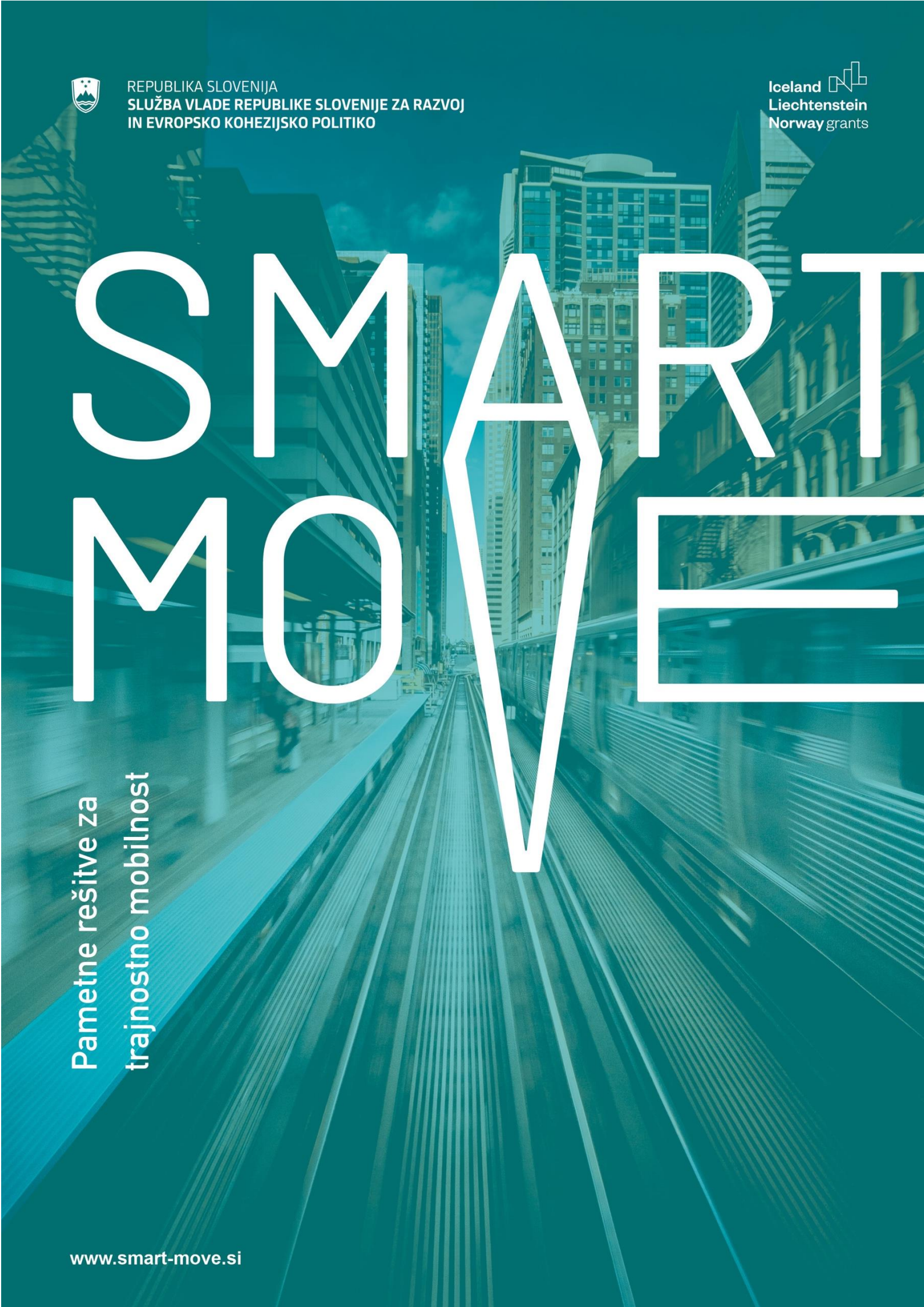
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SLUŽBA VLADE REPUBLIKE SLOVENIJE ZA RAZVOJ
IN EVROPSKO KOHEZIJSKO POLITIKO
Iceland
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Norway grants
SMART
MOVE
Pametne rešitve za
trajnostno mobilnost
www.smart-move.si

Partnerji projekta

Projekt SmartMOVE sofinancirajo Islandija, Lihtenštajn in Norveška s sredstvi Finančnega mehanizma EGP v višini 1.609.166,79 EUR. Namen projekta je blaženje podnebnih sprememb in prilagajanje nanje. Sodelujemo skupaj za zeleno, konkurenčno in vključujočo Evropo.

