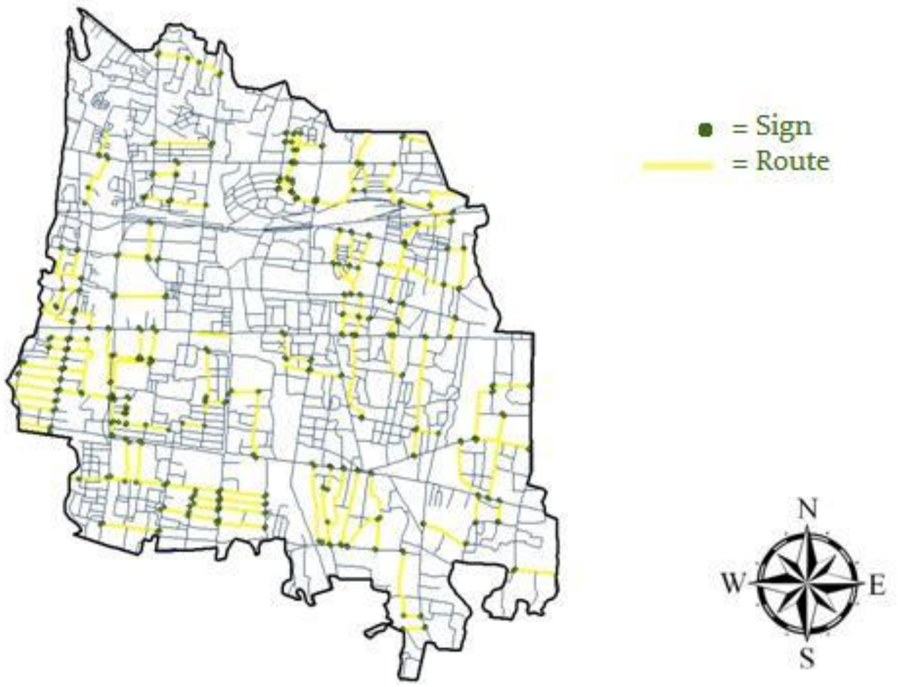


Figure 14 Cycling routes and signing in Yogyakarta

On some roads there is a cycling path marked, but often the markings are not clear. The biggest problem for cyclists is the on-street parking and food stalls on the road, this makes cycling dangerous. For the CDIA pre-feasibility study the number of on-street activities on the three main corridors (Figure 15) have been counted (CDIA, 2011c). The number of on-street parked vehicles and stalls on the street is very high (Table 24), making walking and cycling uncomfortable and dangerous.

Table 24 Number of on-street activities

	Car	Motorcycle	Becak	Bicycle	Andong	Stall
Corridor 1	1,310	6,741	923	247	60	1,141
Corridor 2	422	1,423	271	73	7	324
Corridor 3	375	552	164	40	1	150
Total	**2,107**	**8,716**	**1,358**	**360**	**68**	**1,615**

Source: CDIA (2011c)

Figure 15 Corridors in Yogyakarta

Source: CDIA (2011d)

CDIA also conducted a household survey to investigate the opinion of the public on some transport issues. One of the issues dealt with was the quality of walking paths. Table 25 shows that almost half of the respondents were satisfied with the quality, continuity and width of the cycling paths. Less people are satisfied with the amount of shade and safety. The numbers also show that more than half of the respondents is not satisfied. A visual assessment of the quality of the walking paths also indicates that these are often obstructed by stalls and parked vehicles. Often the walking paths are broken and there are many changes in height levels, making walking uncomfortable and impossible for disabled people.

Table 25 Results of household survey on walking paths per income class

Issue	Households with a view of *Excellent or Good*				
	Poorest	Poor	Middle	Upper	**Total**
Quality of walking surfaces	48%	44%	46%	41%	**45%**
Continuity of walking path (no obstructions)	49%	40%	41%	37%	**42%**
Adequate width for walking demands levels	57%	53%	43%	42%	**48%**
Adequate shade for pedestrians	27%	24%	26%	25%	**26%**
Adequate personal safety for pedestrians	32%	31%	27%	25%	**29%**

Source: CDIA (2011b)

In Yogyakarta some attempts have been undertaken to organize car free days in the area of Malioboro Street. The purpose of the car free day is to limit air pollution, but also to create public awareness about the negative effects of motorized transport. Although the road was blocked for motorized traffic some motorcycles still got through, making the car free day not a complete success (Jibi, 2011).

Surakarta

The information for Surakarta is more limited, but some things can be said about the quality of walking and cycling paths. In Surakarta four pedestrian bridges have been installed, ensuring safe street crossings (Tatralok, 2010). As in Yogyakarta the number of on-street parked cars has been counted for one of the major roads, Jalan Slamet Riyadi. In total 218 cars were counted on a length of 2,705 meter (CDIA, 2011e). More information on walking and cycling paths was not available. Visual assessment of the walking paths shows the same conditions as in Yogyakarta. When walking paths are present these are used for other activities, mainly parking. In places without walking paths pedestrians will have to walk in the bank of the roads or on the street between the other traffic. Surakarta also organizes car free days, but unlike Yogyakarta, on a regular base. Each Sunday morning from 5 to 9 AM Jalan Slamet Riyadi is blocked for motorized traffic. The success of the car free day in Surakarta seems to be higher (Surakarta, 2012).

Comparison of both cities
Because the availability of data is limited it is hard to make a good comparison between the two cities. For both cities information on the number of on-street parked cars is available. The number of on-street parked cars in Surakarta seems to be a bit lower, taking the total length of the roads used for counting into account. Surakarta also has some pedestrian bridges to cross the street and has more success with the car free days. On the other hand Yogyakarta has done some improvements for cyclists. So both cities show some improvements, but only for walking or cycling. At the moment the length and quality of walking and cycling paths is not yet sufficient.

Table 26 Score indicator ‘Walking and cycling paths’

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Walking and cycling paths				

Indicator: Clearly defined transport goals, objectives and indicators

Source(s):
- Litman (2011b)

Description indicator:
This indicator measures how well goals and objectives are defined. It also looks at the availability of indicators in policy documents and the relation of these indicators to the objectives. Clearly defined transport goals and objectives make it possible to control local government actions. The indicators are needed to track progress.

Unit(s):
Assessment of how clear goals and objectives are formulated.
Are the objectives measurable?
Are indicators used?
Do the indicators relate to the goals and objectives?

Availability:
A master plan for the transport system was found for both cities and in 2011 in both cities CDIA helped to develop transport plans. Earlier transport plans are not available, because transport planning used to be done on a regional level before 2006.

Yogyakarta
Master plan Yogyakarta City 2009-2023 (Bappeda Kota Yogyakarta, 2008):

Goals:
- Support economy
- Support tourism
- Support education
- Preserve the environment and culture
- Towards the international city

Objectives:
- Creating an environmentally friendly transport system
- Giving priority to public transport
- Controlling transport demand
- Not giving priority to motorized vehicles
- Encouraging community and private participation

The goals contain some elements of sustainability, but it is not the main focus. The social aspect is missing. It is not clear how transport can contribute to the goals. The definition of objectives could have been clearer. For the objectives it is not clear how the progress will be monitored or when the objective has been achieved. The influence of transport on sustainability is shortly described in the master plan, but it does not really deal with the aspects of sustainability. In the goals and objectives some of these aspects can be seen, but the direct relation between transport policy and sustainability is not described.

Indicators:
The master plan contains many indicators, some of them relate to the goals and objectives, others not. Targets for the indicators are not set.

