

Towards Certification of Sustainable Mobility: A Qualitative Multi-Criteria Modelling Approach

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Abstract

The concept of sustainable mobility is aimed at minimising environmental impacts of transportation systems while meeting the needs of individuals and communities. This includes encouraging citizens to choosing sustainable modes of transportation: walking, cycling, public transport, carpooling, and telecommuting. We present an ongoing attempt at rewarding organisations that actively support the sustainable mobility of their employees. We propose a sustainable mobility certificate, which can be received by organisations that fulfil sustainable mobility goals and objectives. The assessment is carried out using a qualitative rule-based multi-criteria model, which considers 50 sustainable mobility indicators. Other elements of the certification process include methods for assessing the mobility structure of employees in the organisation and its potential for improvement. In this paper, we present the multi-criteria evaluation model and illustrate its application for assessing the status of sustainable mobility of employees at a Slovenian research institute.

Keywords: sustainable mobility; mobility certificate; SmartMOVE project; multi-criteria model; method DEX

1. Introduction

The mobility of people and goods is one of the cornerstones of modern society. However, ever increasing traffic causes various adverse effects on individuals, communities and the environment: congestion, air and noise pollution, infrastructure strain, social isolation and inequality, economic costs and others (Bıyık, et al., 2021).

Ljubljana, the capital city of Slovenia, is no exception. With approximately 300,000 inhabitants, Ljubljana is one of the smallest European capital cities. Nevertheless, it is faced with severe traffic problems. There are over 220,000 jobs in the city, which account for over 25% of all jobs in Slovenia. As a result, over 120,000 people commute to Ljubljana daily from elsewhere. This means approximately 100,000 vehicles entering and exiting Ljubljana on a daily basis. The majority of those are private cars; the estimated average occupancy is 1.2 persons per vehicle. Thus, it is essential to employ the concepts of sustainable mobility (Gallo and Marinelli, 2020; Morfoulaki and Papatthaniou, 2021), particularly to reduce the number of cars in favour of public transportation and other more sustainable means of transportation, such as walking, cycling and car sharing.

SmartMOVE¹ is an ongoing project aimed at the preparation of strategies and mobility plans, in order to justify the need for systematic development of sustainable mobility in the Ljubljana Urban Region. The main

¹ <https://www.smart-move.si/en/>

goal is to limit the negative environmental impacts resulting from unsustainable forms of mobility and the long-term development of sustainable mobility. Several novel approaches have been or are being proposed and assessed. One of them is a system of dynamic on-demand collective passenger transport as a sustainable alternative to the existing transport modalities (Bohanec, et al., 2023). Others include the development of mobility plans for large organisations that are located on main mobility hubs, such as the University Medical Centre and Business Trade Center. Specific policy recommendations for decision-makers in the field of sustainable mobility are also being prepared.

In this paper, we address another ongoing SmartMOVE activity: development of a *certificate* for organisations that take good care of *sustainable mobility* of their *employees*. The idea is that a company that monitors, actively supports, evaluates and, in the long term, improves the mobility of their employees towards sustainability is encouraged and awarded by an officially and publicly recognised certificate, which may, in perspective, bring advantages to such companies, e.g., in obtaining governmental projects and funds.

The central component of the analytical process as part of the certification consists of a *multi-criteria evaluation model* that prescribes the necessary conditions and evaluation criteria for awarding the certificate. The model considers 50 indicators, with which it assesses important aspects of sustainable mobility, including the current situation in the organisation, its vision and management, performance in terms of general and specific measures/activities for improvement, and their monitoring and evaluation. Technically, the model is qualitative and rule-based, developed according to the DEX (Decision Expert) method (Bohanec, 2022). Another important part of the certificate is the assessment of the current *mobility structure of employees* and *potential* for its improvement, which is aimed at perpetual monitoring and managing of the situation. The certificate proposal also defines the certification process and means of acquiring the necessary data, which includes interviews with the organisation's management and surveys of employees' mobility behaviour.