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SmartMOVE

Smart Mobility Measures for Sustainable Mobility in Slovenia

DS T3: Development, Introduction and Management of the Sustainable Mobility Certificate

Task T3.1: State-of-the-Art Analysis

Report Summary in English

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Version 1.0
Ljubljana, 30th September 2022

SMART MOVE Pametne rešitve za trajnostno mobilnost

Abstract

The document presents the results of activity T3.1*: State-of-the-Art Analysis* as the first phase of DS T3 work package *Development, introduction and management of the Sustainable Mobility Certificate* (the so-called “Green Certificate”) within the SmartMOVE project. The activity was primarily intended to collect information on professional and scientific approaches to the management of sustainable mobility and the status of projects, recommendations and comparable certificates at home and abroad. We have identified six decisions relevant to the area covered by SmartMOVE; of these, three will be addressed in detail in the project: evaluating modes of transport and effects of changes on a particular route, evaluating mobile plans and their effects in employers, and defining the criteria for granting a "Green Certificate". A review of scientific and professional publications confirmed that the approach based on multi-criteria modelling, which we have envisioned in the project, is correct, as it is often used in the wider area of sustainable development and management. We also summarized from the literature over 100 indicators or criteria used or proposed in similar projects. The criteria belong to three main groups: Economic, Environmental and Social. In some contexts, Technical, Implementation, Institutional, Promotion, Infrastructure and Political aspects must also be considered. In the field of sustainability certificates, we did not find a certificate equal to or at least very similar to the planned "Green Certificate", but we have found an abundance of recommendations (from the EU, Slovenian Government and European projects), as well as requirements put forward in comparative certificates (such as "Cyclists-Friendly", “Pedestrians-Friendly” and certificates in Norway), which will collectively provide a solid basis for continuing the work on DS3 activities.

Conclusions

We identified six decision problems relevant to the area covered by SmartMOVE; of these, three will be addressed in detail in the project: (1) evaluating modes of transport and effects of changes on a particular route, (2) evaluating mobile plans and their effects in organisations, and (3) defining the criteria for granting a "Green Certificate".

Based on the literature review, we can conclude that *multi-criteria modelling methods* (MCDM) are well established and widely used in the area of *sustainable urban mobility planning* (SUMP). We can confirm that this methodological approach is suitable and feasible for addressing decision problems in the SmartMOVE project.

At the same time, we also find a great variety between:

- *decision problems* in which MCDM methods were used,
- used *MCDM methods* themselves,
- *decision models* and *criteria systems* that have been developed or used in the studies.

Addressed *decision problems* can be classified from general to concrete. The general ones are mostly related to the evaluation of the SUMP state in cities (prevalently large cities) or regions. In most studies, they used somewhere between 10 and 50 criteria, some of which are only partially or even not at all related to the issues addressed by SmartMOVE (e.g., investments in infrastructure facilities, urban logistics, political aspects). On the other hand, there are specific decision problems, which are in principle close to SmartMOVE's needs (e.g., evaluating the situation on location, evaluating the introduction of a new mode of transportation), but then they typically use very problem-specific criteria, which are not directly applicable in SmartMOVE and will need to be adjusted.

We also found four *general systems* of indicators or criteria aimed at evaluating SUMP states: SUMI, SUTI, I_SUM and CAMSUD. The systems are different and their use looks heavily geographically conditioned: SUMI in EU, SUTI in Asia, I_SUM in Latin America and CAMSUD in Germany. In EU, it seems that SUMI enjoys the greatest consensus, with the remark that the approach might be very demanding in practice and far exceeds SmartMOVE's needs.

Due to the relatively large number of variables that appear in models in this field, most authors classify them into *groups* or *structure* them into a tree (just like us in Appendix 1). Almost full consent is about the three main groups of criteria: Economic, Environmental and Social. Some authors add other groups, such as a group of Technical criteria, which we also took over in Appendix 1. In some other studies, some other groups of criteria are suggested: Security, Political, Implementation, Promotional, Institutional, Infrastructure, and Management.

