Sheffield University Management School.

Promoting **S**ustainable **F**reight **T**ransport in Urban Contexts:
Policy and Decision-Making Approaches

Sustainability Indicators for Urban Freight Transport

An Analysis in Sheffield, UK

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Outline

1. Introduction
2. Material and methods
3. A proposal of indicators for sustainable UFT
4. Further steps
5. Conclusions

1. Introduction

- Developed as a part of secondment activities by SRL (UEx) at the SCC (June-July 2019)
- A joint collaboration with SEERC to search solutions to urban freight issues in the city of Sheffield.
- Work in-progress

1. Introduction

- Transportation and delivery of goods constitutes a vital component for most economic and social activities taking place in urban areas.
- Urban Freight Transport (UFT) is not only essential for economic growth but also for better urban environment.
- UFT is broadly defined as encompassing "*all movements of goods (as distinct from people) into, out of, through or within the urban area made by light or heavy goods vehicles. Also included are service vehicle movements (refuse collection, utilities, etc.) and demolition/construction traffic*" (Ballantyne et al., 2013).

1. Introduction

- Due to globalisation, e-commerce, and population and employment growth, freight volumes are increasing.
- However, freight in cities is unpopular because of its negative impact on citizens, namely congestion, emissions, safety and noise (Zunder et al., 2016).
- UFT plays a crucial role in the economic welfare of cities (stock replenishment, good deliveries, waste management, etc.), but also has a number of negative effects.

1. Introduction

Sustainable UTF can be a solution to:

- **Environmental issues:**
  - Air quality
  - Greenhouse gas emissions
  - Noise pollution
- **Social issues:**
  - Road congestion
  - Safety and intimidation
- **Economic issues:**
  - Economic losses due to delivery delays
  - Inefficiency for carriers due to regulations and restrictions
  - Lower customer service level

1. Introduction

- Many measures have been proposed aiming at reducing the negative effects of freight transport in cities:
  - Russo & Comi (2011)
  - Lindholm (2013)
  - Creazza, *et al.* (2014)
  - De Marco, *et al.* (2018)

1. Introduction

- "*An issue not clearly defined and measured is also considered difficult to be improved*" (Böhringer & Jochem, 2007), so
- In order to evaluate UFT measures performance, suitable indicators are needed .
- Actually, there is a wide consensus on the role that sustainability indicators play to monitor improvement and to gauge progress in reaching established goals and government policies (Munier, 2011)

1. Introduction

- The aim of this report is to describe a set of indicators for UFT in order to provide policy-makers with a valuable tool for measuring and evaluating their strategies on this issue.
- Under the umbrella of the ProSFeT project, this report is focused on the specific context of the urban area of the city of Sheffield (UK), although the methodological procedure and the set of indicators might be utilised in other similar urban contexts

2. Material and methods

- According to ISO (2018), *"indicators are by definition quantitative, qualitative or descriptive measures that enable information on a complex phenomenon, such as the dynamic urban environment, to be simplified into a form that is relatively easy to use and understand"*.
- How to evaluate, monitor and assess urban transport measures has been widely researched (Lindholm, 2013).

2. Material and methods

- The academic literature on indicators is wide and deep, as indicators can be applied to many different fields of research.
- According to Parris and Kates (2003), more than 500 sustainable indicator efforts can be observed in the literature, of which almost 300 have an urban scope.
- Other authors, such as Munier (2011), confirms that figure, and some researchers estimate that their number is not finite (Zavadskas et al., 2007).

2. Material and methods

REFERENCES	MAIN CONTRIBUTIONS
Lindholm (2013)	UFT indicators defined in terms of accessibility, environment, costs, life quality, and delivery characteristics.
Buldeo Rai, et al. (2017)	A set of 45 indicators based on four pillars (profit, planet, people and policy) are formulated in fourteen sub-categories, divided in twenty-four sub-indicators.
De Marco, et al. (2018)	A set of City Logistics Indices (CLI) used as indicators of the breadth and number of City Logistics measures implemented in a city.
Sdoukopoulos, et al. (2019)	Main characteristics of UFT indicators: progress over time, provide valuable information, enable to make comparisons among different areas, be accessible, transparent, accurate, and scientifically produced.
Huovila, et al. (2019)	Based on an input-process-output structure, a classification of smart sustainable city indicators is provided.

