REVIEW ARTICLE

Policy-aware assessment of environmental impacts from transport in smart cities

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Abstract: In recent research a performance evaluation framework for traffic management and Intelligent Transport Systems was developed, consisting of a set of Key Performance Indicators (KPIs) for the themes of traffic efficiency, safety, pollution reduction and social inclusion, all of which are key components of a smart city. One of the innovative elements of these KPIs is their ability to consider the transport policy layer, in the sense that the evaluation of the suitability and effectiveness of different strategies and ITS options is calculated in relation to the decision maker's high-level transport policy rather than objectively. This is achieved through weighting factors, whereby more important policy objectives are weighted more heavily in the calculation. But while the theoretical framework is ready to accommodate the policy layer, no methodology to determine the values of the weighting factors has been developed so far. The present study, therefore, concentrates on the development and testing of such a methodology, focusing on the environmental impact aspect of urban mobility management and ITS in the context of smart cities. The development is based on existing policy objectives and legislation in different cities and countries, while testing is carried out using the purpose-developed CONDUITS_DST software with data from microsimulation models before and after the implementation of a bus priority signalling system in Brussels, Belgium. The results show that the method captures the expected effects, but also that it is able to reflect policy objectives and deliver evaluation results in relation to their alignment with those.

Keywords: Key Performance Indicators, traffic management, pollution reduction

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1. Introduction

Cities today share common transport problems and objectives with respect to mobility management, and put great focus on Intelligent Transport Systems (ITS). The market offers decision makers a variety of ITS solutions, from which they are required to choose the most suitable and effective ones. Making this choice is a non-trivial task, however, especially given that transport problems are multi-dimensional by nature. Hence, a performance evaluation framework that addresses the various dimensions of transport problems, while at the same time reflecting the perspectives and priorities of decision makers, is required[1].

In recent research work (FP7 CONDUITS) such an evaluation framework was formulated, consisting of a set of Key Performance Indicators (KPIs) for four themes of mobility management: efficiency, safety, pollution reduction and social inclusion[2]. The KPIs were subsequently validated through before- and after-evaluation of real-world case studies in the cities of Paris, Rome, Tel Aviv and Munich, using real data supplied by the local authorities and transport operators[3–4]. Through the conduct of the case studies, it was concluded that the KPIs were easy to apply and required already available data, thus forming a very useful evaluation tool for assisting city decision makers of in the field of mobility management and ITS, and to some extent for identifying best practice and lessons learnt elsewhere.

Yet the necessity for extending the CONDUITS framework from its current state of a tool for evaluating existing systems to a tool for evaluating future systems becomes apparent, given the current economic climate and the increasing need of making as informed decisions as possible within the context of smart cities. Follow-up work within the framework of the CONDUITS-DST spinoff project, sponsored by Kapsch TrafficCom, has concentrated on integrating the CONDUITS KPIs with traffic microsimulation. The outcome has been a predictive evaluation tool for mobility management and ITS, called CONDUITS_DST, in which three of the four KPI categories have been integrated to date: the pollution generated by the various transport modes in the form of greenhouse gas emissions, the traffic efficiency, expressed through measures such as travel time and network reliability; and the traffic safety, represented by metrics such as accidents, and direct and indirect safety impacts. Preliminary testing of the tool in four European cities (Brussels, Stuttgart, Tel Aviv and Haifa) using existing microsimulation models has, again, confirmed the validity of the methodology and has demonstrated the viability, usefulness and timeliness of the approach[5–7].

One of the innovative elements of the CONDUITS approach is its ability to consider the transport policy layer, in the sense that the evaluation of the suitability and effectiveness of different mobility management strategies and ITS options is calculated in relation to the decision maker's high-level transport policy rather than objectively. In other words, the CONDUITS approach has the ability to capture the fact that a certain option that may be beneficial to one city (or country) may not be as beneficial to another, not because of the impact that it may have, but because it may not agree with the latter's high-level policy. For example, an option that delivers moderate benefits in terms of reducing particulate matter (PM) emissions but has great benefits in terms of improving traffic safety may not be the best solution for a city in which pollution reduction is a more important high-level policy objective than road safety.