MCDM methods used in individual studies are also diverse. As expected, the majority are relatively simple methods that use linearly structured criteria and evaluate decision alternatives either using weights (methods SAW, WAM, WSM) or on the basis of a comparison of alternatives relative to each other (BWM) or according to the exposed (ideal or worst) alternatives' characteristics (TOPSIS, VIKOR). Surprisingly, the AHP method, which is considered to be the most widespread MCDM method, is poorly represented. On the other hand, the PROMETHEE method, which belongs to the class of outranking methods, is well represented. Although it is an established method, we believe that methods of this type are not suitable for SmartMOVE, as they require a finite list of predefined alternatives, which are evaluated without making an explicit, observable multi-criteria model. In SmartMOVE, this would mean that each decision analysis task (e.g., evaluating a mobility plan) should have been carried out from the beginning for each organisation. For SmartMOVE, we believe there are better suited methods with which we develop decision models only once and then only evaluate alternatives using organisation-specific input data. We also need an explicitly developed model to formulate criteria of the "Green Certificate".

All MCDM methods used in the studies belong to the class of *quantitative* methods, which use numerical variables in models, and alternatives are evaluated using continuous aggregation functions. This type of methods is dominated in MCDM. However, we also found studies where they used this type of

method by expressing all or some input data with discrete numerical values. This means that in SUMP there are indicators whose values are difficult to be represented with continuous numerical values, which also opens the door for using *qualitative* MCDM methods. This might include DEX, the method developed at IJS.

In the literature review, we did not find any model or practical case directly applicable in SmartMOVE, however there are many alike. To support our further development of multi-criteria models, we collected all indicators/criteria suggested in the literature and made a tree-structured union of them (presented in Appendix 1). The structure is deliberately large and inclusive, as we want to use it as a pool of ideas for the forthcoming development of SmartMOVE models.

An overview of the authorship of scientific publications by *country* shows an interesting picture with some prevailing countries in the EU (Greece, Lithuania, Scandinavian countries, Portugal, Spain, Italy, Poland), Latin America (Brazil, Ecuador, Colombia) and Asia (Thailand, Taiwan). There is almost complete absence of North America, Africa, Australia, New Zealand and China.

We did an overview of *integrated transport strategies* (ITS) and mobile plans for institutions (MP), as well as of a scientific research in the field of sustainable mobile plans. The purpose of the review was to understand the procedures for the production of ITS and MP, to learn about the problems that ITS and MP touch, the measures proposed to solve these problems, and indicators/criteria they use to evaluate the current mobility state and progress of organisations.

We have also examined a comprehensive *national energy and climate plan*, which indicates that implementing traffic measures is very important for the planned objectives, since the volume of road traffic in Slovenia is constantly increasing and is a source of considerable greenhouse gas emissions and energy consumption. SmartMOVE's activities are well matched by some of the measures provided by the national strategy, such as promoting travel companionship, new public transport services and promoting sustainable mobility.

The review of the *existing certificates* did not reveal any that would fully meet the goals we have set for our "Green Certificate": using a sufficiently general and scientifically justified approach, which does not only include environmental and climate criteria, in a simple enough, attractive and fair way evaluate (1) the current state of management of sustainable mobility in organisations and (2) encourage and reward meaningful measures for improvement. We were surprised by the relatively poor coverage of employers- and employees-related topics in the scientific literature. However, this topic was better covered within CIVITAS, ENDURANCE and CH4LLENGE projects, where we found a number of useful recommendations and tips for evaluating the sustainable mobility of organizations and their employees.

Considering specific certificates, we found three certificates that are well-established in Slovenia and partly address aspects of the "Green Certificate": the "Green Star" certificate, managed by the project partner CER, and the "Cyclists-Friendly" and "Pedestrian-Friendly" certificates (https://www.sptm.si/gradiva/certifikati). Some comparable certificates are used in Norway, too, , such as "Eco-lighthouse" and "Bicycle-Friendly Workspace". We shall take these certificates as examples of good practice.