Table 1: Some recent papers on UFT indicators

2. Material and methods

- Obviously, UFT indicators need to be integrated into a UFT strategy defined accordingly to the, possibly conflicting, interest of different stakeholders: city administrators, freight carriers and shippers, and residents.
- In a similar way, the identification of UFT indicators should also consider the stakeholders' differing interest.

3. A proposal of indicators for SUFT

- The proposal for this report is based on two previous set of indicators developed by BESTUFS (2006) and Buldeo Rai et al. (2018).
- These indicators are based on the triple bottom line of sustainability (3 P's): economic (profit), environmental (planet), social (people).
- As these pillars are generally accepted in the development of indicator systems for urban sustainability (Huovila et al., 2019), they are used in this report for delivering a proposal for UFT indicators.

3. A proposal of indicators for SUFT

	SUB-CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
ECONOMIC	FREIGHT TRANSPORT	MODAL SPLIT	Modal split	tkm non-road modes vs total tkm
		VEHICLE TYPE	Vehicle type	tkm low/non-emission truck/van vs total tkm trucks/van
		EFFICIENCY	Loading rate	Avg. % volume uilisation when entering the city Avg. % weight uilisation when entering the city
	INFRASTRUCTURE	SOFT MODE INFRASTRUCTURE	Network coverage Maintenance (Non-) motorised travel time	km soft mode transport tracks vs total km transport tracks km obstacle-free soft mode transport tracks vs total soft mode transport track Avg. Cycling time between two nodes vs Avg. Time with private car
		INTERMODAL CONNECTIVITY	Freight facilities	Intermodal freight facilities vs total freight facilities
		CHARGE AND FUEL INFRASTRUCTURE	Charge and fuel infrastructure	Alternative charging/fuel stations vs total fuel stations
		PARKING INFRASTRUCTURE	(un) loading	km2 for temporary (un) loading activities vs km2 commercial spaces
		CONGESTION	(Off) peak travel time Off-peak system performance Length Intensity	Avg. Difference speed during peak and off-peak on representative corridors Avg. Difference speed during off-peak ad free flow on representative corridors Avg. Km congestion on daily peak vs. Total km motorised transport tracks Avg. Daily congestion length x congestion duration
	EMPLOYMENT	EMPLOYMENT	Employment	Jobs created by sustainable urban transport sector vs total jobs in urban transport

Table 2: Economic indicators (Adapted from Buldeo Rai, et al., 2018)

3. A proposal of indicators for SUFT

	SUB-CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
ENVIRONMENTAL	LAND DEVELOPMENT	LAND DEVELOPMENT	Land development	Transport infrastructure developments on brownfield vs total number of transport infrastructure
	ENERGY CONSUMPTION	CITY COUNCIL VEHICLE FLEET	Energy consumption of CC vehicles	Avg. Energy consumption of city council vehicles (Mj per 100 km)
		FREIGHT VEHICLE FLEET	Energy consumption of freight vehicles	Avg. Energy consumption of freight vehicles registered (Mj per 100 km)
	EMISSION STANDARD	CITY COUNCIL VEHICLE FLEET	Emissions CC vehicles	City council vehicles with one of the two latest EURO emission standards vs total city council vehicles
		FREIGHT VEHICLE FLEET	Emissions freight vehicles	Freight vehicles with one of the two latest EURO emission standards vs total freight vehicles
	EMISSION	PM_{10}	PM10 emissions	Days with PM10 values higher than 40 μg/m3 vs total days (normalised by the number of measurement stations)
		$PM_{2.5}$	PM2.5 emissions	Days with PM2.5 values higher than 25 μg/m3 vs total days (normalised by the number of measurement stations)
		NO_X	NOx emissions	Days with NOx values higher than 40 μg/m3 vs total days (normalised by the number of measurement stations)
		GREENHOUSE GAS EMISSIONS	GHG emissions	Tonnes of CO2 equivalent units vs total vehicle-km

Table 3: Environmental indicators (Adapted from Buldeo Rai, et al., 2018)

3. A proposal of indicators for SUFT

	SUB-CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
SOCIAL	SAFETY	FINAL OUTCOME	Accidents	Traffic 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
	SECURITY	SECURITY	UFT security	Reported transport-related crimes and incident vs total vehicles in the city
	NOISE	REGULATION	Noise standard	Freight vehicles registered within EU noise standards vs total freight vehicles
		EXPOSURE	Noise exposure	Inhabitants exposed to levels of noise higher than 55 dB vs total inhabitants
		OCCURRENCE	Noise level	Road length with noise level higher than 55 dB vs total road length