In what follows, we first describe our approach to the development of the certificate, which included a study of the state-of-the-art on the topic and related work, and identification of possible certification criteria. This is followed by a presentation of certificate concepts, with special emphasis on the DEX model and an example of its application.

2. Methodological Approach

As the first stage of certificate development, we conducted a thorough state-of-the-art analysis (Bohanec, et al., 2022). The two main findings, which considerably shaped our further work, were:

1. We could not find any existing certificate that would fully meet the goals (section 3) we had set for ours.
2. Multi-criteria decision-modelling methods (MCDM) (Greco, et al., 2016; Kulkarni, 2022) are well established and widely used in the area of sustainable urban mobility planning (SUMP) (Garcia-Ayllon, et al., 2021).

Actually, there exist certificates that in some way address the aspects of mobility and sustainability. In Slovenia, there are three well-established certificates: Green Star², Cyclists-Friendly Employer Certificate³ and Pedestrian-Friendly Organization⁴. The former addresses general aspects of green transformation and climate action, and only barely touches upon sustainable mobility. The latter two are specific and address only cycling and walking, respectively, as sustainable means of mobility. Some comparable certificates are used in Norway (Bohanec, et al, 2022), too, such as “Eco-lighthouse” and “Bicycle-Friendly Workspace”. Overall, we were surprised by a relatively poor coverage of employers- and employees-related topics in the scientific literature. However, this topic was much better covered in research projects, such as CIVITAS⁵, ENDURANCE⁶,

² <https://www.green-star.si/>

³ <https://cfe-certification.eu>

⁴ <https://www.sptm.si/application/files/3116/3584/8163/Izhodisca-in-kriteriji-za-pridobitev-certifikata-pesci.pdf>

⁵ <https://civitas.eu/>

⁶ <https://www.rupprecht-consult.eu/project/endurance>

CH4ALLENGE⁷ and ELTIS⁸, where we found a number of useful recommendations and tips for evaluating sustainable mobility of organizations and their employees. The principles advocated there have been meticulously translated into the development of the SmartMOVE certificate.

During the literature review, we systematically collected sustainability indicators and criteria that could be used – directly or adapted – for our purpose. Ultimately, we made a collection of more than 100 criteria (Bohanec, et al, 2022). Most of them address Economic, Environmental and Social aspects of SUMP. Somewhat less frequently mentioned aspects are also Technical, Security, Political, Implementation, Promotional, Institutional, Infrastructure, and Management. While this collection turned out too wide for the sole purpose of certification, it gave us a good starting point and a number of criteria to choose from. Among the reviewed studies, the most useful were those that addressed specific decision problems, for example introduction of shared transport resources in cities (Cieśla, et al., 2020), and sustainable urban mobility evaluation at specific locations or organizations (Zapolskytė, et al., 2020; Ortega, et al., 2021). The work of Awasthi, et al. (2018) stands out for a very clear structure of SUMP-assessment criteria.

Considering the data acquisition from employees and managers of an organization, we were most convinced by SUMP self-assessment questionnaires developed in the CH4ALLENGE project, which consist of series of carefully designed and as-simple-as-possible yes-no questions. We chose to follow their general approach, but formulated our own set of questions/criteria that specifically address sustainable mobility of employees in organizations.

3. The SmartMOVE Certificate

3.1. Purpose

The SmartMOVE certificate is intended to raise awareness and promote the sustainable mobility of employees in organizations. It can be rewarded to any organization that:

- continuously monitors travel habits and mobility structure of its employees,
- designs and implements activities to improve sustainable mobility, and monitors and evaluates their results,
- shows a good state and/or sufficient improvement of sustainable mobility.

The certificate explicitly addresses only the mobility of *employees* and excludes other means of transportation, such as for logistics, which would require a different approach.

3.2. Requirements

The basic requirements for the certification process and corresponding criteria are:

- **Minimality:** The certification methodology should include as few relevant criteria as possible.
- **Operability:** All used criteria must be measurable and obtainable relatively easily through surveys and interviews with the organisation's representatives.
- **Simplicity:** The approach should be effective and simple enough for its users.