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Appendix 1: Collection of Indicators/Criteria from the Literature

- Economic
  - Revenues (Awasthi, et al., 2013) (Awasthi, et al., 2018)
  - Investment costs (Awasthi, et al., 2018) (Regmi, 2020)
  - Operating costs (Awasthi, et al., 2013) (Awasthi, et al., 2018) (Cieśla, at al., 2020) (Manzolli, et al., 2021) (Regmi, 2020)
  - Travel costs for users (Awasthi, et al., 2018) (Cieśla, at al., 2020, per 1 km)
  - Transport costs for access and mobility (Chou, 2017)
  - Reducing mobility costs: public and private (Marletto, Mameli, 2012)
  - Infrastructure costs (Chou, 2017) (Cieśla, at al., 2020) (Gudmundsson, Regmi, 2017)
  - Long-term viability (Chou, 2017)
  - Economic efficiency (Cavalcanti, et al, 2017)
  - Fuel consumption (Gudmundsson, Regmi, 2017)
  - Energy [per distance] (Villegas Flores, et al., 2021)
  - Costs of congestion (Gudmundsson, Regmi, 2017) (SUMI, 2020)
  - Perceived economic opportunity (Gudmundsson, Regmi, 2017)
  - Energy efficiency (SUMI, 2020)
  - Traffic congestion (Kiba-Janiak, Witkowski, 2019) (Perra, et al., 2017)
  - Implementation costs (Manzolli, et al., 2021)
  - Fleet renewal rate (Manzolli, et al., 2021)
  - Contribution to economic sectors (tourism, …) (Morfoulaki, Papathanasiou, 2021)
  - Cost of land use (Ortega, et al., 2021)

- Environmental
  - Energy conservation (Awasthi, et al., 2013) (Chou, 2017) (Garcia-Ayllon, et al., 2021)
  - Conformance to environmental standards (Awasthi, et al., 2013)
  - Fossil fuel consumption (Awasthi, et al., 2018)
  - Air quality (Gudmundsson, Regmi, 2017) (Manzolli, et al., 2021) (Regmi, 2020)
  - Air pollution: greenhouse gasses emissions (Awasthi, et al., 2018) (Chou, 2017) (Cieśla, at al., 2020) (Gudmundsson, Regmi, 2017) (SUMI, 2020) (Manzolli, et al., 2021) (Marletto, Mameli, 2012) (Morfoulaki, Papathanasiou, 2021) (Ortega, et al., 2021) (Regmi, 2020) (Villegas Flores, et al., 2021)
  - Air pollution: local pollutants (Awasthi, et al., 2018) (Garcia-Ayllon, et al., 2021)
  - Impact on land use (Awasthi, et al., 2018) (Gudmundsson, Regmi, 2017) (Ortega, et al., 2021) (Marletto, Mameli, 2012) (Morfoulaki, Papathanasiou, 2021) (Ortega, et al., 2021)
  - Noise pollution (Chou, 2017) (Garcia-Ayllon, et al., 2021) (Gudmundsson, Regmi, 2017) (SUMI, 2020) (Manzolli, et al., 2021) (Marletto, Mameli, 2012) (Morfoulaki, Papathanasiou, 2021) (Villegas Flores, et al., 2021)
  - Reduction of individual motorization rate (Cavalcanti, et al, 2017)
  - Average traffic speed (Cavalcanti, et al, 2017) (Cieśla, at al., 2020) (Manzolli, et al., 2021) (Morfoulaki, Papathanasiou, 2021) (Perra, et al., 2017)
  - Road transpositions (viaducts, trenches) (Cavalcanti, et al, 2017)
  - Prioritization of public transportation (Cavalcanti, et al, 2017) (Marletto, Mameli, 2012) (Morfoulaki, Papathanasiou, 2021)
  - Infrastructure improvements (Cavalcanti, et al, 2017)
  - Ratio of alternative fuels supplying means of transport (Cieśla, at al., 2020)
  - Improving competitiveness (Garcia-Ayllon, et al., 2021)
  - Congestions and delays (SUMI, 2020)
  - Opportunity for active mobility (SUMI, 2020)
  - Percentage using private cars (Kiba-Janiak, Witkowski, 2019)
  - Percentage using public transport (Kiba-Janiak, Witkowski, 2019)
  - Average annual concentration of NO_2 (Kiba-Janiak, Witkowski, 2019)
  - Average annual concentration of PM (particulate matter) (Kiba-Janiak, Witkowski, 2019)
  - Control of environmental impacts (Lima, et al., 2014)

- Natural resources (Lima, et al., 2014)
- Reduction of trips (Lima, et al., 2014)
- Demand for parking (Ortega, et al., 2021)
- Demand for public transport (Ortega, et al., 2021)