CDIA Pre-feasibility study Yogyakarta (Phase 1: 2011-2015) (CDIA, 2011d)

Goal:

- Formulate a sustainable urban transport sector strategy and high priority investment package for the greater Yogyakarta urban area.

Objectives:

- Establish an urban transport sector strategy in Yogyakarta, and recommend necessary policy and regulatory frameworks to implement the strategy. The strategy aims to help the government of Yogyakarta to form a long-term vision for sustainable urban transport development which will support Yogyakarta's economic development and social wellbeing
- Identify priority and bankable transport investments that either minimize environmental impacts, or actually improve environmental conditions and climate change mitigation, and
- Strengthen the capacity of urban transport institutions involved in management and service delivery, including local and provincial level agencies as applicable.

The goals and objectives have been clearly formulated. The objectives are outcome oriented. The objectives are achieved when the outcomes are finished. With these objectives it is hard to measure the quality of the outcomes.

Indicators:
The CDIA study has used many of the same indicators used in the master plan, but has also conducted surveys to obtain more information. The relation between the indicators presented in the documents and the proposed measures is not clear. What the targets are is also not clear from these documents. This makes it hard to say if the proposed measures were successful.

Surakarta
Tatralok Surakarta City 2009 (Tatralok, 2010)

Goal:

- The goal of the Tatralok (Transport plan) is to develop a transport system that is effective within the meaning of safety, high accessibility, integration, sufficient capacity, regular, smooth and fast, easy, timely, convenient, affordable rates, orderly, secure, low-pollution and efficient in the sense of the public burden of low and high utility in one unified national transportation network.

Objectives:

- Development and construction of infrastructure and facilities
  - Increased capacity of transport infrastructure and facilities
  - Improvement and development roads
  - Development of transport network
  - Improvement of transport safety
  - Improvement of transport services sector
  - Improvement of transport planning studies
- Developing an improved transport network strategy
  - Develop a network of transportation services
  - Develop inter- and intra modal integration of transportation modes
- Transportation Resource Development
  - Increase the participation of the public and private sector
  - Integrated allocation of government resources

    - Increase the budget for transport
- Human Resource Development and Transport Management
    - Improvement of human resources in transport
    - Enhancing coordination among and between regions
    - Development of IT management for transportation

The goal is not clearly defined. It contains many issues that need to be developed "effectively". Also in the objectives there are a lot of things that need to be developed, but again it is not clear how this should be done.

Indicators:
The Tatralok uses many indicators, most of them related to the transport system, but some do not even relate to the urban transport system (e.g. aviation loads). For the indicators it is not clear how they are related to the goal and objectives and what targets are. It looks like all available data was used.

CDIA Pre-feasibility study on urban transport for Surakarta (2011-2030) (CDIA, 2011e)

Goal:

- Undertake an urban transport strategy for Surakarta

Objectives:

- To establish an urban transport sector strategy in Surakarta and formulate necessary policy and regulatory frameworks to implement the strategy. This strategy aims to help the government of Surakarta to form a long-term vision for a sustainable urban transport development which will support Surakarta's economic development.
- To identify priority and bankable transport investments for its citizens that do not have any direct negative impacts on the environment, but would rather contribute to improved overall environmental conditions and mitigate climate change.
- To strengthen the capacity of key institutions involved in the management and service delivery of the urban transport sector, including local and provincial level agencies, as applicable.

The goal, as written above, was not really presented in the CDIA report as a goal, but shows what the starting point was for the study. The objectives were formulated in the terms of reference for the project. The objectives are quite similar to those of the CDIA Yogyakarta study.

Indicators:
In the CDIA study many indicators are used. It is not completely clear which should be used to monitor and evaluate the project. An economic evaluation is done to calculate the benefits of the improved bus system (BatikSoloTrans, BST). This ex-ante evaluation could be compared to the actual benefits, but this is not explained in the report.

Comparison of both cities
For both cities one transport plan was available that had been prepared by the cities themselves and one that was made with the assistance of CDIA. The goals and objectives in the first transport plans were very broad and ambitious and therefore not clearly defined. Also these plans use too many indicators without a clear relation to the goals and objectives. The reports from CDIA were much more structured and the goals and objectives were better described, although they are not yet completely measurable. That these two cities seek assistance from an organization like CDIA shows that they acknowledge the problems they

have and that they want to develop their transport system in a sustainable direction. Some important steps have been taken, but the capacity and knowledge in these cities still needs to be strengthened further.

Table 27 Score indicator 'Clearly defined transport goals, objectives and indicators'

Indicator	**Yogyakarta**		**Surakarta**	
	Trend	Currently	Trend	Currently
Clearly defined transport goals, objectives and indicators				

Indicator: Quality of open space

Indicator source(s):

- Lautso et al. (2004)

Description indicator:
Open space is important for wildlife to breed and live. Open space can also be used by people for recreation. The quality of open space is affected by human activities, like transport. In the PROPOLIS approach the amount of noise in an area is used to define the quality of open space.

Unit(s):
In the land use maps the types of areas that are considered as open space have to be chosen. Then the noise levels for these areas should be calculated. In the PROPOLIS approach areas with a noise level lower than 45 dB(A) are considered to be of high-quality. The total area that meets these requirements as a percentage of the total area is the score on 'quality of open space'.

Availability:
Land use maps were available for both cities, but detailed spatial information on noise levels was not.

Yogyakarta and Surakarta
In Figure 16 and Figure 17 the land uses for Yogyakarta and Surakarta are shown. Blue fields are built environment, green fields are natural areas and blue lines are roads. The areas that are shown correspond with the administrative area for both cities, which is the study area in this research. In both cities the built environment is dominant, but traces of natural land uses can be seen along rivers and railways and near the fringes of the cities some green areas can be seen. In Surakarta there are more and larger greener areas. This suggests that the quality of open space is higher in this city, providing more space for human recreation and space for other species to live. Although it is not known what the noise levels are, it can be assumed that these are lower in Surakarta, where the presence of motor-vehicles is not as overwhelming as it is in Yogyakarta. Most of the larger green areas are used for agriculture. A check on the reliability of the data on Google Maps, shows that most of the green areas really are natural areas. Table 28 summarizes the land use types for both cities. As can be seen in the figures, the built environment in Yogyakarta is larger. The amount of grass area, which is available for recreation, is higher in Surakarta.

In Table 29 and Table 30 the types of land use are displayed for a different source in both cities. Here the change in land use can also be seen. Both cities show the same figures and trends. Almost one-third of the area is used for housing and this is also the land use that is increasing most. The change in land use can be misleading as for both cities the total area of land in the starting year is lower. Based on these figures it is hard to tell how much land is natural, as it is not clear what is included in the 'other' category. Surakarta has a little bit more area of agricultural land use, which is in line with the comparison made for Figure 16 and Figure 17.