Table 4: Social indicators (Adapted from Buldeo Rai, et al., 2018)

3. A proposal of indicators for SUFT

	IMPACT CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
ECONOMIC	FREIGHT VOLUMES AND COMMODITIES IN URBAN AREAS	TRANSPORT DEMAND	Volumes Transported in Urban Areas	Amount of goods transported into urban areas (thousand tonnes)
		LOGISTICS	Good receivers	Type of good receivers. Case specific.
			Logistics costs	% on sales
			Share of urban transport cost compared to total SC	% on total costs
			Salaries in urban freight transport	% on sales; % on total logistics costs
		POPULATION	Population density	Persons/km2
			Share of population in urbanised areas	% on total population
			Household size	Average number of persons per private household
	URBAN FREIGHT TRANSPORT FLEET	FREIGHT VEHICLES	Number of vehicles according to GVW and age	Number and % on the total (LGV, HGV). Age in number of years
			Proportion of goods vehicles in total traffic	LGV and HGV as % of all motor vehicles
			Ownership of vehicles	Public haulage vs own account transport
			Vehicles operating in cities	% on the total. % of each type of vehicle by receiver's sector
		URBAN TRAFFIC FLOW	Number of vehicles entering the cities	Number (%) classified by vehicle type (LGV, HGV, …)
			Distribution of freight vehicles movements over the day	% of vehicle type in use by time of day
		SERVICE VISITS & WASTE COLLECTION	Service visits	Number of service visits and mean dwell time (minutes) by type of service visit
			Waste collection	Number of waste collection services used by premise; Number of vehicle trips per week to the premises to collect waste
		PERFORMANCE	Freight vehicles kilometres/miles	Number of vehicle kilometers/miles (by vehicle type)
			Use of load capacity	Load factor (by vehicle type)

Table 5: Economic indicators I (Adapted from BESTUFS II, 2006)

3. A proposal of indicators for SUFT

	IMPACT CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
ECONOMIC	URBAN DELIVERIES	GENERAL DELIVERIES CHARACTERISTICS. OPERATORS.	Combined shipments	% of combined shipment (by type of haulier: own account, 3rd party, …)
			Delivery days and times	% on the total by day and type of goods sector (Food, Non food, HoReCa, Clothes)
			Regularity of trips	% trips daily, weekly, occasionally
			Origin of delivery trips	% of trips by type of origin (within/out the city; UCC, non-permanent collection/distribution)
			Number of stops per tour, per day	% on total by type of vehicle, by type of goods sector, etc.
			Trip length	km/miles per trip by vehicle type
			Distance between shops	Average distance between stops by owner type and vehicle type
			Trip times	Average trip times by vehicle type (hours, minutes)
			Travel time to and within the city centre	Average travel time from city border to first destination; Average travel time in city centre
		GENERAL DELIVERIES CHARACTERISTICS. RECEIVERS	Deliveries at premises	Distribution (%) of the establishments, employment and deliveries / pick-ups by activity
			Dwelling time in urban areas	Mean dwell time (minutes) by business type, by vehicle type
			Loading and unloading times	Mean loading/unloading time (minutes) by vehicle type, by business type
		HOME DELIVERY	Home delivery services offered by shops	Number (%) of shops offering home delivery services by type of business
			Number of km/mile covered by inhabitant	Number (%) of km/miles covered per inhbitant for urban freight purposes
	CONTRIBUTION TO ECONOMY	EMPLOYMENT IN TRANSPORT & LOGISTICS	Number of jobs in transport	Number of freight transport employees
			Number of transport related companies	Number of freight transport companies

Table 6: Economic indicators II (Adapted from BESTUFS II, 2006)

3. A proposal of indicators for SUFT

	IMPACT CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
ENVIRONMENTAL	ENVIRONMENT	ENERGY USE	Typical fuel consumption by vehicle type	Typical fuel consumption in liters per 100 km (by vehicle type); Average fuel consumption by age and type of vehicle (miles per gallon)
			Energy consumption in urban freight transport	Average fuel consumption considering city stops
			Non-renewable fuel resources	Number (%) of vehicles running on alternative fuels (Hybrid, natural gas, fuel cells)
		EXHAUST EMISSIONS	Typical emissions factor by type of vehicle	Emissions factors by vehicle type and pollutant (CO2, Nox, PM) according to EURO 6 emissions limit
			Share of urban freight in exhaust emissions	Emissions from freight vehicles compared to the total traffic (% on the total by type of vehicle). Emissions from freight vehicles in urban areas compared to all their activities (% on the total by type of vehicle)
		NOISE	Noise level driving trucks	Noise level by vehicle type (dBA)
			Noise levels loading/unloading trucks	Noise level by vehicle type (dBA)