- Social
  - Gender equity (Awasthi, et al., 2013)
  - Social equity (Awasthi, et al., 2018)
  - Social justice (Garcia-Ayllon, et al., 2021)
  - Social inclusion (Lima, et al., 2014) (Morfoulaki, Papathanasiou, 2021)
  - Equity in using public space (Cavalcanti, et al, 2017)
  - Labor welfare (Awasthi, et al., 2013)
  - New jobs (Morfoulaki, Papathanasiou, 2021)
  - Ethics/fairtrade practice (Awasthi, et al., 2013)
  - Number of potential users (Awasthi, et al., 2018)
  - Impact on city congestion reduction (Awasthi, et al., 2018)
  - Number of private cars replaced (Awasthi, et al., 2018)
  - Number of public parkings replaced (Awasthi, et al., 2018)
  - Human health (Chou, 2017) (NRI, 2022)
  - Meeting travel needs of the population (Chou, 2017)
  - Attractiveness and quality of the urban landscape (Chou, 2017)
  - Quality of life (Cavalcanti, et al, 2017) (Lima, et al., 2014) (NRI, 2022)
  - Universal accessibility (NRI, 2022)
  - Preservation of cultural heritage (Cavalcanti, et al, 2017)
  - Policies for social action (Cavalcanti, et al, 2017)
  - Integrated policies (Cavalcanti, et al, 2017) (Lima, et al., 2014) (Perra, et al., 2017)
  - Public participation in decision making (Cavalcanti, et al, 2017) (Lima, et al., 2014)
  - Availability and quality of the public transportation system (Cavalcanti, et al, 2017) (Lima, et al., 2014) (Morfoulaki, Papathanasiou, 2021) (Zapolskytė, et al., 2020)
  - Regional integration (Cavalcanti, et al, 2017)
  - Promotion of healty habits (Garcia-Ayllon, et al., 2021)
    - Bicycle use (Garcia-Ayllon, et al., 2021)
    - Rationalization of private car use (Garcia-Ayllon, et al., 2021) (Marletto, Mameli, 2012) (Marletto, Mameli, 2012) (Ortega, et al., 2021)
    - Mobility on foot (Garcia-Ayllon, et al., 2021)
    - Promotion of physical exercise(Garcia-Ayllon, et al., 2021)
  - Urban planning (NRI, 2022)
  - Improvement of public space (Garcia-Ayllon, et al., 2021) (SUMI, 2020) (Marletto, Mameli, 2012) (Villegas Flores, et al., 2021)
  - Satisfaction with mobility services (Gudmundsson, Regmi, 2017) (SUMI, 2020) (Kiba-Janiak, Witkowski, 2019)
  - Affordability (Gudmundsson, Regmi, 2017) (SUMI, 2020) (Perra, et al., 2017) (Regmi, 2020)
  - Urban functional diversity (SUMI, 2020)
  - Bicycle use (Kiba-Janiak, Witkowski, 2019) (Lima, et al., 2014) (Morfoulaki, Papathanasiou, 2021) (Perra, et al., 2017)
  - On foot use (Kiba-Janiak, Witkowski, 2019) (Lima, et al., 2014) (Morfoulaki, Papathanasiou, 2021)
  - Easing non-motorized mobility (Marletto, Mameli, 2012)
  - Support to citizens (Lima, et al., 2014)
  - Education and active citizenship (Lima, et al., 2014)
  - Diversity of transportation modes (Lima, et al., 2014)
  - Diversification of users (NRI, 2022)
  - Fare policy (Lima, et al., 2014)
  - Occupancy rate of vehicles (Perra, et al., 2017)