From a decision maker's point of view this policy-awareness is invaluable, as it provides the means to present results to non-expert audiences (such as politicians) in a simple, fast and effective way. The policy layer is integrated in the CONDUITS KPIs through weighting factors, whereby more important policy objectives are weighted more heavily in the calculation. But while the theoretical framework is ready to accommodate the policy layer, no methodology to determine the values of these has been developed so far.

The present study, therefore, concentrates on the development and testing of a method for setting the weights in the CONDUITS KPIs. The focus here is the pollution aspect of mobility management and ITS in the form of pollutant emissions from vehicle traffic, and the relevant CONDUITS KPI is tackled. The method is based on existing policy objectives and legislation in different cities and countries with respect to the three main categories of air pollutants, namely carbon dioxide (CO_2), nitrogen oxide (NO_x) and particulate matter (PM). Testing is then carried out through the CONDUITS_DST software using data from microsimulation models before and after the implementation of a bus priority signalling system in Brussels, Belgium.

The paper is structured as follows: Section 2 introduces the background of the study, including the CONDUITS evaluation framework (KPI) for pollution reduction and a review of different air pollution policy objectives and legislation, which inform the development of the weighting methodology. Section 3 then goes on to formulate the methodology and to present the rationale behind it. The results of the testing of the method on the case study in Brussels are reported in Section 4, along with a discussion of the analysis carried out. Finally, Section 5 concludes the paper and identifies areas of future work.

2 .Background

2.1 The CONDUITS Evaluation Framework

Performance measures have the ability to effectively evaluate the outputs of specific solutions. However, when attempting to conduct a higher-level evaluation through a multi-dimensional benchmarking scheme comparing different cities with each other, performance measures are generally not suitable. The reason is that such a task necessitates the systematic and synthetic description of the cities' transport policies and infrastructures and the analysis of their impacts, which can only be expressed by a set of measures reflecting each individual scheme evaluated[8]. This issue creates difficulties in the communication of the results to non-technical audiences, such as politicians and the general public, and a common way to deal with it is to combine individual performance measures into composite performance indices (KPIs)[9–10].

The main advantage of KPIs is simplicity, as it is much easier to understand and grasp a single number rather than a large collection of individual measures, whose meaning often requires trained insight and careful analysis. The disadvantage, nevertheless, is that an aggregate number does not provide immediate insight into which aspects of the performance are changing or why, making it difficult to distinguish the sensitivity of an index to changes in its component measures. However, this ambiguity may lead to some other advantages. The index increases the opportunity for all modes and markets to be included, conveys the idea that each service is important, and elevates the discussion about how to best measure and report system performance. This cooperation between modes and sectors enhances awareness, broadens perspectives and leads to more comprehensive solutions.

In line with the European Commission's strategy on the future of transport, as presented in the 2001 and 2011 white papers[11–12], a performance evaluation framework was defined by the FP7 CONDUITS project, consisting of a set of measures and KPIs for the four themes of traffic efficiency, traffic safety, pollution reduction, and social inclusion[2]. The most important KPIs for each of the four themes are listed in Table 1.

Among the KPIs of the complete framework, this study focuses on pollution reduction, and specifically the index of emissions from motor vehicles. The relevant KPI is defined[2] as the weighted sum of all distance-averaged emissions per vehicle and per vehicle type in the network, i.e.,

$$I_{pol} = \frac{\sum_{VT}\sum_{ET} w_{VT} w_{ET} Q_{VT,ET}}{\sum_{VT}\sum_{ET} w_{VT} w_{ET}} \tag{1}$$

