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USING INDICATORS TO DISENTANGLE THE TRANSPORT-RELATED SUSTAINABILITY OF A CITY

D. Meers, Vrije Universiteit Brussel (MOBI)

E. Hermans, Universiteit Hasselt (IMOB)

H. Buldeo Rai, Vrije Universiteit Brussel (MOBI)

T. van Lier, Vrije Universiteit Brussel (MOBI)

Y. Shen, Universiteit Hasselt (IMOB)

C. Macharis, Vrije Universiteit Brussel (MOBI)

Abstract

As a consequence of the growing awareness on sustainability in relation to passenger mobility and freight transport, cities encounter the need to monitor and benchmark their performance. An indicator-based evaluation framework on city level can be employed to evaluate the performance in a simple and unambiguous manner. This paper applies such a framework, based on a wide range of indicators, on a case study. The results of this case study show that the applicability of the framework depends mainly on data quality and data availability, where poor or few data hinders comparability and aggregation. To actually monitor a city's performance, time series data should be collected and a city classification can be made up for benchmarking purposes. Finally, the case study also sheds light on the quest to collect appropriate data in an inexpensive and regular way.

Keywords: sustainability – transport – mobility – logistics – evaluation framework – case study – indicators

1. Introduction

A multitude of challenges, such as the negative impacts of transport operations on society, growing environmental awareness and the long-term impact of transport infrastructure investments, illustrate the need for a (more) sustainable development of transportation systems and induce city governments to evaluate and monitor the sustainability of their city. Urban transport systems are often very complex, making ex-post and ex-ante evaluations of policy measures a challenging task. This paper describes the application of an indicator evaluation framework to a Belgian case study.

Recently, there has been an explosion of interest in the use of indicators and indexes in various domains, (see e.g. the review by Bandura, 2008), including the transport (e.g. Hermans, 2009) and sustainability domain (e.g. Mori and Christodoulou, 2012). Indicators, which represent a particular aspect of a phenomenon, and indexes, a combination of individual indicators, are in fact useful tools for policy making and communication. From literature (e.g. Litman, 2005, Hermans, 2009) it can be concluded that indicators and indexes are applied for monitoring, enabling the assessment of relative performance (compared to other entities) or the identification of trends (evolvements over time) thereby serving as a warning signal or providing useful information for target setting. Moreover, by regularly collecting indicator data, the impact of policy measures can be assessed, the progress towards targets evaluated and priorities set. Finally, communication to both experts and the general public benefits from indicators and indexes as they draw attention to particular issues or show information in a condensed way.

At various levels (i.e. national, regional, local) entities compare their own performance with a specific benchmark in order to gain insight in their relative position or evolution, learn about their weaknesses and monitor their progress. For example, within the domain of transport, countries are benchmarked in terms of their road safety performance (e.g. Bax et al., 2012) and cities regarding their mobility maturity and performance (van Audenhove et al., 2014). Within this paper, focus lies on the transport-related sustainability of cities. To preserve the liveability of urban environments, the mobility system needs to move towards sustainability. To this end, a thorough understanding and assessment of the current performance is required (Black et al., 2002; Yigitcanlar and Dur, 2010). However, given the complexity of sustainability, an extensive set of indicators is needed to represent this phenomenon.

Existing indicator frameworks often focus solely on passenger movements or urban logistics while both can clearly impact one another (Buldeo Rai et al., 2015; Rodrigue, 2006). At the European level, initiatives such as the Sustainable Urban Transport Plan (SUTP) (Van Uytven, 2014), Sustainable Urban Mobility Plan (SUMP) (Wefering et al., 2014) and Sustainable Urban Logistics Plan (SULP) (Ambrosino, 2014) aim to support urban authorities in the planning, development and implementation of transportation management. These initiatives, however, don't provide a performance assessment framework. The World Business Council for Sustainable Development (WBCSD) developed a high-level indicator set. In contrast to the indicator framework presented by Buldeo Rai et al. (2015) and van Lier et al. (2015), complex techniques are used to transform input data into indicators, making it a timely and costly practice, especially for small- and middle-sized cities (Buldeo Rai et al., 2016). Despite its comprehensiveness, the WBCSD indicator set is highly data-demanding and was found to be too complex for local communities to implement by van Lier et al. (2015). This paper uses the indicator set developed by the latter authors and applies it to a small Belgian city.