The simplicity requirement clearly distinguishes this certificate from *mobility plans*, which are commonly developed in relation with sustainable mobility (Kiba-Janiak, Witkowski, 2019; Rupperecht, et al., 2019). Although both require a fairly detailed insight into the organization's mobility structure and its relationship to sustainable mobility, the certificate is intended as a significantly simpler (and cheaper) approach. The certification process could be roughly described as a subset that corresponds to the initial part of creating mobility plans; it excludes a detailed consideration of specific activities, which are an integral part of mobility plans and require a lot of work. Having a mobility plan is not required for obtaining the certificate.

⁷ <http://www.sump-challenges.eu/> - Addressing the four key challenges of sustainable urban mobility planning

⁸ <https://eltis.org> - The EU Urban Mobility Observatory

The certification process should be performed by a reputable organization with properly trained auditors. The procedure must be clear and have clear objectives, equal for all – thus the need for an explicit evaluation model. Also, the certification process must be self-sustaining: the foreseen procedures and instruments must provide all the data necessary for the certificate awarding decision.

Regardless of the final decision – whether the organization receives a certificate or not – the process is also expected to show a clear picture of the state of sustainable mobility in the organization, its strengths and weaknesses, and above all, suggest possibilities for future improvements.

3.3. Certification process

The proposed certification procedure consists of three steps:

1. Preliminary self-evaluation: Unsupervised and free of charge, performed by the candidate organizations themselves using a simple and publicly available questionnaire, consisting of ten questions. The aim is to determine whether the organization meets the essential requirements for obtaining the certificate.
2. First certification: Carried out in collaboration with the organisation and certification auditor. The aim is to assess the state of sustainable mobility in the organization. This includes two major categories: (1) general assessment from various aspects, such as organization, vision, plans, implementation and monitoring of activities, etc., and (2) travel habits, mobility structure and potential for further improvement. The category (1) is assessed by the multi-criteria model, further detailed in section 4. The category (2) is assessed through employee surveys and numeric models, which are not presented here.
3. Renewal of the certificate: Carried out after the certificate expires (provisionally each three years). The process includes the main step, which is exactly the step 2 above, and an additional step: reviewing the changes and results of the previous period, in order to determine whether sustainable mobility in the organization improved, worsened or remained at approximately the same level. The certificate is not renewed if the status has worsened substantially.

4. Qualitative Multi-Criteria DEX Model

The central component of the SmartMOVE certification method is a qualitative multi-attribute rule-based model, developed according to the DEX method. The model defines criteria for granting the certificate; in total, there are 50 criteria (not shown here for space limitation) that address various aspects of sustainability, from criteria addressing the management of sustainable mobility in the organisation, to those addressing general activities toward improvement (e.g., education of employees) and specific measures addressing sustainable means of transportation. According to certificate goals (section 3.1), which aim to reward organizations that are aware and already take good care of sustainable mobility, we formulated eight criteria that must be necessarily fulfilled:

1. Established (planned and regularly addressed) commitments regarding sustainable mobility.
2. Perpetual monitoring of travelling habits and mobility structure of employees.
3. Having a policy, strategy or plan for incorporating the principles of sustainable mobility.
4. Assigned a person or body for the coordination of sustainable mobility activities.
5. Cooperation with research or consulting organisations regarding sustainable mobility.
6. Having recognized the potential for sustainable mobility transformation.
7. Building awareness and educating employees.
8. Having planned, ongoing or already implemented sustainability measures.

These and the remaining 42 criteria are assessed through the discussion between the organisation's representatives and the auditor. The DEX model is qualitative, thus the fulfilment of individual criteria is expressed in terms of a three-valued scale {no, partly, yes}. These assessments are guided by the *Auditor's Manual* (currently available only in Slovenian language) that consists of a questionnaire addressing all individual criteria and prescribing conditions for assigning criteria values.