where I_{pol} is the value of the KPI (with smaller values

Table 1. List of key CONDUITS KPIs for each of the four themes

Category	KPI	Description
Traffic efficiency	Mobility	Average travel time to different destinations in the highway and public transport networks, weighted by importance according to policy objectives
	Reliability	Average total duration of congestion on all links of the highway and public transport network, weighted by importance according to policy objectives
Traffic safety	Accidents	Average number of accidents at links and junctions of the transport network, weighted by mode (car, bus, pedestrian …) and severity (serious injury, fatality)
	Direct safety impacts	Average number of actions taken to avert safety-critical situations, weighted by mode and location according to policy objectives
	Indirect safety impacts	Total duration of safety-related critical occurrences, but not necessarily avoidances of safety hazards, weighted by mode and location
Pollution reduction	Motor vehicle emissions	Sum of all distance-averaged emissions per vehicle and per vehicle type in the network, weighted according to policy objectives
	Electric vehicle emissions	Sum of distance-averaged equivalent electricity generation emissions per electric vehicle in the network, weighted according to policy objectives
Social inclusion	Accessibility	Average number of activities (work, education, leisure, …) located within a certain travel time or distance threshold, weighted by importance according to policy
	Mobility of special groups	Proportion of trips undertaken by societal groups potentially facing social exclusion (elderly, disabled, …) for participating to activities, weighted by importance according to policy
	Public transport usage of special groups	Proportion of users of public transport services from societal groups potentially facing social exclusion, weighted by importance according to policy

Note: The values of the weights w_{VT} and w_{ET} are the policy-aware element of the KPI, and can be set by the decision maker to reflect high-level policy objectives, as will be seen next.

indicating less pollution, and hence better performance), w_{VT} denotes the weighting factor for each vehicle type in the network (passenger car, motorcycle, bus, Heavy Goods Vehicle (HGV), etc.), w_{ET} is the weighting factor for each pollutant emission type (CO_2, NO_x or PM), and $Q_{VT,ET}$ is the variable expressing the quantity of a certain pollutant emission from a certain vehicle type.

Depending on the type of evaluation, the data source of the $Q_{VT,ET}$ quantity varies. Specifically, in a before-and after-evaluation of an already realised/implemented ITS scheme, $Q_{VT,ET}$ can be obtained from actual pollutant emission data collected from the field through sensors. In the case of predictive evaluation of a proposed scheme, on the other hand, $Q_{VT,ET}$ can be calculated from the output of microscopic traffic simulation models (such as PTV VISSIM, PARAMICS or AIMSUN), combined with an appropriate pollutant emissions model (such as AIRE, COPERT or ENVIVER).

2.2 Overview of Air Pollution Policy Objectives

Road transport is widely recognised as a major contributor of adverse effects on the environment, with air pollution being an important global issue needing to be addressed, especially in urban areas. For this purpose, fairly strict standards and guidelines with respect to pollutant emissions have been adopted by the automotive industry, such that car manufacturers increasingly develop vehicles that avoid these emissions directly (e.g., electric and ultra-low emission vehicles). At the same time, pollutant emission threshold values have been adopted by governments and local authorities, which have been integrated in their high-level policy objectives, and with which any transport scheme is expected to comply. The present study focuses on the policy objectives of three pollutants, namely CO_2, NO_x and PM, which are to be used in the determination of the weighting factors in Equation (1) in relation to the importance of each one.

Governments and environmental bodies provide regulations for air pollution under various classifications. Limit values are the maximum acceptable concentrations that are provided for the protection of human health, while threshold values are defined as the levels at which the public must be informed of high concentrations of pollutants. Target values are the ones that should not be exceeded within a given time period, whereas critical levels refer to concentrations above which direct adverse effects may occur on trees or natural ecosystems, but not on humans.

As from the point of view of urban mobility and ITS the effects of pollutants on human health are of most importance, the limit values for the three pollutants tackled as set by a number of different countries are considered, and are shown in Table 2. It should be noted that limit values given in ppm (parts per million) have been converted to μg/m^3 based on the molecular weight of the respective pollutant. Also, as some limits are given as ‘24-hour’ values with a certain number of allowed exceedances, ‘annual’ limit values have been devised for comparison purposes.

Table 2. Pollutant emission limit values for different countries (μg/m^3)

Country	CO_2	NO_x	PM
European Union[13]	810,000	40	40
USA[14]	810,000	99.74	12
Hong Kong[15]	810,000	40	50
Australia[16]	810,000	56.45	8
Thailand[17]	810,000	56.45	50

It can be seen from Table 2 that limit values for CO_2 are much higher than the other two pollutants. This is because CO_2 is a global pollutant rather than a local one, and therefore is not a direct concern to local air quality (and to human health) except when in very high concentrations. In fact, limit values for CO_2 only exist for indoor areas, and the only standard addressing CO_2 at the national level is the Kyoto Protocol[18], which foresees CO_2 percentage target reductions rather than actual limit values. However, given that common outdoor levels of CO_2 range between 350 ppm to 450 ppm, and that concentrations over 500 ppm usually suggest that a large combustion source is nearby[19], it is reasonable to adopt a value of 450 ppm (810,000 μg/m^3) as the equivalent CO_2 limit value for the purposes of this study.