The next section briefly describes the final indicator set selection, before it is applied to the case study in section three. The case study focuses firstly on the data gathering needed to feed the indicators and secondly discusses lessons learnt for the city itself and for the future application and generalization of the indicator framework and its potential to construct an overall evaluation index.

2. Indicator framework

The indicator set proposed by Buldeo Rai et al. (2015) and van Lier et al. (2015) builds on the triple bottom line (people, planet, profit), extended by a fourth P, being policy. This implies that a transportation system should contribute to economic growth and social and environmental improvements. The policy dimension was added, to stress the potential impact of policy interventions. This framework aims to provide an index based on relatively uncomplicated, measurable and manageable sustainability indicators. The final core indicator list includes 85 indicators. An overview of the hierarchical indicator framework is shown in Figure 1. For more information on the development of the indicator framework and the indicator selection, we refer to van Lier et al. (2015). The possibility to create a composite indicator or index, based on this general indicator framework is discussed further in this paper, building on the case study findings. The proposed indicator framework does not assume data availability, nor data comparability, as no data-related compromises were made, not to miss out relevant indicators due to data gaps. The use of the indicator framework can be framed in a broader policy assessment framework that includes four methodologies that can be used for urban freight policy assessment, as discussed in Buldeo Rai et al. (2016). By analysing the indicator framework it can be assessed whether a city is moving towards increased sustainability.