Attribute	Scale
CERTIFICATE	unacc ; acc; good; exc
BASICS	unacc ; acc; good; exc
POTENTIAL FOR SUCCESS	unacc ; acc; good; exc
ORGANIZATION	unacc ; acc; good; exc
Management	no; partly; yes
Research and experience	no; partly; yes
Adaptation of work	no; partly; yes
VISION AND GOALS	unacc ; acc; good; exc
SITUATION AND SCENARIOS	unacc ; acc; good; exc
VISION	unacc ; acc; good; exc
PRIORITIES AND GOALS	unacc ; acc; good; exc
MEASURES	unacc ; acc; good; exc
GENERAL MEASURES	unacc ; acc; good; exc
SPECIFIC MEASURES	unacc ; acc; good; exc
Sustainable modes of transport	unacc ; acc; good; exc
Walking	no; partly; yes
Cycling	no; partly; yes
Public transportation	no; partly; yes
Motorised vehicles	no; partly; yes
Measures for customers	unacc ; acc; good; exc
ACTING AND MONITORING	unacc ; acc; good; exc
SPATIAL PLANNING	no; partly; yes
RESPONSIBILITY AND FINANCING	no; partly; yes
MONITORING AND EVALUATION	no; partly; yes

Figure 1: Top-level structure of the certificate evaluation DEX model.

The 50 criteria are then aggregated according to the model hierarchy. The top-level structure of criteria is shown in Figure 1. The root criterion is called CERTIFICATE and represents the overall assessment, using the four-valued scale: {unacceptable, acceptable, good, excellent}. Capital letters denote criteria that correspond to particularly important aspects of sustainable mobility, which are assessed in the process:

- **POTENTIAL FOR SUCCESS**: Considering the organisation's management and leadership, awareness of the mobility situation, and orientation and commitment towards sustainable mobility.
- **ORGANIZATION**: Considering the management of sustainable mobility on the organization and collaboration with other organisations, such as research and consulting organizations and neighbouring organizations that might share the same mobility space, issues and policies.
- **SITUATION AND SCENARIOS**: Knowledge of traveling habits of the employees, identification of relevant stakeholders, and awareness of the mobility structure and potentials.
- **VISION**: The existence and level of sustainability mobility plans, long-term vision of the organization in the area of sustainable mobility.
- **PRIORITIES AND GOALS**: The existence and quality level of sustainable mobility priorities and goals, with particular emphasis on monitoring SMART (Specific, Measurable, Achievable, Relevant, Time-bound) targets.
- **GENERAL MEASURES TO IMPROVE MOBILITY**: Conducted or already implemented general measures/projects, such as education of employees, providing appropriate information (e.g., maps with mobility options and public transport timetables).
- **SPECIFIC MEASURES TO IMPROVE MOBILITY**: Specific measures regarding various means of sustainable transportation: walking, cycling, public transportation, and reducing the use of individual cars. For instance, cycling incorporates measures: easy access, parking lots and stands, proximity to the entrance, measures against theft, maintenance kits, bikes available at the workplace, awards for cycling to work and discounts for employees for purchasing bike equipment.

- SPATIAL PLANNING: Local arrangement of space, traffic and facilities.
- RESPONSIBILITY AND FINANCING: Action plans and ongoing activities for sustainable mobility.
- MONITORING AND EVALUATION: Perpetual monitoring and evaluation of completed and ongoing sustainable mobility projects and measures.

Regarding the value scales of criteria (Figure 1) it is worth noting that the red colour indicates undesired values that lead to rejection of the certificate. For instance, the red “no” denotes that Management is an essential criterion that has to be at least partly fulfilled. The black “no” that occurs with some other criteria tells us that they are still important, but not essential. The green colour indicates particularly advantageous values.

Table 1: Decision rules for assessing ORGANIZATION.
 ‘>=’ and ‘<=’ mean ‘better or equal’ and ‘worse or equal’, respectively.
 ‘*’ represents any value.