3. Weighting Methodology

Having gathered information on high-level policy objectives for the three pollutants in question (PM, CO_2 and NO_x), the method for setting the weighting factors in the corresponding CONDUITS KPI is devised here. Focusing of the emission type weighting factors (w_{ET}), the first step is to consider the relative importance of the pollutants, which will give an indication of the order of difference between the weights. In this respect, if the severity of the effects on human health is considered, PM should be weighted as most important, while CO_2 should be assigned the lowest weight. Specifically, intoxication of the blood is the most important adverse effect of CO_2, and this occurs almost exclusively in enclosed areas rather than outdoors. This order of difference is additionally confirmed by the limit values of the three pollutants, as outlined in Table 2; since PM generally has the strictest limit value, its weight in the KPI should be highest.

Nevertheless, there is a further consideration that needs to be made with respect to the weighting factors of the pollutants, and this is the fact that there is an order of magnitude of difference in the quantity of each pollutant emitted from traffic. For instance, Table 3 shows the total quantities of each of the three pollutants emitted from traffic on a road corridor in an urban area, as calculated using the AIRE emissions modelling tool in a previous related study by the authors[5], but in the same site as the one tackled in the present paper (Section 4). It is evident that CO_2 dominates both NO_x and PM in terms of quantity (which is expected given that CO_2 is naturally present in the atmosphere as part of the earth's carbon cycle), and also that NO_x dominates PM. In fact, it can be observed that the quantity of CO_2 is approximately 180.6 times higher than that of NO_x and approximately 4690.6 times higher than that of PM, and that the quantity of NO_x is approximately 25.97 times higher than that of PM.

Table 3. Pollutant quantities per vehicle type (mg)[5]

Vehicle type	CO_2	NO_x	PM
Bus	190,160,226	5,503,500	140,620
Articulated bus	356,682	8,302	301
Car	2,155,459,269	5,277,315	314,706
HGV	135,273,041	2,951,044	73,357
Total	**2,481,249,218**	**13,740,161**	**528,984**

As such, for the base scenario where the three pollutants are weighted as equally important to the decision maker, the NO_x weighting factor (w_{NOx}) should be approximately 180.6 times higher than the CO_2 weighting factor (w_{CO2}), and the PM weighting factor (w_{PM}) should be 4690.6 times greater than w_{CO2} and 25.97 times greater than w_{NOx}. Taking a base value of w_{CO2} = 100 for simplicity purposes, then the corresponding values for the other weighting factors will be w_{NOx} = 18060 and w_{PM} = 469 060; this is the base "unweighted" (UNW) scenario, where the weighting factors only balance out the order of magnitude differences between the pollutants.

Other weighting scenarios can be further defined on the basis of the pollutant emission limit values for the different countries, thus taking into account high-level policy objectives in that respect. These include the European Union (EU), USA, Hong Kong (HK), Australia (AUS) and Thailand (TH) scenarios and are shown in Table 4. It should be noted that while a base value of 100 is taken for w_{CO2}, this is not restrictive, and different values could be used, provided the values for w_{NOx} and w_{PM} are proportionally adjusted.

Table 4. Pollutant weighting scenarios

	Scenario name					
w_{ET}	UNW	EU	USA	HK	AUS	TH
w_{CO2}	100	100	100	100	100	100
w_{NOx}	18,060	2,025,000	812,111	2,025,000	1,434,898	1,434,898
w_{PM}	469,060	2,025,000	6,750,000	1,620,000	10,125,000	1,620,000

With respect to the weighting factors for the vehicle types (w_{VT}), these are set as the inverse of the Passenger Car Unit (PCU) equivalent value of each type, as defined in Transport for London's Traffic Modelling Guidelines[20]. It should be noted, though, that in the case of pollutant emissions, some vehicles, such as trams and bicycles, but also pedestrians, do not produce emissions, and are therefore assigned weighting factors of zero. The vehicle type weight values are shown in Table 5.