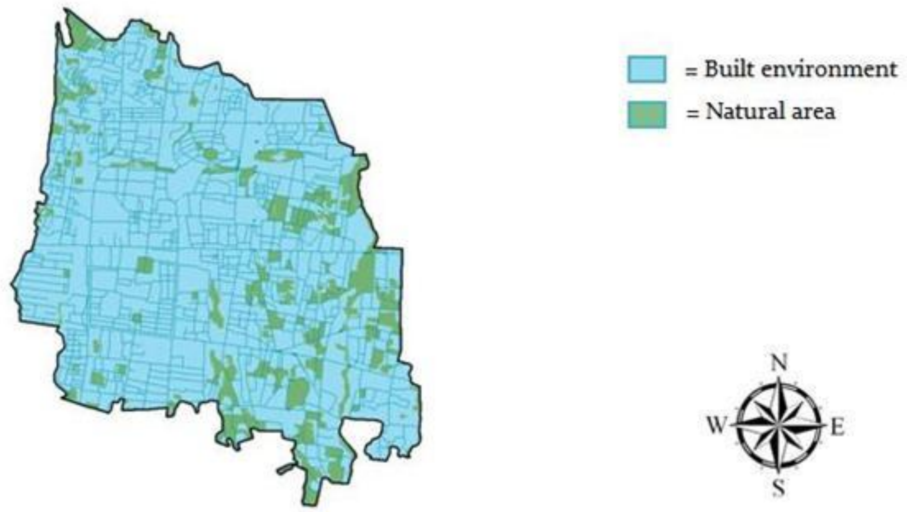


Figure 16 Yogyakarta land use

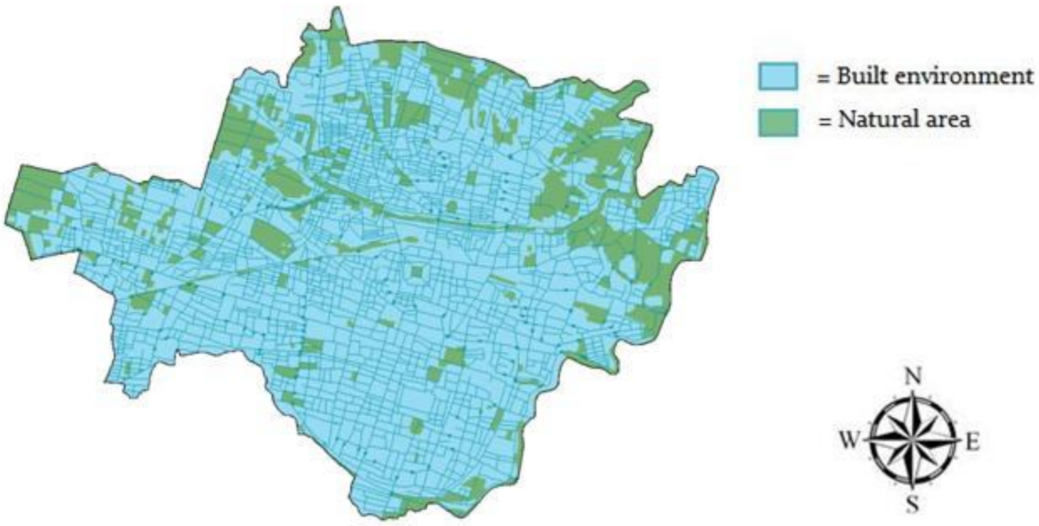


Figure 17 Surakarta land use

Table 28 Land use Yogyakarta and Surakarta

Type of land use	Yogyakarta		Surakarta	
Settlement	84,4%	84,7%	78,3%	79,2%
Building	0,3%		0,9%	
Paddy field	9,3%	15,3%	8,3%	20,8%
Grass	3,1%		7,9%	
Garden	1,4%		3,7%	
Moor	1,5%		0,1%	
Water	0,1%		0,8%	

Source: Land use map Central Java (Date unknown)

Table 29 Land use Yogyakarta

Type of land use	Area (Ha)				Change in area (Ha/yr)
	2000	2005	2006	%	
Housing/residential	2,048.20	2,103.19	2,104.52	65%	9.39
Services	272.50	274.63	274.72	8%	0.37
Company	263.49	273.03	273.45	8%	1.66
Agriculture	139.95	138.52	136.80	4%	-0.52
Industrial	48.91	52.23	52.23	2%	0.55
Wasteland	12.28	20.21	20.11	1%	1.31
Other	388.10	388.16	388.16	12%	0.01
Total	3,173	3,250	3,250		

Source: CDIA (2011b)

Table 30 Land use Surakarta

Type of land use	Area (Ha)						Change in area (Ha/yr)
	2003	2004	2005	2006	2007	%	
Housing/residential	2,672.21	2,682.19	2,707.27	2,716.59	2,731.02	62%	14.70
Services	428.06	427.36	426.6	427.63	427.13	10%	-0.23
Company	282.42	286.1	286.56	287.48	287.48	7%	1.27
Agriculture	210.83	273.23	257.04	248.52	234.59	5%	5.94
Industrial	101.09	101.42	101.42	101.42	101.42	2%	0.08
Waste land	78.29	66.84	56.13	53.38	53.38	1%	-6.23
Other	569.44	566.92	569.04	569.04	569.04	13%	-0.10
Total	4,342	4,404	4,404	4,404	4,404		

Source: Tatralok (2010)

Comparison of both cities

This indicator is about the quality of open space. As the noise levels are not known spatially to a detailed level, it is impossible to calculate the quality, but measured noise levels for Yogyakarta show very high values (see indicator 'Justice of exposure to noise'). The area of open space is available and this information shows that both Yogyakarta's and Surakarta's land uses are dominated by the built environment and especially residential buildings. The natural area in Surakarta is larger than Yogyakarta's.

Table 31 Score indicator 'Quality of open space'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Quality of open space				

Indicator: Justice of exposure to air pollution

Source(s):

- Lautso et al. (2004)

Description indicator:

This indicator measures the exposure of people to particular matter (PM) and nitrogen dioxide (NO_2). Both have negative impacts on the health of people (Lautso et al., 2004). PM increases the frequency and severity of respiratory ailments with the risk of premature death and is also a risk factor of cancer. NO_2 causes reduced lung functions and airway responsiveness.

Unit(s):

In PROPOLIS transport models are used to calculate the emission of PM and NO_2. The concentration level of the emissions is calculated per raster cell and related to the population in this cell. The number of people living in areas exceeding concentration levels is measured and later normalized for the total population. PROPOLIS uses the EU guidelines for the concentration levels. For both PM and NO_2 the average annual concentration may not exceed 40 $\mu g/m^3$.

Availability:

Transport models were not available for calculating emission levels. The concentration of emissions in both cities has been measured at some locations in the city, but not for complete years. These data can be found in the indicator 'Transport emissions'. These values show that at some locations the values are higher than the annual average allowed concentrations. But these data do not provide enough information to say something about the justice of exposure. And it is also not clear how many people are exposed to the air pollution.

Comparison of both cities

No information is available for this indicator.

Table 32 Score indicator 'Justice of exposure to air pollution'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Justice of exposure to air pollution				

Indicator: Justice of exposure to noise

Source(s):

- Lautso et al. (2004)

Description indicator:
This indicator measures the number of people annoyed by traffic noise. Noise can interfere with hearing and causes sleep disturbance, cardiovascular and psychoendorine effects, clinical effects, community annoyance and behavioral effects (Lautso et al., 2004).

Unit(s):
In the PROPOLIS approach transport models are used to calculate traffic loads on road segments. These segments are then used to calculate noise emissions. Through noise propagation functions the noise levels in raster cells is calculated. These levels are related to number of people living in the raster cell to see how many people are affected by noise. The following levels for annoyance are used:

- 55 dB(A): 33% of people is disturbed
- 65 dB(A): 50% of people is disturbed
- 70 dB(A): 100% of people is disturbed

Availability:
Models were not available for calculating noise levels. Transport models are used in both cities, but only for predicting traffic loads. For Yogyakarta noise levels have been measured.