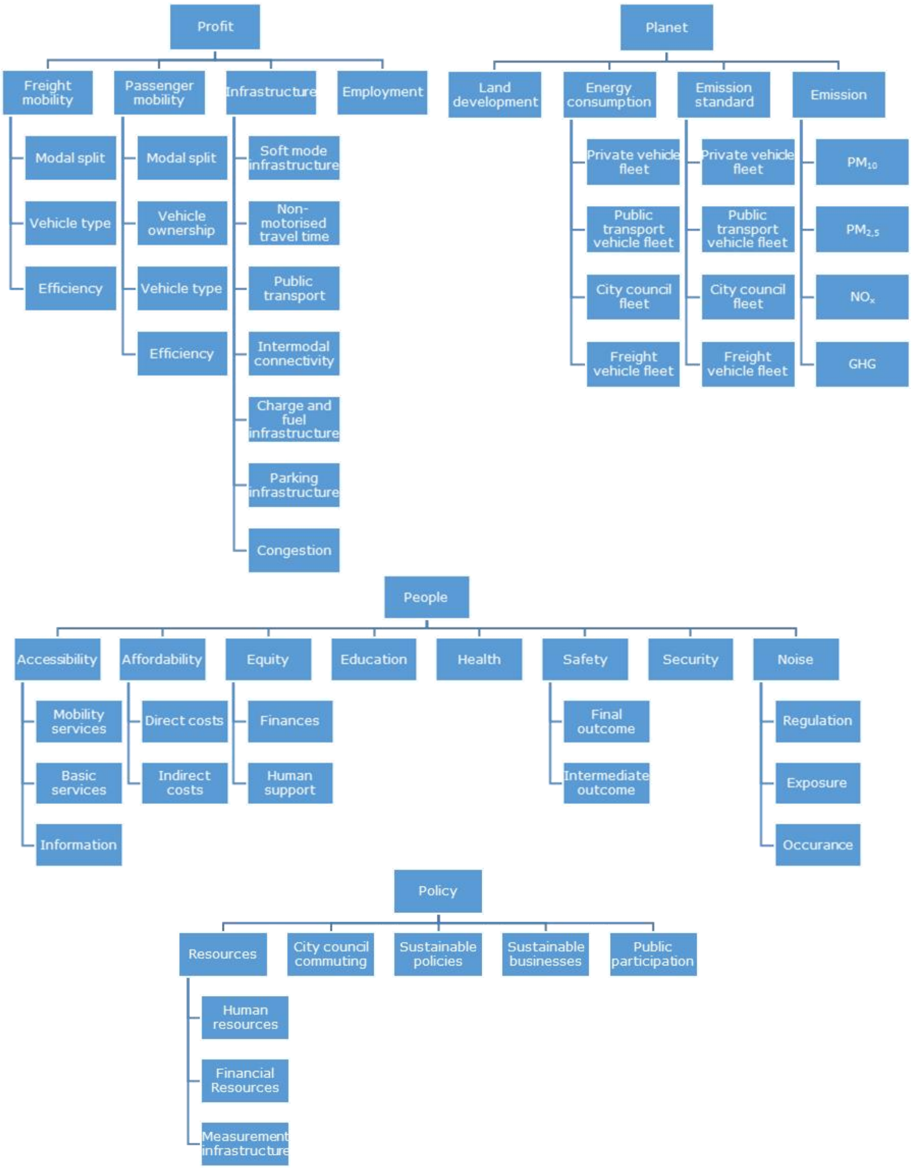

Figure 1 Four P-based indicator framework

3. Case study

The indicator framework was applied to a small Flemish city, being Deinze. The municipality of Deinze, located in the province of East Flanders, covers 76km² for just over 30.000 inhabitants. Regarding transport infrastructure, the city is located close to the E17 highway and the river Lys runs through it. The basis for the case study was elaborated in the work of Jacobs (2016) and extended in this paper. The city was chosen for its scale and for the fact that the city authorities were cooperative in providing data.

3.1. Case specific results

To fill out the indicator framework, different governmental and private agencies were contacted to gather as much raw input data as needed. Out of the 85 indicators in the framework, only 38 could nevertheless be completed for Deinze. An additional 8 could partly be filled in or a proxy-indicator could be formulated. The scarce data availability is not surprising, as for the creation of the indicator framework data availability was not considered, not to exclude relevant indicators. Some of the lacking input data are currently not collected or the data are not shared by the agency collecting the data.

Different issues can be raised in relation to the quality of the raw data gathered to feed the indicator framework. Some input data are collected on a regular basis, which allows to easily make comparisons over time. Other input data are, however, collected irregularly or only case-based. The data collected in this case, therefore only allow to sketch an incomplete image of the city's performance. A second problem in the data collection relates to the geographical level for which the data are representative. The different agencies (city, public transport operators, police…) collecting data often do this for their operating ranges only, which often are not the same. Therefore some data are aggregated for the regions in which Deinze is located, while others account for the city centre itself. A third issue relates to the reference year of the data source. As mentioned, not all agencies collect the relevant data on a regular basis, leading to a dataset with data from different years, making it near to impossible to identify trends. Fourthly, some data are collected by Jacobs (2016) with limited resources and time, but clearly not all data can be collected 'on the field'. The table below gives an overview of the collected indicators with respect to Deinze. Indicators indicated in green were calculated based on the collected input data and are used to discuss opportunities in terms of constructing a transport-related sustainability index (see section 3.3). The indicators depicted in orange are incomplete and data on indicators depicted in red could not be collected.

Table 1 Policy indicators for Deinze

Indicator	**Value**	**Source + reference year**
Human resources – Mobility FTEs	12.5%. Measured only for city council members.	City of Deinze - 2016
Human resources – Freight mobility FTEs	0%. Measured only for city council members.	City of Deinze - 2016
Financial resources – Internal	23%.	City of Deinze - 2015
Financial resources – External		
Measurement infrastructure – Emissions	0.	City of Deinze – 2016
Measurement infrastructure – Noise	0.	City of Deinze – 2016
City council commuting	80%.	City of Deinze – 2016
Sustainable policies		
Sustainable businesses		
Public participation	0.1%.	City of Deinze – 2016

Table 2 Profit indicators for Deinze

Indicator	Value	Source + reference year
Modal split (F)		
Vehicle type (F)		
Efficiency (F) – Loading rate (volume)		
Efficiency (F) – Loading rate (weight)		
Modal split (P) – Share alternative modes		
Vehicle ownership (P) – Private car	51.4%.	City profile - 2015
Vehicle ownership (P) – Company car		
Vehicle type (P) – Private car		
Vehicle type (P) – Company car		
Efficiency (P)		
Soft mode infrastructure – Network coverage	23%. Cycling infrastructure versus road infrastructure.	City of Deinze - 2016
Soft mode infrastructure – Maintenance		
(Non-)motorised travel time – Walking	325%. Data for two 'representative routes'	GoogleMaps - 2016
(Non-)motorised travel time – Cycling	108%. Data for two 'representative routes'.	GoogleMaps - 2016
Public transport – Seats		
Public transport – Services	6.7. 4.9 trains and 8.4 buses.	De Lijn and NMBS - 2016
Public transport – System performance (on-time services)	77%. Buses only.	De Lijn - 2016
Public transport – System performance (occupancy rate)		
Public transport – Network coverage		
Public transport – Vehicle type	0%. Buses only.	De Lijn - 2016
Intermodal connectivity - Passenger facilities		
Intermodal connectivity - Freight facilities	0%. None.	City of Deinze - 2016
Charge and fuel infrastructure	12.5%.	Oplaadpunten.org and Gouden Gids - 2016
Parking infrastructure - Bicycle	21%.	Jacobs - 2016
Parking infrastructure - Park & Ride (P&R)		
Parking infrastructure - (Un)loading	0%. (none)	City of Deinze - 2016
Congestion - (Off-)peak travel time	30.4%. 6.7% in morning peak, 54.1% in evening peak for 'representative route'.	GoogleMaps - 2016
Congestion - Off-peak system performance		
Congestion - Length		
Congestion - Intensity		
Employment		