Table 5. PCU equivalents and vehicle type weighting values

Vehicle type	PCU [20]	w_{VT}
Car	1.0	1.0
Bus	2.0	0.5
Articulated bus	3.2	0.3125
HGV	2.3	0.4348

To test the weighting methodology, a real-world case study is employed, whereby an environmental impact assessment in terms of pollution of a proposed ITS scheme is carried out on using before- and after-data from a microscopic simulation model in the CONDUITS_DST software. This is described in the next section.

4. Application and Results

4.1 The CONDUITS_DST Software

Performance evaluation using the CONDUITS KPIs is facilitated by the CONDUITS_DST software, which is a specialised tool working as an additional module to microsimulation software packages, such as PTV VISSIM. The tool selects and aggregates relevant output data from simulation models and uses it as input to the calculation of the KPIs. At the current stage the modules for traffic efficiency, pollution reduction and traffic safety evaluation have been developed, and a predictive social inclusion evaluation module is under development.

For the present study, the pollution reduction module of CONDUITS_DST is used. This combines the results estimated by the microsimulation and included in so-called "vehicle records" (i.e., files containing the simulation results per individual vehicle) with the output of an external emissions model (AIRE), and hence calculates the CONDUITS KPI for pollution reduction, as presented in Equation (1), according to different scenarios set up by the planner. The individual components of CONDUITS_DST and the flow of information between them are shown in Figure 1.

Valuable simulation results rely on the aggregation of many simulation runs with different seeds, and so CONDUITS_DST allows for more than a single mutation (seed) to be used to generate the input required by the KPI. The results generated by the tool enable easy comparison between different simulation runs and scenarios. Most importantly, CONDUITS_DST enables the conduct of policy-aware performance evaluation by providing an interface for setting the desired weighting factors. It is this interface that is used in the present study to enter the weighting scenarios defined in the previous section.

An important feature to note here is the transferability of CONDUITS_DST, as this is not bound to any particular microsimulation platform and can work equally well with available modelling tools providing vehicle logs, such as PTV VISSIM, PARAMICS, etc.

4.2 Application Case Study

The research described has been carried out in close cooperation with city authorities, with CONDUITS_DST being validated through an existing case study in the city of Brussels. Following the EU directive and the high interest of the Brussels-Capital Region to provide a better quality of life to its citizens, the city authority has been constantly seeking for ways to deliver a more efficient transport system on one hand, but a less polluting one on the other. One of the measures pursued involves increasing the share of public transport in the modal split, which requires making it more competitive compared to motorised private transport. With an already dense public transport network (70 public transport lines with a total length of more than 700 km), though, any improvements must be based on the existing system.

One of the means to introduce a more competitive public transport system is by reducing travel times. To achieve that, the Brussels-Capital Region has introduced a programme aiming at increasing the operational speed of most of its public transport lines. The programme focuses on reducing delays around signallised intersections by giving priority to public transport