Yogyakarta
For Yogyakarta measured noise volumes are available for the years 2008-2011, see Table 33. These have been measured on several locations in the city. Data for 2008 was collected at different locations than the last three years. These last three years show an increase of noise. The noise levels are very high. Although transport models were not available for calculating noise levels and comparing these with population densities, based on the measured noise levels it can be concluded that this indicator scores very low due to the high noise levels on all locations.

Table 33 Noise levels in Yogyakarta

	2008	2009	2010	2011
Noise level (dB(A))	65.4-79.7	67.8-82.6	70.9-77.2	73.8-78.4
Average	75.2	72.6	74.5	75.8

Sources: (BLH, 2012), (Kota Yogyakarta, 2012b)

Comparison of both cities
Data for Surakarta was not available, so a comparison cannot be made. Data for Yogyakarta show a trend of increasing noise levels and current levels that are very high.

Table 34 Score indicator 'Justice of exposure to noise'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Justice of exposure to noise				

Indicator: Vehicle ownership

Indicator source(s):

- Kane (2010)

Description indicator:
Originally this indicator was called 'Car and bicycle ownership'. In Yogyakarta and Surakarta many people own and use a motorcycle. Therefore the indicator is now called 'Vehicle ownership' to give a better view on the total ownership of vehicles. Cycling is a very sustainable mode of transport, so the higher the ownership the better. Cars and motorcycles provide mobility, but also cause negative externalities. The level of motorized vehicle ownership should not be too high and also the change in this level should not be too high, as the infrastructure does not have enough capacity.

Unit(s):
Number of cars, motorcycles and bicycles per 1,000 citizens

Availability:
Vehicle ownership data is available for both Yogyakarta and Surakarta for the motorized vehicle fleet. There are no numbers on the ownership of bicycles. The number of buses in both cities is also included, as these numbers show some interesting differences.

Yogyakarta
For Yogyakarta data on vehicle ownership is available for many years, but there is a gap between 2001 and 2004. Therefore the average annual growth is calculated for the years 2004 to 2010, which is also better comparable to the data for Surakarta. Table 35 shows the total vehicle ownership and
Table 36 shows the vehicle ownership per 1,000 citizens.

Table 35 Total vehicle ownership in Yogyakarta

Year	Car	Bus	Motorcycle
1999	29,091	1,178	152,800
2000	29,797	959	159,259
2001	30,284	932	168,468
2004	31,432	2,885	213,690
2005	32,069	4,428	226,414
2006	32,332	5,329	240,075
2007	32,667	6,528	256,224
2008	32,873	8,266	273,538
2009	33,056	9,572	288,619
2010	36,533	9,968	297,802
Annual growth (2004-2010)	2.6%	23.8%	5.7%

Data source: BPS Kota Yogyakarta (2007), BPS Kota Yogyakarta (2009), Kota Yogyakarta (2012b), Pemerintah Kota Yogyakarta dinas perhubungan (2003)

Table 36 Vehicle ownership per 1,000 citizens in Yogyakarta

Year	Car	Bus	Motorcycle
1999	73	3	385
2000	75	2	401
2001	76	2	424
2004	74	7	500
2005	74	10	520
2006	73	12	539
2007	72	14	568
2008	72	18	599
2009	71	21	624
2010	78	21	636
Annual growth (2004-2010)	1.1%	21.9%	4.1%

Surakarta

In the data for Surakarta the numbers for commercial vehicles and special vehicles are excluded as it is not clear how and if these are used in the Yogyakarta data, it is assumed that these are not used. Including the commercial vehicles would make a difference to the total number of vehicles, as numbers are around 13,000. Special vehicle numbers are around 20 and would not make a big difference to the total number. Table 37 shows the total vehicle ownership and Table 38 shows the vehicle ownership per 1,000 citizens.

Table 37 Total vehicle ownership in Surakarta

Year	Car	Bus	Motorcycle
2005	28,186	1,921	160,336
2006	28,999	1,797	169,272
2007	26,638	1,779	175,926
2008	31,911	1,830	192,498
2009	33,535	1,835	208,309
2010	36,903	1,953	223,683
2011	43,158	2,009	269,760
Annual growth	7.8%	0.8%	9.2%

Data source: CDIA (2010), CDIA (2011f), Dishub Surakarta (2012), Tatralok (2010)

Table 38 Vehicle ownership per 1,000 citizens in Surakarta

Year	Car	Bus	Motorcycle
2005	53	4	300
2006	57	4	330
2007	52	3	341
2008	61	3	368
2009	64	3	396
2010	70	4	422
2011	81	4	505
Annual growth	7.7%	0.8%	9.2%

Comparison of both cities

Both cities show increasing numbers in the motorized vehicle fleet. In Surakarta the increase of car and motorcycle ownership is higher than in Yogyakarta. Surakarta has surpassed Yogyakarta in the number of car ownership per 1,000 citizens and the number of motorcycles is also fast growing towards the numbers in Yogyakarta. The average annual growth rates for cars and motorcycles are alarming in Surakarta. The total number of cars in Yogyakarta is increasing every year, but has shown some declines when it is calculated per 1,000 citizens. Also in Yogyakarta the number of motorcycles keeps increasing with alarming rates, though less fast as in Surakarta.

The number of buses shows very different figures for both cities. In Surakarta the number slowly increases, but in Yogyakarta the number has exploded, with an average annual growth rate of 23.8% in the total number of vehicles. The cause for this increase is not clear. Most buses that drive around in Yogyakarta are older than ten years and new buses are rarely seen. According to the CDIA interim report the size of the authorized vehicle fleet was 432 of which 77% is older than 15 years (CDIA, 2011b).

Table 39 Score indicator 'Vehicle ownership'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Vehicle ownership				

Indicator: Transport emissions

Indicator source(s):

- OECD (1999)
- European Environment Agency (2011)

Description indicator:
At the local level transport is responsible for a large share of the air pollution, especially in places where road traffic concentrates and congestion occurs. Pollution has negative effects on human health, but also harms the condition of buildings and monuments. At the regional level pollution has ecological impacts and at the global level the emission of CO_2 is related to climate change.

Unit(s):
Pollutant emissions caused by transport are used:

- CO_2
- CO
- HC
- NO_X
- PM_{10}
- SO_X
- VOC

Most emissions are measured in parts-per-million (ppm), PM_{10} is measured in $\mu g/m^3$.

Availability:
For Yogyakarta information has been found for several years, for Surakarta only one year is available. There are some gaps in the data, some pollutants are not measured in all years or cities. Also the data seems to be not very reliable and the quality is sometimes doubtful. The contribution of transport to the air quality is not clear, some sources have been found that indicate the contribution, but for each pollutant this will be different.

Yogyakarta and Surakarta
The measured amounts of emissions are listed in Table 40 for Yogyakarta and
Table 41 for Surakarta. These numbers are based on several measurements in both cities. For Yogyakarta several sources were used. From these sources the standards are also adapted. There are some differences between the values that are not logical. This might be due to wrong units, even though most of the information came from the Environment Agency (BLH). Also in Yogyakarta different locations are used to measure the air quality.