	Management	Research and experience	Adaptation of work	ORGANIZATION
1	no	*	*	unacc
2	partly	no	<=partly	acc
3	partly	<=partly	no	acc
4	>=partly	no	no	acc
5	partly	*	yes	good
6	partly	>=partly	>=partly	good
7	partly	yes	*	good
8	yes	no	partly	good
9	yes	partly	no	good
10	yes	*	yes	exc
11	yes	>=partly	>=partly	exc
12	yes	yes	*	exc

The aggregation of values in the model is governed by decision rules. Table 1 shows decision rules for determining the value of ORGANIZATION with respect to three lower-level criteria: Management, Research and experience, and Adaptation of work. For all possible combinations of values of these three criteria, the corresponding value of ORGANIZATION is given in the rightmost column. It is easy to see that Management is indeed an essential criterion: whenever its value is “no”, ORGANIZATION is “unacceptable”, regardless of the remaining two criteria (rule 1). Other value combinations lead to other (acceptable or better) values of ORGANIZATION.

Similar decision tables are defined for all aggregate criteria in the model, i.e., those that depend on lower-level criteria. In total, there are 31 such tables. Thanks to automatic verification carried out by the DEXiWin software⁹, which was used to develop the model, all decision tables are complete (they define outputs for all input combinations) and consistent (the better input value always leads to a better or the same output assessment).

Notice that DEX is a qualitative MCDM method and there are, in principle, no weights associated with criteria. The certificate result is determined by a bottom-up aggregation of 50 input questionnaire values, according to the structure of the model (Figure 1) and decision rules (example in Table 1). Decision rules were designed to ensure that the eight required criteria are considered more important than others in the sense that when they are not fulfilled, the final evaluation is “unacc” and the certificate cannot be awarded. The remaining criteria have similar impact with respect to each other, however their “importance” (in the sense of MCDM weights) varies depending on values of other criteria in the same context. Consider, for example, rule 12 in Table 1. When both Management and Research and experience are “yes”, then Adaptation of work is not really important (denoted by “*”) to assess the ORGANIZATION as “exc”. By the same token, rule 10 declares Research and experience not important whenever both Management and Adaptation of work are evaluated as “yes”.

⁹ <https://dex.ijs.si/dexisuite/dexiwin.html>

5. An Example Application

Currently, the proposed approach is in the testing stage. So far, it has been verified on a sample of five organisations that collaborate with SmartMOVE. In the following we show an example application at Jožef Stefan Institute (JSI). JSI¹⁰ is the largest and leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff of around 1,200 specialize in physics, chemistry and biochemistry, electronics and information science, nuclear technology, energy utilization and environmental sciences. JSI has facilities in two locations. The headquarters and main facilities are located in a densely populated in the SW part of Ljubljana, and the other location is the Reactor Center Podgorica, located approximately 10 km out of the main city area. Although sustainable mobility is regarded by JSI as an increasingly important concept, it has not been addressed in a systematic and organised manner yet.

The experiment involved two JSI departments (of Knowledge Technology and Environmental Sciences), with collectively about 100 employees working at both locations. The assessments of input criteria in the DEX model were obtained in collaboration with JSI environmental experts, who are experienced in the area of sustainable mobility. Employing the DEX model yielded top-level results as shown in Figure 2.

Attribute	JSI
CERTIFICATE	unacc
BASICS	unacc
POTENTIAL FOR SUCCESS	unacc
ORGANIZATION	good
Management	partly
Research and experience	partly
Adaptation of work	yes
VISION AND GOALS	acc
SITUATION AND SCENARIOS	acc
VISION	acc
PRIORITIES AND GOALS	acc
MEASURES	exc
GENERAL MEASURES	good
SPECIFIC MEASURES	exc
Sustainable modes of transport	exc
Walking	yes
Cycling	yes
Public transportation	yes
Motorised vehicles	yes
Measures for customers	acc
ACTING AND MONITORING	acc
SPATIAL PLANNING	no
RESPONSIBILITY AND FINANCING	partly
MONITORING AND EVALUATION	no

Figure 2: Assessment of the mobility situation at JSI.