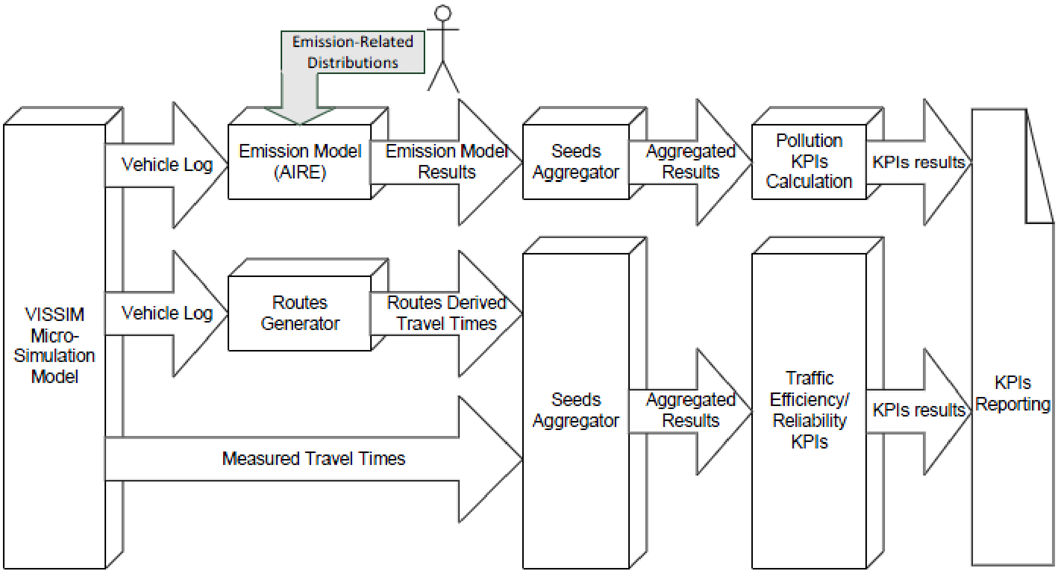

Figure 1. CONDUITS_DST structure and components[6].

vehicles over other traffic. This strategy promotes the attractiveness of public transport, both in the short- and the long-term, by offering lower travel times; however, it is also likely to have an undesired side-effect of increased pollution levels from traffic, especially in the short-term, due to increased waiting (idle) times and more stops and accelerations by private transport vehicles.

This side-effect is evaluated in the present study using CONDUITS_DST, in conjunction with relevant high-level policy objectives. More specifically, the prospective pollution impact of the introduction of priority signals along bus line no. 49 is analysed, taking into account the policy objectives as expressed by pollutant emission limit values. The study consists of four cases, representing the states before and after the implementation of the system in the morning and evening peak periods, respectively. From the planning phase of the signal control a calibrated VISSIM simulation network has been developed for all four cases (Figure 2).

4.3 Results

Several simulation runs are carried out over an evaluation period spanning three hours in the respective peak, extracting the necessary input data for the pollution KPI calculation in CONDUITS_DST. For each set of runs, the KPI calculation is carried out using each of the six pollutant weighting scenarios shown in Table 4, and the vehicle type weighting factors of Table 5.

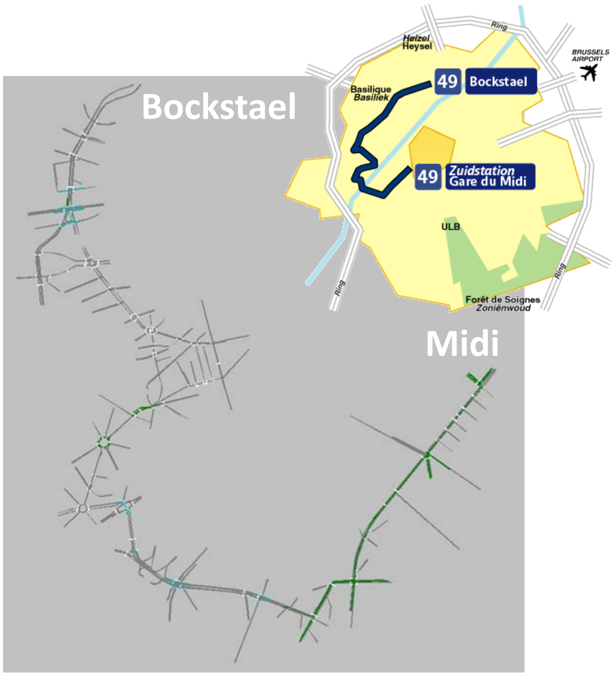

Figure 2. Line 49 and simulation network for the Brussels case study.

Table 6 shows the results of the KPI calculation for pollution in the four peak periods before and after the implementation of the priority measures, for each of the pollutant weighting scenarios, i.e., UNW, EU, USA, HK, AUS and TH. As can be immediately observed, the values for the after-case are higher than the before-case across all six weighting scenarios. Table 7 shows the corresponding percentage increase for each case and weighting scenario, where this finding is confirmed, as KPI increases of 6–9% and of 4–5.8% are observed for the morning and evening cases respectively. A brief comparison with other indicators of the simulation, such as the number of stops and delay times, both for private and public transport, confirm this outcome. The results, hence, show that, while public transport observes a decrease of 20–60% in the number of stops and an increase of the average speed of 3–6%, car drivers experience an increase of their journey time, along with an increase in the pollution levels.