Table 40 Air quality in Yogyakarta

Emission type	2008 (KY)	2009 (BLH Excel)	2009a (BLH website)	2009b (BLH website)	2010 (BLH Excel)	2011 (BLH Excel)	2011 (BLH website)	Standard
Number of measurements	8	10	25	25	10	10	4	
HC	-	-	3.33-147 μg/m^3	5.00-140 μg/m^3	-	-	131-163 μg/m^3	160 μg/m^3
NO_X	203-369 μg/m^3	1.67-19.2 μg/m^3	95.2-112 μg/m^{3*}	1.40-135 μg/m^{3*}	18.7-101 μg/m^3	48-443 μg/m^3	18.3-125 μg/m^3	400 μg/m^3
CO	3,700-34,500 μg/m^{3*}	4150-15078 μg/m^3	3,700-18,500 μg/m^{3*}	3,700-13,600 μg/m^{3*}	16,016-157,556 μg/m^3	825-2,630 μg/m^3	3,435-12,595 μg/m^3	30,000 μg/m^3
O_3	-	10.8-101 μg/m^3	3.17-15.0 μg/m^{3*}	3.17-14.4 μg/m^{3*}	30.0-452 μg/m^3	41-1,210 μg/m^3	4.91-11.4 μg/m^3	235 μg/m^3
PM_{10}	-	-	-	-	13-52.3 μg/m^3	14.7-51.2 μg/m^3	-	150 μg/m^3
$PM_{2.5}$	-	-	-	-	-	13.2-64.5 μg/m^3	-	15 μg/m^3
SO_X	42.3-123.2 μg/m^3	40-877 μg/m^3	2.54-127 μg/m^{3*}	4.51-128 μg/m^{3*}	235-1,503 μg/m^3	265-366 μg/m^3	12.6-119 μg/m^3	900 μg/m^3
Pb	0.05-0.246 μg/m^3	0.016-1.32 μg/m^3	0.235-1.45 μg/m^3	0.23-1.21 μg/m^3	0.198-0.351 μg/m^3	0.03-0.157 μg/m^3	1.00-1.21 μg/m^3	2 μg/m^3

Sources: (BLH, 2009, 2011, 2012), Kota Yogyakarta (2012b)
*Units have been converted from ppm to μg/m^3

Table 41 Air quality in Surakarta

Emission type	Surakarta (2008)	Standard
HC	0.10-2.85 ppm	0.05 ppm/24 hours
NO_X	0.006-0.050 ppm	20 ppm/8 hours
CO	0.06-4.87 ppm	35 ppm/24 hours
O_3	0.008-0.040 ppm	0.10 ppm/24 hours
PM_{10}	10.0-114.0 $\mu g/m^3$	100 ppm/24 hours
SO_X	0.03-0. 20 ppm	0.24 ppm/3 hours
VOC	0.1-2.85 ppm	1.92 ppm/24 hours

Sources: CDIA (2011f), Tatralok (2010)

These numbers show the total amount of these emissions in the air, not the contribution of transport to it. But for carbon monoxide the contribution of transport might be around 65% (CDIA, 2011g) and it is claimed that more than 70% of the air pollution in Surakarta can be attributed to transport (Sry, 2011).

The values for carbon monoxide show large differences. The values for Surakarta and the local standards seem to be quite low, as international standards are 9 ppm/8 hours or 35 ppm/1 hour (European Commission 2012; United States Environmental protection agency, 2011). It is likely that here the numbers for O_3 and CO got mixed up, comparing both sources.

For Yogyakarta the contribution of transport to the emission of CO_2 is known. The values are compared to some other cities in Indonesia, see Table 42.

Table 42 CO_2 per capita contributed by the transportation sector in 2004

City	CO_2 (ton)	CO_2 (ton)/Capita
Yogyakarta	299,840	0.6
Surabaya	1,474,337	0.6
Cilegon	207,575	0.6
Semarang	889,334	0.6
Bogor	202,709	0.3
Denpasar	770,459	1.3
Balikpapan	112,443	0.2

Source: PUSTRAL (2006)

Comparison of both cities

Overall the air quality in Yogyakarta is worse than in Surakarta. Both cities are exceeding some of the air quality standards, although it is not clear how the values were measured. The PM_{10} concentrations in Surakarta are higher than in Yogyakarta, but CDIA's interim report for Surakarta (CDIA, 2011f) claims that PM_{10} levels in Yogyakarta are as much as 34-131 $\mu g/m^3$, but these numbers were not found in other documentation. The values presented are the total amounts of emissions in the air, it is not clear what the contribution of transportation is, but it can be assumed that transport is accountable for a large part of the emissions. The CO_2 levels of several cities in Indonesia show that Yogyakarta scores in the middle; the situation in Denpasar is worse, but Bogor and Balikpapan score lower.

For Surakarta data is only available for one year, so trends cannot be made. The data for Yogyakarta shows huge fluctuations, these data do not seem to be reliable; making a trend would not give useful information.

Table 43 Score indicator ‘Transport emissions’

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Transport emissions				

Indicator: Share of non-motorized transport

Indicator source(s):

- Bojković et al. (2010)
- Castillo and Pitfield (2010)
- Litman (2011b)

Description indicator:
Motorized transport is the source of many transportation problems. Non-motorized modes on the other hand are considered to be very sustainable, there is no (or a little) emission of pollutants, little space is required and it benefits the physical health.

Unit(s):
Modal shares of passenger transport in percentages.

Availability:
For both cities limited information on modal shares was found, which makes it difficult to estimate trends. Also the way of calculating the modal shares was not the same for both cities, in Yogyakarta a household survey was conducted, in Surakarta traffic counts were used to calculate modal shares.

Yogyakarta and Surakarta

Table 44 Modal shares in Yogyakarta and Surakarta

Mode	Yogyakarta (2003)	Yogyakarta (2010)	Surakarta (2009)
NMT	22%	11%	6%
Car	12%	8%	16%
Motorcycle	53%	70%	74%
Public transport	8%	6%	3%

Modal shares for Yogyakarta (2010) are based on a household survey (400 households), for Surakarta they are based on traffic counts.
Sources: CDIA (2011b), CDIA (2011f), Pemerintah Kota Yogyakarta dinas perhubungan (2003)

Comparison of both cities
In both cities the motorcycle is dominant, almost three-quarters of all trips. According to the data found non-motorized transport is the second largest mode in Yogyakarta, with in total 11%; cycling 4%, walking 4%, Becak and Andong 3%. In Surakarta the modal share of non-motorized transport is only 6%. The difference might be explained by the way the modal split was calculated. With traffic counts fast modes have a higher chance of being counted, so these modes can be overrepresented. It is also not clear how the traffic counts were conducted, if these were only done on major roads they might miss non-motorized traffic on the more traffic calmed streets. Little information is available about previous modal shares, but figures indicate that the share of the motorcycle was less dominant and the shares of the non-motorized modes and public transport were higher (CDIA, 2010, 2011b).

Table 45 Score indicator 'Share of non-motorized transport'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Share of non-motorized transport				

Indicator: Traffic fatalities

Indicator source(s):

- Bojković et al. (2010)
- Haghshenas and Vaziri (2012)
- Lautso et al. (2004)
- CAI Asia (2010)
- UTBI (2006)

Description indicator:
Transport is a major cause of death in many countries. The PROPOLIS report (Lautso et al., 2004) shows figures of more than 40,000 traffic fatalities in Europe per year and in 25% of the cities more than 10 inhabitants per 100,000 are killed in traffic accidents.

Unit(s):
Fatalities/100,000 inhabitants
Fatalities/1,000,000 vehicle-kilometers

Availability:
There is some information on traffic fatalities, but there are gaps in the availability. The reliability of the numbers is low, as the different sources show for Surakarta. Data for the total amount of vehicle-kilometers is not available, so traffic fatalities are only normalized for population numbers.