F=Freight; P=Passenger

Table 3 People indicators for Deinze

Indicator	Value	Source + reference year
Mobility services - Walking distance		
Mobility services - Facilities		
Basic services		
Information - Transport node (A)	6.3%. Only in train station, not in bus stops.	Jacobs - 2016
Information - Transport node (V)	100%. Present in train station and bus stops, but only one dynamic in bus stop.	Jacobs - 2016
Information - Pedestrian crossing node (A)	13.6% Traffic lights with signal.	Jacobs - 2016
Information - Pedestrian crossing node (V)	28.4%. Share of crossings with 'studded tiles'.	Jacobs - 2016
Information - Transport vehicle (A)	0% of buses. No train data.	De Lijn - 2016
Information - Transport vehicle (V)	0% of buses. No train data.	De Lijn - 2016
Direct costs		
Indirect costs		
Finances		
Human support		
Education	17%. 'Mobility education' is organised by city and police (Might be overestimations as non-inhabitants can also attend).	City of Deinze - 2016
Health		
Final outcome - Accidents	0.48%.	Lokale statistieken - 2014
Final outcome - Freight related accidents	9.66%.	Police - 2014
Final outcome - Fatalities	0.01%. 2 fatalities.	Lokale statistieken - 2014
Final outcome - Injuries	0.61%. 161 slightly injured, 13 severely wounded.	Lokale statistieken - 2014
Intermediate outcome - Safety violations (alcohol and drugs)	4.06%.	Police - 2015
Intermediate outcome - Safety violations (speed)	1.31%.	Police - 2015
Intermediate outcome - Safety violations (protective systems)		
Intermediate outcome - Vehicle assessment		
Intermediate outcome - Emergency services	5.4min. 6.3min. for paramedics, 4.5min. for the fire dpt.	Data hospital – 2013, Fire Dpt. - 2016
Security		
Regulation – Passenger vehicles		
Regulation – Freight vehicles		
Exposure – Lden		
Exposure – Lnight		
Occurance - Lden	100%.	Flemish authorities - 2016
Occurance - Lnight	100%.	Flemish authorities - 2016

A=auditory; V=Visual

Table 4 Planet indicators for Deinze

Indicator	Value	Source + reference year
Land development		
Energy consumption - Private vehicle fleet		
Energy consumption - Public transport vehicle fleet	1.633MJ/100km for buses. Train data not available.	De Lijn - 2015
Energy consumption - City council vehicle fleet		
Energy consumption - Freight vehicle fleet		
Emission standard - Private vehicle fleet		
Emission standard - Public transport vehicle fleet	71% of the buses have EURO4 or better.	De Lijn - 2016
Emission standard - City council vehicle fleet		
Emission standard - Freight vehicle fleet		
Emission - PM_{10}	8 days. Based on hourly interpolation for whole of Belgium (4x4km raster).	IRCEL - 2014
Emission - $PM_{2,5}$		
Emission - NO_x		
Emission - GHG		

The indicator set that was gathered for Deinze can serve only as a baseline scenario for the future, as no time series were collected. When similar data can be collected in the future, trends could possibly be found indicating (behavioural) changes due to policies. A first analysis of the currently collected results was already performed by Jacobs (2016). Here, we discuss some insights on data availability from analysing the tables above. The content of the tables is discussed, following the 4 P subdivision.

In the profit category, almost half of the required indicator data could be gathered. Most data that could be acquired relates to indicators on public transport and infrastructure. Only few operational indicators could be calculated, based on real-time information of, for instance, GoogleMaps. Although it seems that for the indicators related to congestion, it is difficult to acquire input data and calculate the final indicators. The table also suggests that it is easier to obtain indicators related to passenger transport than those related to freight transport. This is not surprising as cars are linked to households, while freight vehicles are linked to companies that can operate from different locations. Indicators that were particularly hard to obtain relate to the modal split and to the efficiency of vehicles. There is a big data gap in fleet-specific information, particularly in relation to vehicle usage.