Considering the percentage increase of the KPI between the different weighting scenarios, it can be clearly observed that the policy-aware KPI values (i.e., the ones based on the limit values of different countries) are higher than the respective increase in the UNW scenario (i.e. where pollutants are considered as equally important). This can be largely attributed to the fact that the PM and NO_x emissions are considered as more important by the authorities of the different countries and, as such, figure more prominently in their high-level policy objectives. In practical terms, this means that the foreseen "objective" 4–6% increase

Table 6. Pollution KPI values for each scenario (equivalent emissions units)

Scenario	UNW	EU	USA	HK	AUS	TH
Morning before	258.79	1373.36	368.93	1515.88	409.96	1299.00
Morning after	274.39	1498.49	397.98	1654.64	443.00	1416.88
Evening before	302.43	1562.24	420.99	1724.20	467.46	1478.00
Evening after	315.13	1647.12	441.48	1818.23	490.60	1558.09

Table 7. Percentage change in the pollution KPI values

Scenario	UNW	EU	USA	HK	AUS	TH
Morning before	+ 6.0%	+ 9.1%	+ 7.8%	+ 9.2%	+ 8.0%	+ 9.0%
Morning after						
Evening before	+ 4.0%	+ 5.4%	+ 4.8%	+ 5.4%	+ 5.0%	+ 5.4%
Evening after						

in pollution as a result of the implementation of the scheme may actually correspond to more severe increases from the point of view of decision makers.

A further observation that can be made is that four-digit KPI values are obtained for the EU, HK and TH weighting scenarios, while the USA and AUS ones are three-digit and closer to the UNW scenario values. This can be explained by the fact that the USA and Australia appear to have less strict legislation with regard to NO_x and PM emissions compared to the EU, Hong Kong and Thailand. Practically speaking, this means that the same ITS scheme or solution will have different perceived impact severity by decision makers in different countries as a result of the different high-level policy objectives. In other words, a scheme's adverse impacts may be acceptable in one city or country but unacceptable in another one, purely due to alignment or non-alignment with policy objectives respectively, which is exactly what the weights are supposed to capture.

5. Conclusions and Further Work

A method for policy-aware evaluation of urban mobility and ITS schemes was introduced in this paper, with the objective of being used in conjunction with the CONDUITS KPIs and the corresponding CONDUITS_DST software, in order to assist decision-making in smart cities. The method uses the pollutant emission limit values that are in effect in different countries' legislations to derive appropriate weighting factor values for three key pollutants, CO_2, NO_x and PM, in the calculation of the corresponding CONDUITS KPI for pollution from motor vehicle emissions. The results of the application on a real case study in the city of Brussels featuring the implementation of a system granting priority to public transport at signalised intersections showed that the method can not only capture the expected side-effect of the increase in pollution levels, but that it is also able to reflect policy objectives and deliver evaluation results in relation to their alignment with those.

From a decision maker's point of view, this policy-awareness is invaluable, as it provides the means to present results to non-expert audiences in a simple, fast and effective way. On the other hand, it should be acknowledged that through the allocation of weights in a manner ensuring full alignment with policy objectives, a certain degree of subjectivity is inevitably introduced in the results of the evaluation. In order to reduce this, hence, it could be appropriate to employ an expert-based methodological approach to fine-tune the weight values, such as the well-known Delphi method[21–22], which is based on a series of questionnaires with controlled feedback for the purpose of reaching a relatively narrow range of outcomes by comparing opinions in an iterative fashion.

While the present study has shed some light on the topic of policy-aware evaluation of the environmental impacts of mobility management and ITS schemes and solutions in smart cities, work in this direction continues. It is an essential next step to conduct more analyses and apply the method in different case studies. It is likely that a more thorough calibration of the weighting factors will be necessary, as the individualities of cities and regions will need to be considered, and so it is foreseen to develop an advanced calibration mechanism that planners can apply once to their specific settings so that they can then produce policy-aware evaluation results, tailored to their needs. It is also important to be able to systematically incorporate the views of experts in the evaluation procedure, and so work will continue along this direction in order to derive more robust weighting scenarios for the CONDUITS pollution KPI, which incorporate expert knowledge. Finally, it is foreseen to develop similar appropriate weighting methodologies for the other KPIs (traffic efficiency, traffic safety, social inclusion) and to incorporate them in CONDUITS_DST.

Conflict of Interest and Funding

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