Yogyakarta and Surakarta
The data for total traffic fatalities in Yogyakarta and Surakarta is presented in Table 46 and the number of fatalities per 100,000 inhabitants is shown in
Table 47. The average annual number of traffic deaths in cities in low-income Asian countries is 15.2/100,000 inhabitants (Kenworthy, 2011). Based on this figure the values for Yogyakarta seem to be very low. Information on the vehicle-kilometers in both cities was not available.

Table 46 Total traffic fatalities in Yogyakarta and Surakarta

Year	Yogyakarta	Surakarta
2000	8	-
2001	8	-
2002	11	-
2006	-	164 (28)
2007	-	129 (57)
2008	6	113 (28)
2009	23	-

The values for Surakarta show data from hospital reporting and police reporting, the latter between brackets.
Source: CDIA (2011b), CDIA (2011g), Pemerintah Kota Yogyakarta dinas perhubungan (2003), Tatralok (2010)

Table 47 Traffic fatalities per 100,000 inhabitants in Yogyakarta and Surakarta

Year	Yogyakarta	Surakarta
2000	2.0	-
2001	2.0	-
2002	2.8	-
2006	-	32
2007	-	25
2008	1.3	22
2009	5.0	-

Here only the hospital data is used for Surakarta.

Comparison of both cities

The first thing that can be noticed is that there are large differences between the number of fatalities between Yogyakarta and Surakarta. A reason for these differences is probably the use of police reporting for Yogyakarta. As the data for Surakarta shows there are large differences between the hospital data and police data. According to the CDIA interim report for Surakarta (CDIA, 2011g) the hospital data are more reliable. The trend in the hospital data suggests a decrease of traffic deaths. For Yogyakarta it is hard to make any conclusions regarding the number of traffic fatalities and the corresponding trend in these numbers.

Table 48 Score indicator 'Traffic fatalities'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Traffic fatalities				

Indicator: Local government expenditures on transportation

Source(s):

- Haghshenas and Vaziri (2012)
- Lautso et al. (2004)

Description indicator:

This indicator shows much the local government invests in the transport system. With the fast motorization in the cities of Yogyakarta and Surakarta problems will occur if there is not enough invested in new infrastructure and transport services. These investments can be separated in private and public transport to show where the interests of the local government lie.

Unit(s):

In the PROPOLIS report this indicator is measured as the transport investment cost per inhabitant.
Haghshenas and Vaziri (2012) calculate it is a percentage of the total budget.
The ratio between private and public transport investment can also be used to see where most money is invested (Kenworthy, 2011).

Availability:

For Yogyakarta the transport investments for one year were found. For Surakarta no information is available. The data for Yogyakarta cannot be separated in a private and public transport part.

Yogyakarta

The transport investments for 2012 in Yogyakarta are shown in Table 49. The first column shows total investments, the second as percentage of the total local budget and the last investments per inhabitant.

Table 49 Transport investments in Yogyakarta

	Total expenditure (Rupiah)	As percentage of total	Per inhabitant (Rupiah)
Transportation	15,166,829,396	1,6%	32,384
Infrastructure	14,075,045,090	1,5%	30,052
Total transport	29,241,874,486	3.1%	62,437
Total local budget	934,387,078,100	-	1,995,096

Source: (Kota Yogyakarta, 2012a)

Comparison of both cities

A comparison of both cities cannot be made as there was no information on transport investments found for Surakarta. For Yogyakarta information was available for only one year, making it impossible to make a trend. The investments in transport as a percentage of the total budget and calculated per citizen are both very low. A good reference was not found to compare this figure, but data from local governments in Australia show that expenditures on transport and communication is between 25-30% of the total expenditures (Australian Government, 2010).

Table 50 Score indicator Local government expenditures on transportation’

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Local government expenditures on transportation				

Indicator: Availability of planning information and documents

Source(s):

- Litman (2011b)

Description indicator:
This indicator deals with the transparency of the local government. When planning information is available local people can get engaged in the planning process. There will also be a better accountability for the policy makers if plans are available.

Unit(s):
For this indicator a check-list has been made to assess the availability of planning information and documents. First the availability of transport planning documents on the website of the local governments was checked, then on the website of the local transport organizations, thirdly by using a search engine (Google) and finally by calling the local transport organizations and asking which planning documentation is available.

Availability:
As this indicator describes the availability of planning information and documents there will always be a result for this indicator. If there is no information available that will be the result for the indicator.

Yogyakarta
In Yogyakarta planning information was only found by calling the transport organization.

Table 51 Availability of planning documents in Yogyakarta

Source	Planning information and documentation available?
Website Yogyakarta City	No
Website transport organization	No
Search engine	No
Telephone call	Yes, available at transport organization (Bappeda)

Surakarta
In Surakarta planning information can be requested t the transport organization, but this has to be done through an official letter.

Table 52 Availability of planning documents in Surakarta

Source	Planning information and documentation available?
Website Surakarta City	No
Website transport organization	No
Search engine	No
Telephone call	Only available after sending a request letter (Dishubkominfo)

Comparison of both cities
For both cities planning information could not be found online. The information is available at the transport organizations, but in Surakarta first a letter should be written. So for both cities it is not easy to obtain information about transport planning. About trend in availability no information is available, but it is not likely that in the past information was better accessible.

Table 53 Score indicator 'Availability of planning information and documents'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Availability of planning information and documents				

Indicator: Traffic injuries

Source(s):

- Litman (2011b)
- Lautso et al. (2004)
- Castillo and Pitfield (2010)
- UTBI (2006)
- OECD (1999)
- Umwelt Bundes Amt (2004)
- CST (2002)

Description indicator:
Traffic accidents are responsible for many fatalities as has been shown in a previous indicator, but it also causes injuries. Some of these injuries will require hospitalization and victims might be affected for the rest of their life. The PROPOLIS report (Lautso et al., 2004) states that in 25% of the European cities more than five persons per 1,000 inhabitants are injured every year in traffic accidents.

Unit(s):
Serious injuries/100,000 citizens
Serious injuries/1,000,000 vehicle-kilometers

Availability:
The same data sources were available for the serious injuries as for the fatalities.

Yogyakarta and Surakarta
The total number of serious injuries is displayed in Table 54 and for the number of injuries per 100,000 inhabitants in
Table 55.

Table 54 Serious injuries due to traffic accidents in Yogyakarta and Surakarta

Year	Yogyakarta	Surakarta
2000	3	-
2001	2	-
2002	4	-
2006	-	1,348 (37)
2007	-	1,484 (28)
2008	48	1,217 (10)
2009	68	-

The values for Surakarta show data from hospital reporting and police reporting, the latter between brackets.
Source: CDIA (2011b), CDIA (2011g), Pemerintah Kota Yogyakarta dinas perhubungan (2003), Tatralok (2010)

Table 55 Serious injuries per 100,000 citizens in Yogyakarta and Surakarta

Year	Yogyakarta	Surakarta
2000	0,8	-
2001	0,5	-
2002	1,0	-
2006	-	262
2007	-	284
2008	10	231
2009	15	-

Comparison of both cities

As for the data on traffic fatalities a good comparison cannot be made, because the data is not reliable and shows differences that are too large. The hospital data for Surakarta shows very high numbers of serious injuries. Considering the traffic conditions in Yogyakarta these kinds of numbers should also be expected for this city. The numbers for Surakarta seem to be quite low compared to the number used in the PROPOLIS report (more than 5 traffic injuries per 1,000 citizens in 25% of European cities). The WHO estimates that every year worldwide 20-50 million people are injured in traffic accidents (WHO, 2009). This comes down to approximately 285 to 715 injuries per 100,000 citizens. In this light the numbers for Surakarta seem to be average to low.