In the planet category, only three indicators could be calculated. Based on this single case study it is difficult to explain why this is the case. The indicators related to (transport) emissions require dedicated measurement infrastructure which is non-existent in a small city such as Deinze. Only for PM_{10} an estimate can be given, based on data interpolations from other measurement stations. Regarding energy consumption and the emission standard of vehicles, only data from public transport operators could be obtained. Obviously, estimating the energy consumption for the complete private and freight vehicle fleets is challenging.

The policy category is the one where the highest share of indicators could be calculated. The major reason for this might not in the least be the good cooperation that was provided by the city authorities to the research and data collection of Jacobs (2016). The lacking indicators mainly relate to the businesses in the city. Also in the people category, more than half of the indicators could be calculated. The indicator values that could be listed mainly relate to two indicator categories, being information on accessibility and safety. Data on the latter is consistently gathered by authorities, while information on the former can easily be gathered by field work or from the transport service providers.

3.2. Challenges in data collection

Besides the lessons learnt by applying the suggested indicator framework to the case of Deinze, also more general findings could be derived from the case study. Difficulties in data collection arose when data where not publicly available. If the data existed though, it was challenging to find the right agency (and the right person within) to acquire the required input. In some cases, these data are sensitive and not easily shared, an example here is the occupancy rate of public transport vehicles (Jacobs, 2016). Much depends upon the goodwill of the organization owning the data. As a central data platform is lacking, contacting different agencies can be a time-consuming business.

A second challenge relates to incomparable datasets. An example is the aggregation of data on different geographical levels. As mentioned, these aggregation levels often relate to the operational (geographical) area that a specific agency or data manager is responsible for. Therefore, some datasets represent the municipality of Deinze as such, while others represent a greater area (e.g. the local police of Deinze and Zulte cooperate). As is clear from the tables above, also the reference year of the different indicators varies between 2013 and 2016. A better benchmark would consist of data from the same reference year, preferably as recent as possible. Some data are, however, not measured on a yearly basis (e.g. a one-time survey conducted in Deinze in 2012 on inter alia modal choice).

A third category of input data relates to data which is currently not measured. Data gathering is often both time consuming and costly. To feed other indicators, specific analytical skills are required to transform input data into indicators, as the examples of the indicators related to mobility- and basic services, which require spatial analysis, prove. Lacking data can be completed by bottom-up solutions, which become increasingly available through for instance smart phones. Inhabitants could (help to) collect data regarding infrastructure (e.g. available parking spaces on a spot), noise (Maisonneuve et al., 2009) etc.

Finally, as stated before, an incomplete framework is not a waste of energy as the analysis of Jacobs (2016) already proves. An analysis of the (incomplete) indicator framework is a good starting point for the broader evaluation of a city's performance and can still help in identifying bottlenecks and potential solutions.

3.3. A next step in terms of indicator data analysis: an aggregated index

The data values mentioned in the tables above give an up-to-date indication on the performance of Deinze regarding its transport-related sustainability. Given that data of only 1 city is available, no benchmarking or relative comparison between cities is possible. However, results from similar data collection efforts for the indicator set in the future, can be compared to the current indicator data to identify progress/decline per indicator. We discuss a number of methodological issues that might arise when one wants to draw conclusions at a more aggregated level, rather than per indicator. In this respect, the combination or aggregation of several indicators in an index is an interesting topic to pay attention to. Given the limited data set, some illustrations are given; the actual computation of a transport-related sustainability index score for the city of Deinze is left outside the scope of this paper.

The process of combining indicators consists of several steps. The theoretical framework needs to be developed, appropriate indicators selected and data collected. These steps have been described above. Next, the indicator data needs to be processed, followed by weighting and aggregation into an index. For detailed methodological insights we refer to Hermans (2009) and Shen and Hermans (2016). Below, we provide an answer to a number of issues that occur during the index process and illustrate this by means of the collected sustainability data for Deinze.

Why carefully considering the direction of each indicator?