- Technical
  - Possibility of expansion (Awasthi, et al., 2013) (Awasthi, et al., 2018)
  - Service network (Awasthi, et al., 2013)
  - Occupancy rate (Awasthi, et al., 2013)
  - Number of users (Awasthi, et al., 2013)
  - Mobility (Awasthi, et al., 2013)
  - Travel cost (Awasthi, et al., 2013)
  - Service reliability (Awasthi, et al., 2013) (Awasthi, et al., 2018) (Gudmundsson, Regmi, 2017) (Manzolli, et al., 2021) (Regmi, 2020)
  - Travel time (Awasthi, et al., 2013) (Awasthi, et al., 2018) (Garcia-Ayllon, et al., 2021) SUM I(Manzolli, et al., 2021) (Ortega, et al., 2021) (Villegas Flores, et al., 2021)
  - Accessibility (Awasthi, et al., 2013) (Cavalcanti, et al, 2017) (SUMI, 2020) (Marletto, Mameli, 2012) (NRI, 2022)
    - to transport system (Gudmundsson, Regmi, 2017) (Lima, et al., 2014) (Regmi, 2020)
    - to urban functions (Gudmundsson, Regmi, 2017)
    - universal accessibility (Lima, et al., 2014)
    - physical barriers (Lima, et al., 2014)
    - legislation for users wit special needs (Lima, et al., 2014)
    - increasing alternatives for mobility (Marletto, Mameli, 2012)
    - improvement in accessibility (NRI, 2022)
    - better connectivity (NRI, 2022)
  - Spatial accessibility (Awasthi, et al., 2018) (Gudmundsson, Regmi, 2017)
  - Customer responsiveness (Awasthi, et al., 2013)
  - Connectivity to multimodal transport (Awasthi, et al., 2013) (Awasthi, et al., 2018) (SUMI, 2020) (Regmi, 2020)
  - Adapted to customers with specific needs (Awasthi, et al., 2013) (Cavalcanti, et al, 2017)
  - Suitability to disabled customers (Awasthi, et al., 2018) (SUMI, 2020) (Zapolskytė, et al., 2020)
  - Reachability to locations (Awasthi, et al., 2018)
  - Frequency of transport (Awasthi, et al., 2018) (Ortega, et al., 2021) (Zapolskytė, et al., 2020)
  - Service area network (Awasthi, et al., 2018)
  - Park and ride facility (Awasthi, et al., 2018)
  - Traffic fatalities (Gudmundsson, Regmi, 2017) (SUMI, 2020) (Morfoulaki, Papathanasiou, 2021) (Regmi, 2020)
  - Traffic safety (NRI, 2022)
  - Safety (Awasthi, et al., 2018) (Chou, 2017) (Cavalcanti, et al, 2017) (SUMI, 2020) (Kiba-Janiak, Witkowski, 2019) (Marletto, Mameli, 2012) (Perra, et al., 2017) (NRI, 2022)
    - number of road accidents (Cieśla, at al., 2020) (Lima, et al., 2014) (Villegas Flores, et al., 2021)
    - number of fatalities (Cieśla, at al., 2020) (Kiba-Janiak, Witkowski, 2019)
    - number of people injured (Cieśla, at al., 2020)
    - number of damaged means of transport (Cieśla, at al., 2020)
  - Security (Awasthi, et al., 2018) (Gudmundsson, Regmi, 2017) (SUMI, 2020)
  - Quality (Lima, et al., 2014) (Regmi, 2020)
    - number of available means of transport (Cieśla, at al., 2020)
    - average waiting time (Cieśla, at al., 2020)
    - comfort level (Cieśla, at al., 2020)
  - Vehicle occupancy (Awasthi, et al., 2018)
  - Modern and clean facilities (Awasthi, et al., 2018)
  - Staff service quality (Awasthi, et al., 2018)
  - Integration with IT (Awasthi, et al., 2018)
  - Using innovative technologies (Cavalcanti, et al, 2017)
  - Punctuality (Manzolli, et al., 2021)
  - Capacity, passengers / h (Manzolli, et al., 2021)
  - Liveability (Marletto, Mameli, 2012): public space, noise, air pollutants

  - Road density (Perra, et al., 2017)
  - Bicycle parking available (Zapolskytė, et al., 2020)
  - Bicycle paths (Zapolskytė, et al., 2020)

- Political
  - Integration of political actions (Lima, et al., 2014)
  - Acquisition and management of resources (Lima, et al., 2014)
  - Urban mobility policy (Lima, et al., 2014)
  - Integrated planning [8] (Lima, et al., 2014)

- Implementation (Manzolli, et al., 2021)
  - Traffic interference
  - City environment interference
  - Implementation time
  - Implementation costs (Ortega, et al., 2021)

- Promotion (Perra, et al., 2017)
  - bicycles
  - pedestrian
  - public transport
  - green technologies and measures

- Institutional (Singh, 2012)

- Infrastructure (Villegas Flores, et al., 2021)