Table 56 Score indicator 'Traffic injuries'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Traffic injuries				

Indicator: Basic road safety law, licensing and traffic enforcement

Source(s):

- CAI Asia (2010)

Description indicator:
This indicator deals with the efforts made on a local level to increase traffic safety.

Unit(s):
Overview of local road safety law
Overview of local licensing
Number of traffic police officers per 100,000 inhabitants

Availability:
Information from the police on traffic enforcement has been requested, but has not been received. Most laws concerning traffic safety are made on an national level, so for the local level no laws were found. There was some information on licensing found on the websites of both cities about parking fees and licensing, this information is presented below.

Yogyakarta and Surakarta
Only the parking fees are used to evaluate this indicator. In Table 57the parking fees for Yogyakarta are listed, Table 58 shows the fees for Surakarta.

Table 57 Parking fees Yogyakarta

Vehicle type	Zone I	Zone II	Non-permanent
Bicycle	200	200	200
Electric bicycle	500	500	500
Motorcycle	1,000	500	2,000
Car	2,000	1,500	3,000
Small bus/truck	15,000	10,000	20,000
Large bus/truck	20,000	15,000	30,000
Truck 3 axes	30,000	20,000	40,000

Source: (Kota Yogyakarta, 2009)

Table 58 Parking fees Surakarta

Vehicle type	Zone C	Zone D	Zone E	Non-permanent
Bicycle	500	500	500	500
Motorcycle	2,000	1,500	1,000	1,000
Car	3,000	2,000	1,500	2,000
Small bus/truck	5,000	3,500	3,000	4,000
Large bus/truck	7,000	5,500	4,000	8,000

Source: (Kota Surakarta, 2011)

Comparison of both cities
Both cities use zones for their parking fees. The fees in Yogyakarta are a bit more expensive, for most vehicles. Only the fee for parking a bicycle is lower. In both cities the fee does not depend on the length of the parking time, one standard fee is used. Other data for this indicator was not available, so conclusions about the score of this indicator cannot be made as it is not clear how much the local government is concerned about traffic safety.

Table 59 Score indicator 'Basic road safety law, licensing and traffic enforcement'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Basic road safety law, licensing and traffic enforcement				

Indicator: Length and density of road network

Source(s):

- OECD (1999)
- CST (2002)

Description indicator:
The presence of infrastructure is related to many transport sustainability issues. The OECD report summed up a number of these relations:

- There is a clear link between the development of infrastructure and increases in traffic volumes.
- The capacity of infrastructure, the accessibility and geographic distribution play an important role in the modal split.
- Decisions concerning infrastructure are closely related to land use planning, local economic development, access to basic services and trade flows.
- A growing demand for transport, its impact on the environment and related external costs, raise the question which is more important: infrastructure expansion or alternative policies.
- Infrastructure has an effect on the environment. Roads cause impermeability of the ground.
- When the capacity of roads is insufficient, congestion and safety problems will increase.

Unit(s):
Total length of road network.
Density of road network, percentage of land covered.
Road condition, speeds and vehicle to capacity ratios (VCR).

Availability:
Information on the length of the roads was available, but as road widths were not available for all roads the total density of roads could not be calculated. Road conditions, speeds and VCR's were also available for both cities.

Yogyakarta and Surakarta
The total length of roads in Yogyakarta is 266 kilometers in an area of 32.5 km^2. The total length of roads per square kilometer is 8.2 km. In Surakarta the total length of roads is 705 km in an area of 44.1 km^2. Here the total length of roads per square kilometer is 16.0 km. Based on these figures the density of roads in Surakarta is twice as high as in Yogyakarta. This seems to be a high number, but a comparison of the road network in Google Maps did show a higher density in Surakarta, but in Yogyakarta many of the roads in neighborhoods (the Kampung) are not part of the road network. The length of the road network has not changed much in recent years, see
Table 60.

Table 60 Road length and class for Yogyakarta

Year	Class I	Class II	Class III	Class IIIA	Class IIIB	Class IIIC	No class	Total
2004	13.1	-	2.769	26.22	0.166	14.39	168.2	**224.9**
2005	13.1	1.77	26.22	0.166	14.39	14.39	165.9	**235.9**
2006	13.1	1.77	26.22	0.166	14.39	14.39	168.1	**238.1**
2007	16.8	1.77	26.22	0.17	14.39	14.39	174.8	**247.8**
2008	16.8	1.77	26.22	0.17	14.39	14.39	174.8	**247.8**
2009	16.8	1.77	26.22	0.17	14.39	14.39	174.8	**247.8**
2010	16.8	1.77	26.22	0.17	14.68	14.39	174.8	**248.1**
2011	16.8	1.77	26.22	0.17	14.68	14.39	174.8	**248.1**

Regency and city roads (state and provincial road excluded)

- Class I and II: Arterial roads
- Class III, IIIA and IIIB: Collector roads
- Class IIIC: local street/neighborhood
- No Class: Residential street

Source: BPS Kota Yogyakarta (2007), Kota Yogyakarta (2012b)

For both cities the condition of the roads was found. Table 61 shows the condition of roads for Yogyakarta and Table 62 for Surakarta. For Yogyakarta data was available for only one year, for Surakarta one previous year was also available, these data show that conditions are worsening. The city roads in Surakarta are in a better condition than the roads in Yogyakarta, for the national roads it is the contrary, but these account for only a small share of the total length of roads.

Table 61 Type and condition of roads in Yogyakarta (2008)

Type of road	Total length (km)	Condition		
		Good	**Fair**	**Poor**
National	18.2	17.6 (97%)	0.6 (3%)	-
Provincial	-	-	-	-
City	247.8	99.2 (40%)	104.2 (42%)	44.4 (18%)

Source: CDIA (2011b)

Table 62 Type and condition of road in Surakarta (2010)

Type of road	Total length (km)	Condition		
		Good	**Fair**	**Poor**
National	13.15	2.65 (20%)	6.05 (46%)	4.45 (34%)
Provincial	16.33	-	4.49 (27%)	10.99 (63%)
City	675.56	402.34 (60%)	232.54 (34%)	41.68 (6%)

Source: BPS Kota Surakarta (2010)

The road network itself and the condition of it have been described, now the condition of the traffic on the roads will be described. For both cities the average speed on the major roads has been measured. Table 63 shows the values for Yogyakarta and Surakarta. In Yogyakarta the major roads are more congested, average speeds are around 20 km/h, while average speeds in Surakarta are a bit higher, around 25 km/h.

Table 63 Average speed on selected roads

City	Average speed (km/h)
Yogyakarta (2010)	20.2
Surakarta (2010?)	25.6

Source: CDIA (2011b), CDIA (2011g)

The differences in speed can be explained by the amount of traffic on the roads. A way to measure this is using the vehicle to capacity ratio. For both cities the VCR has been calculated for most roads. Table 64 shows the VCR values. It is clear that the roads in Yogyakarta are congested as average VCR is reaching 1, the point that the capacity of the road has been reached. Compared to the average VCR in 2003, the number of vehicles has doubled. Average VCR for Surakarta is 0.64 which is not as bad as the situation in Yogyakarta, but some of the roads are scoring very high on the VCR. To illustrate this, the VCR values have been plotted in a graph, see Figure 18 and Figure 19. The figures show that problems in Yogyakarta have developed very fast and in Surakarta many roads are already in a critical state.