It is essential to stress the importance of putting the indicators that will be combined in an index in the same direction. Otherwise, the index value cannot be interpreted in the right way. Bearing the overall objective of more sustainability in mind, an index value should be as high as possible. For each indicator, it needs to be decided whether its direction is positive (i.e. the higher the indicator value, the more sustainable) or negative (i.e. a lower indicator value implying more sustainability). When we look at the policy indicators mentioned above, it can be concluded that they are all in the same, positive, direction. A higher value on each policy indicator should be aimed at. In this case, no data transformation is needed when developing a policy index. On the contrary, the other three categories mix positive and negative indicators; while energy consumption and emissions should be minimized, the indicators on emission standard are to be maximized. In the data processing step, actions should be taken to render all indicators in the same direction.

How to neutralise the unit, scale and direction of indicators?

Each indicator is defined in its own way, expressed in a particular unit and has a positive or negative link with sustainability. In order to create a useful and interpretable index (e.g. with a range between 0 and 1 with a higher value to be aimed at), it is interesting to perform some so-called normalisation on the raw indicator values. A common normalisation technique is rescaling in which the raw indicator values are transformed into normalised values varying between 0 and 1 (Organization for Economic Co-operation and Development, 2008). The maximum value of an indicator over all cities is rescaled to become 1 while the city with the lowest indicator value now receives a transformed indicator value of 0. All values in between are proportionately adapted. In case of a negative direction with sustainability, the city with the lowest indicator value should receive a transformed value of 1 and the one with the highest (most unsustainable) indicator value obtains a score of 0.

Almost all indicators are expressed in a relative way, as a ratio (e.g. number of registered cars versus the number of inhabitants) or share (e.g. freight related accidents versus total accidents). However, the indicator values still differ in magnitude and range, which could bias the index value (e.g. larger indicator values dominating the index score). To illustrate, the current value for (non-)motorised travel time – walking is 325% while that of soft mode infrastructure – network coverage equals 23%. When combining indicators, it is good to start from an equalized set of values, all ranging between 0 and 1 for example. To perform normalisation, a set of cities of time-series data is needed.

What to do with incomplete datasets?

Given that an extensive set of transport-related sustainability indicators has been identified, data collection requires considerable efforts. Still, it is possible that an amount of the information is missing (due to various reasons listed above). In case an indicator has a missing value for a particular city, but is considered to be a key component of the index, imputation might be a possibility rather than deleting the indicator with missing values. In the past, a variety of imputation techniques has been proposed, ranging from very simple to extremely complex ones (see e.g. Howell, 2008; Wilmots et al., 2011). Without going into detail regarding possible techniques, it might be possible, through software, to obtain an estimate for a missing indicator value. This estimate is based on other input data (available indicator values of the city as well as the more extensive indicator values of other cities in the data set). For the case of Deinze, the 8 indicators depicted in orange could be further studied to see if a good estimate can be obtained. Again, data from other cities will reveal valuable information in this respect.

How to weigh the indicators?

After processing the indicator values (see previous paragraphs), the next step in the creation of an index is deciding on the weights to assign to each indicator. In general, the weight of an indicator represents its importance. The decision on which indicator is more important and should therefore receive a higher weight in the index, can be challenging. Often used weighting approaches are: equal weighting (each indicator is given the same weight), participatory methods such as budget allocation (in which experts are asked to distribute a budget over the different indicators from which the relative weights are then computed) and statistical methods (such as principal components analysis and data envelopment analysis (see e.g. Organization for Economic Co-operation and Development, 2008). Each method has its strengths and limitations (Hermans et al., 2008). Within this context, the layered structure should be considered, i.e. all aspects at the first level of the hierarchy are important and should be represented in the index (e.g. all 8 aspects for the people-index). The question of how much variation in weight between these aspects is acceptable could be assessed by an expert panel.

How to aggregate in an index?

The aggregation determines the mathematical operation of combining the weighted indicator values. In general, linear or geometric aggregation is considered. In this case, a geometric aggregation method is better suited because some degree of non-compensability between indicator values is required (Shen and Hermans, 2016). Again, illustrating by the people-index, a city with a bad score on safety but a good score on noise ideally receives a lower index score than a city with an average score on both aspects. In other words, the index should reward cities which score sufficient on all aspects rather than an excellent score on one dimension compensating for bad scores on other aspects.

4. Conclusions and recommendations

This paper discussed how an indicator-based evaluation framework can be used to disentangle the transport-related sustainability of cities. The indicator set, discussed in Buldeo Rai et al. (2015) and van Lier et al. (2015), is finalised and applied to a case study. Even though the set consists of straightforward indicators, only 38 out of 85 indicators could be calculated for the case of Deinze, using available input data. Next, this paper discussed challenges in data collection and proposed some possibilities for data collection that can be applied in small and medium sized cities. This paper also suggested a number of methodological aspects to take into account when creating an index. That way, the performance of a city can be presented in a number of key index values such as a score on the profit, planet, people and policy dimension of transport related sustainability.