Attribute	JSI
CERTIFICATE	unacc
BASICS	unacc
POTENTIAL FOR SUCCESS	unacc
Management	no
[1] Management commitment	no
[5] Management as a role model	no
[2] Stakeholders	no
[3] Status and objectives	no
[4] Recognition of opportunities	no

Figure 3: Assessment of the JSI POTENTIAL FOR SUCCESS. Numbers in brackets refer to individual questions.

Overall, the results indicate that JSI is currently not eligible for obtaining the SmartMOVE certificate. The main reason is the unacceptable assessment of POTENTIAL OF SUCCESS. A deeper analysis of the corresponding subtree of criteria (Figure 3) reveals that such assessment is due to the inactivity of JSI in addressing and managing sustainable mobility issues, and having not assessed the corresponding opportunities and potentials. On the other hand, the situation regarding general and specific sustainability measures is actually very good. Consequently, JSI has a very good potential for obtaining the certificate, subject to improvements that should particularly address the organizational aspects: assigning a sustainable mobility

¹⁰ <https://www.ijs.si/ijsw/V001/JSI>

manager, explicitly formulating vision and goals, and, subsequently, monitoring and assessing the effects of activities. Regarding specific actions, only minor improvements of walking pathways and city bike stations might be beneficial.

6. Conclusions

We have presented an ongoing development of the SmartMOVE certificate, a mechanism for awarding and encouraging organisations for taking care of sustainable mobility of their employees. This includes a continuous monitoring of employees' travel habits and mobility structure, planning and implementing relevant activities, monitoring and evaluating their effects and impacts, possibly achieving and maintaining a good sustainable mobility standard. The main element is a qualitative multi-criteria DEX model, which was specifically addressed in this paper.

In its current form, the model consists of 50 basic (input) and 31 aggregate (result) criteria. The final assessment, which determines the eligibility of the company to receive the certificate, is located at the very top of the model (called CERTIFICATE). Important aspects of evaluation are also obtained at the first and second levels of the model and effectively explain the reasons for the final assessment. The model also facilitates experimentation and can answer the important question: what the organisation needs to change for a better evaluation the next time?

So far, the model has been tested on a sample of five organisations and the results are encouraging. The method is indeed operational and in all use cases we were able to obtain the necessary data relatively easily. This typically means conducting an online survey of (a sample) of employees and conducting two to three meetings with representatives of the organisation.

The proposed approach is not necessarily tied to the certificate, but may have a wider applicability. To the best of our knowledge, it is the most detailed assessment system focusing particularly on sustainable mobility of employees. Even if an organization does not apply for the certificate, it can very clearly recognize their positive achievements and challenges. Compared to the development of a mobility plan, the process is easier, faster and cheaper. Even though it cannot provide all the results we expect from a mobility plan (a detailed overview of the situation, a proposal for specific measures and activities, investment planning), it is nevertheless useful as an initial step.

In the future, we will continue verifying the approach and improving it along the way. However, the main future concern is to establish the certificate as an approved and highly respected means for rewarding organisations that contribute to sustainable mobility. This requires much more than a good assessment approach, particularly a wide public recognition and governmental support.

Acknowledgments

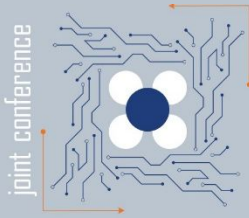
This work has been funded by the SmartMOVE project, which is co-financed by Iceland, Lichtenstein and Norway funds from the EEA Financial Mechanism and corresponding Slovenian participation within the Climate Change Mitigation and Adaptation programme in the amount of 1,609,167 €. The contents of this document are the sole responsibility of the authors and can in no way be taken to reflect the views of the Climate Change Mitigation and Adaption Program Authority.

The authors also acknowledge the financial support from the Slovenian Research and Innovation Agency for research core funding for the programme Knowledge Technologies (No. P2-0103).

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