Table 64 Average VCR values

City	VCR
Yogyakarta (2003)	0.49
Yogyakarta (2008)	0.97
Surakarta (2009)	0.64

For Yogyakarta (2003) 80 roads were used.
For Yogyakarta (2008) 525 road segments were used.
For Surakarta 536 road segments were used. Morning and afternoon peaks are used.
Source: Bappeda Kota Yogyakarta (2008), Pemerintah Kota Yogyakarta dinas perhubungan (2003), Tatralok (2010)

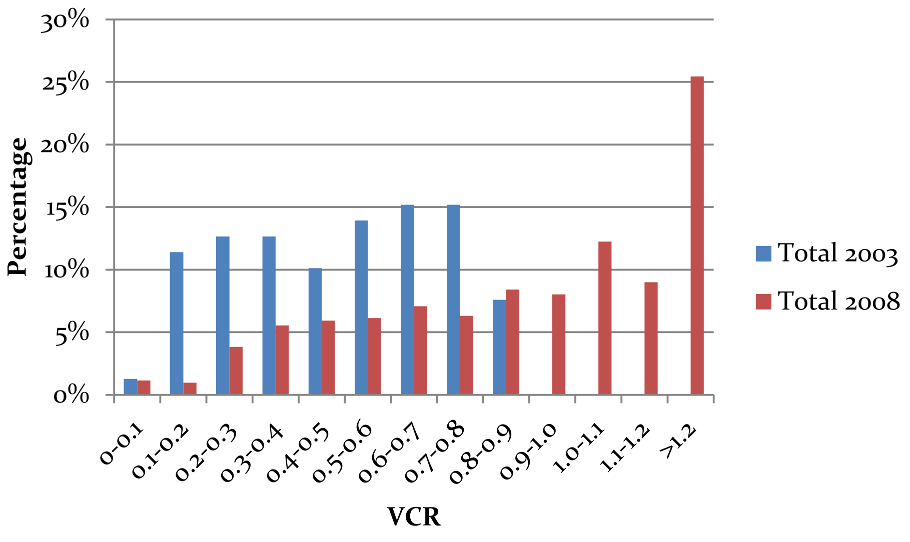


Figure 18 Spread of VCR values in Yogyakarta (2003 and 2008)

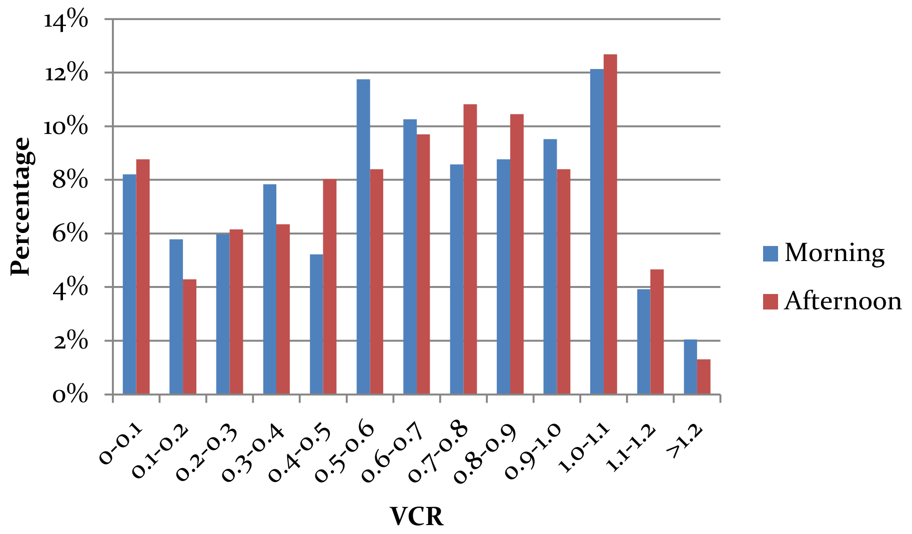


Figure 19 Spread of VCR values in Surakarta (2009)

VCR predictions from 2003 for 2013 show that the increase of vehicles is underestimated, most VCR's are still lower than 1.00 (Pemerintah Kota Yogyakarta dinas perhubungan, 2003). In 2008 new predictions were made; for a baseline scenario with no measures and a scenario with measures (Bappeda Kota Yogyakarta, 2008). The values shown in Table 65 are very concerning, even in the scenario with measures the number of roads with VCR's higher than 1 will be more than 60% in 2028.

Table 65 Predicted VCR's for Yogyakarta

Condition	**Baseline scenario**				**Scenario with measures**			
	2013	**2018**	**2023**	**2028**	**2013**	**2018**	**2023**	**2028**
VCR ≥ 1.00	58.13%	67.69%	78.01%	83.75%	32.89%	36.52%	49.52%	61.19%
1.00 > VCR ≥ 0.60	24.67%	20.08%	12.81%	10.13%	33.84%	32.70%	27.92%	24.28%
0.60 < VCR	17.21%	12.24%	9.18%	6.12%	33.27%	30.78%	22.56%	14.53%

Source: Bappeda Kota Yogyakarta (2008)

Comparison of both cities

In general the condition of the roads and on the roads is better in Surakarta. The amount of traffic on the roads is lower in this city. The road network is denser, providing more space for the vehicles, but motorization in Surakarta is also lower than in Yogyakarta, which also results in lower VCR's and higher speeds, but trends in both cities show that VCR's are increasing, causing lower speeds. This means that the length of the roads is not sufficient for the amount of traffic.

Table 66 Score indicator 'Length and density of road network'

Indicator	**Yogyakarta**		**Surakarta**	
	Trend	Currently	Trend	Currently
Length and density of road network				

Indicator: Public participation

Source(s):

- Litman (2011b)
- Castillo and Pitfield (2010)
- Kane (2010)

Description indicator:
Public participation is important to include the needs of all people, particularly those of the vulnerable, disadvantaged, women and youth, in the planning process. Through public participation the local government can communicate with their citizens, inform them about new plans, receive feedback and provide accountability.

Unit(s):
Kane (2010) defines public participation as: structured sessions with civil society and other transport stakeholders.

Availability:
Information from the local governments about structured sessions was not available, but some information on public participation in the transport plans was found. Also some other forms of public participation were found.

Yogyakarta and Surakarta
The Tatralok of Surakarta describes the planning process for transport planning (Tatralok, 2010). In this process in an early stage surveys are used to obtain information about several issues, in one of the final stages feedback is given to the public about new plans. In Yogyakarta surveys are also used when new transport plans have to be developed, but it is not clear how feedback is given to the public. The master plan for transport does mention that there should be more public participation, but it is not explained how and when this should take place (Bappeda Kota Yogyakarta, 2008).

Both cities have a hierarchical structure; from the city level information is communicated to the district level and the sub-district level. From the sub-district level the representative of neighborhoods is informed about new plans and it is his task to communicate this with the neighborhood. Feedback can be given back through all the levels.

There are also some other forms in which the public can get engaged in the allocation of transport investments, one of them is the National program for community empowerment mandiri (PNPM) in which local communities can receive grants from the national government, another example is the "musrenbang", an annual participatory budgeting process through which residents can direct government investment (CDIA, 2011a).

Comparison of both cities
The available data is not detailed enough to make a distinction between the two cities. Trends show that public participation is increasing, but it is not clear if there are already structured sessions at the moment.

Table 67 Score indicator 'Public participation'

Indicator	Yogyakarta		Surakarta	
	Trend	Currently	Trend	Currently
Public participation				