As an extension of this work, the framework could be applied to other case studies to benchmark the performance of Deinze. The selection of 'good' benchmarking partners of course affects the outcome. Therefore, a classification could be made of 'similar' cities, e.g. in terms of scale in order to suggest policy actions that are probably realistic enough to serve as an example for less performing cities. A comparison between the indicator values of cities reveals interesting insights. In addition, opportunities for further data collection could be researched per indicator.

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Appendix: detailed indicator set

PROFIT

Sub-category	Indicator-category	Sub-indicator	Definition
Freight mobility	Modal split		Tkm non-road modes vs. total tkm
	Vehicle type		Tkm low/non emission vans/trucks vs. total tkm vans/trucks
	Efficiency	Loading rate (volume)	Av. % volume utilisation when entering the city
		Loading rate (weight)	Av. % weight utilisation when entering the city
Passenger mobility	Modal split	Share alternative modes	Pkm by alternative modes vs. total pkm
	Vehicle ownership	Private car	Registered cars vs. number of inhabitants
		Company car	Registered company cars vs. number of inhabitants
	Vehicle type	Private car	Alternative private cars vs. total private cars
		Company car	Alternative company cars vs. total company cars
	Efficiency		Av. % utilisation when entering/leaving the city
Infrastructure	Soft mode infrastructure	Network coverage	Km soft mode transport tracks vs km total transport tracks
		Maintenance	Km obstacle-free soft mode transport tracks vs. total soft mode transport tracks
	(Non-)motorised travel time	Walking	Av. walking time between two nodes vs. av. time with private car
		Cycling	Av. cycling time between two nodes vs. av. time with private car
	Public transport (PT)	Seats	PT seat-km vs. number of inhabitants
		Services	Av. number of services per hour during regular service (06:00-22:00) vs. total number of inhabitants
		System performance (on-time services)	Av. excess travel time (min) due to delay vs. total pkm
		System performance (occupancy rate)	Av. % utilisation of available capacity
		Network coverage	Km PT tracks vs. km total motorised transport tracks
		Vehicle type	Alternative PT vehicles vs total PT vehicles
	Intermodal connectivity	Passenger facilities	Intermodal passenger facilities vs. total passenger facilities
		Freight facilities	Intermodal freight facilities vs. total freight facilities
	Charge and fuel infrastructure		Alternative charging/fuel stations vs. total fuel stations
	Parking infrastructure	Bicycle	Bicycle parking spots vs. total number of inhabitants
		Park & Ride (P&R)	P&R car parking spaces vs. total car parking spaces
		(Un)loading	Km² for temporary (un)loading activities vs. km² commercial space
	Congestion	(Off-)peak travel time	Av. difference speed during peak and off-peak on representative corridors
		Off-peak system performance	Av. difference speed during off-peak and free flow on representative corridors
		Length	Av. km congestion on daily peak vs. total km motorised transport tracks
		Intensity	Av. daily congestion length x congestion duration
Employment			Jobs created by sustainable urban transport sector vs. total jobs in urban transport

PLANET

Sub-category	Indicator-category	Definition
Land development		Transport infrastructure developments on brownfield vs. total number of transport infrastructure developments
Energy consumption	Private vehicle fleet	Av. energy consumption of private vehicles and company cars registered (Mj per 100 km)
	Public transport vehicle fleet	Av. energy consumption of public transport vehicles (Mj per 100 km)
	City council vehicle fleet	Av. energy consumption of city council vehicles (Mj per 100 km)
	Freight vehicle fleet	Av. energy consumption of freight vehicles registered (Mj per 100 km)
Emission standard	Private vehicle fleet	Private vehicles and company cars with one of the two latest EURO emission standard vs. total private vehicles
	Public transport vehicle fleet	PT vehicles with one of the two latest EURO emission standard vs. total PT vehicles
	City council vehicle fleet	City council vehicles with one of the two latest EURO emission standard vs. total city council vehicles
	Freight vehicle fleet	Freight vehicles with one of the two latest EURO emission standard vs. total freight vehicles
Emission	PM_{10}	Days with average PM_{10} values higher than 40µg/m³ vs. total days (normalized by the number of measurement stations (exceeded))
	$PM_{2,5}$	Days with average $PM_{2,5}$ values higher than 25µg/m³ vs. total days (normalized by the number of measurement stations (exceeded))
	NO_x	Days with average NO_x values higher than 40µg/m³ vs. total days (normalized by the number of measurement stations (exceeded))
	GHG	Tonnes of CO_2-equivalent units vs. total vehicle-km

PEOPLE

Sub-category	Indicator-category	Sub-indicator	Definition
Accessibility	Mobility services	Walking distance	Households within walking distance of mobility service vs. total households
		Facilities	PT vehicles with facilities for disabled and pregnant persons vs. total PT vehicles
	Basic services		Average presence (value 1) or not (value 0) of out of 10 spatial functions related to basic & daily activities except for work in grids of 1 km x 1 km (WBCSD, 2015) vs. total inhabitants
	Information	Transport node (auditory)	Auditory information accessible on transport node for disabled PT users vs. total PT nodes
		Transport node (visual)	Visual information accessible on transport node for disabled PT users vs. total PT nodes
		Pedestrian crossing node (auditory)	Auditory information accessible on pedestrian crossing node for disabled infrastructure users vs. total pedestrian crossing nodes
		Pedestrian crossing node (visual)	Visual information accessible on pedestrian crossing node for disabled infrastructure users vs. total pedestrian crossing nodes
		Transport vehicle (auditory)	Auditory information accessible on transport vehicle for disabled PT users vs. total PT vehicles
		Transport vehicle (visual)	Visual information accessible on transport vehicle for disabled public transport users vs. total public transport vehicles
Affordability	Direct costs		Av. budget allocated to transport vs. total household budget
	Indirect costs		Av. daily time spent on non-recreational transport vs. total time
Equity	Finances		Share of the public transport cost for fulfilling basic activities of the household budget for the poorest 25th percentile of the population (WBCSD, 2015)
	Human support		Persons with disabilities assisted with initiatives supported by the city council vs. total inhabitants with disabilities
Education			Inhabitants reached with programmes provided to strengthen mobility knowledge and skills vs. total inhabitants
Health			Inhabitants registered with a transport-related disease vs. total inhabitants
Safety	Final outcome	Accidents	Accidents vs. total inhabitants
		Freight related accidents	Freight-related accidents vs. total accidents
		Fatalities	Traffic-related fatalities vs. total inhabitants
		Injuries	Traffic-related injuries vs. total inhabitants
	Intermediate outcome	Safety violations (alcohol and drugs)	Drivers testing positive on alcohol or drug use vs. total drivers tested
		Safety violations (speed)	Speed limit offenders vs. total tested
		Safety violations (protective systems)	Vehicles without protective systems vs. total vehicles controlled
		Vehicle assessment	Vehicles registered Euroncap 4 or 5 vs. total vehicles registered
		Emergency services	Av. response time
Security			Reported transport-related crimes and incidents vs. total vehicles in the city
Noise	Regulation	Passenger vehicles	Vehicles registered within EU noise standards vs. total vehicles
		Freight vehicles	Freight vehicles registered within EU noise standards vs. total freight vehicles

Exposure	Lden	Inhabitants exposed to Lden noise levels higher than 55dB vs. total inhabitants
	Lnight	Inhabitants exposed to Lnight noise levels higher than 55dB vs. total inhabitants
Occurance	Lden	Road length with Lden noise levels higher than 55dB vs. total road length
	Lnight	Road length with Lnight noise levels higher than 55dB vs. total road length

POLICY

Sub-category	Indicator-category	Sub-indicator	Definition
Resources	Human resources	Mobility FTEs	FTEs regarding passenger mobility vs. total FTEs
		Freight mobility FTEs	FTEs regarding freight mobility vs. total FTEs
	Financial resources	Internal	Budget for sustainable mobility projects vs. total mobility budget
		External	External budget for sustainable mobility projects vs. sustainable mobility budget
	Measurement infrastructure	Emission	Measurement infrastructure stations where emission values are measured
		Noise	Measurement infrastructure stations where noise values are measured
City council commuting			Staff-members using sustainable modes vs. total staff-members for work-commute
Sustainable policies			Compliance of Sustainable Urban Mobility Plan with 7 EU-defined standards (1 standard applied = 14%)
Sustainable businesses			Businesses with certification ISO 14001 or EMAS vs. total businesses
Public participation			Rate of participation in public hearings.