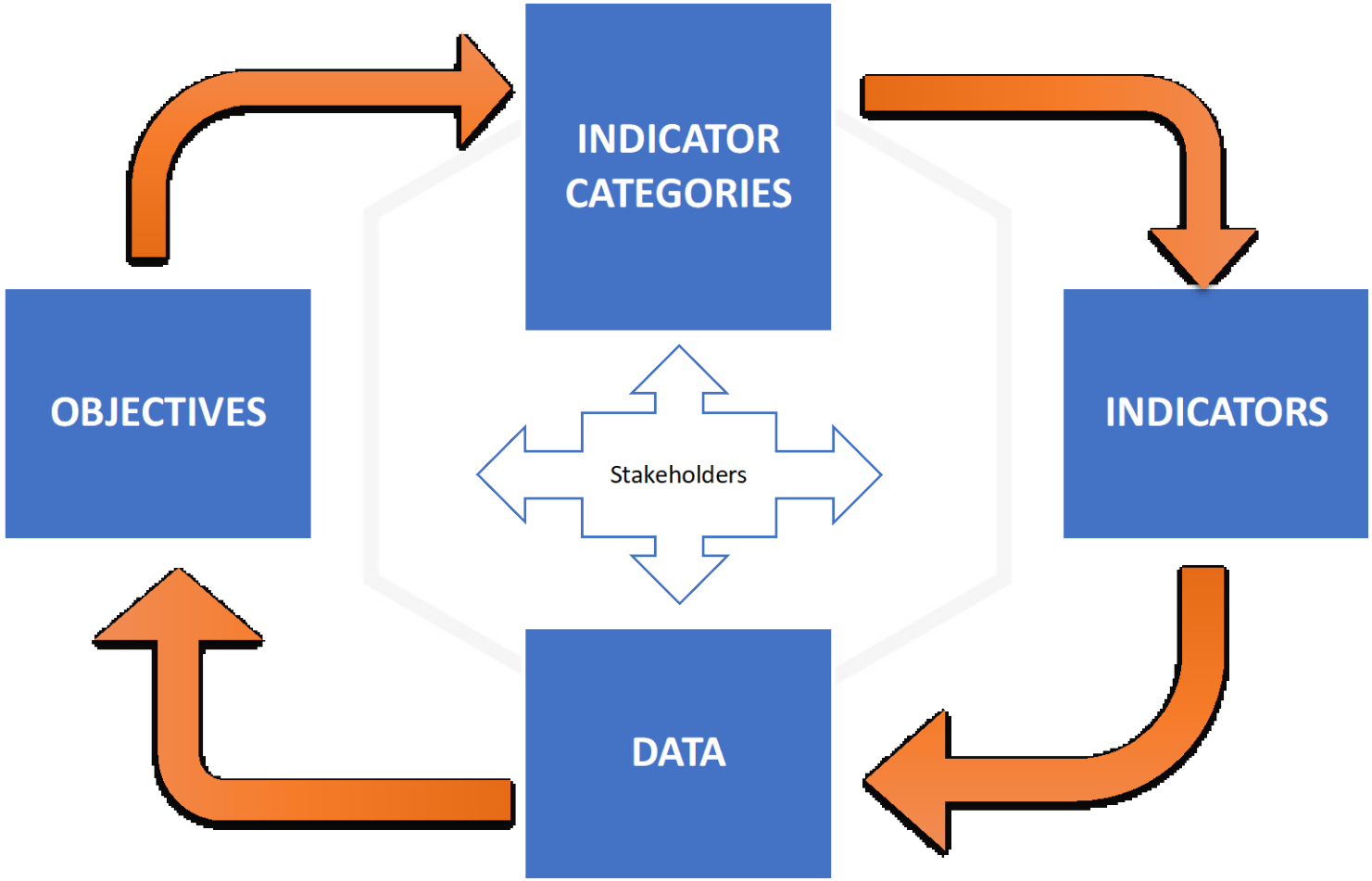
Table 7: Environmental indicators (Adapted from BESTUFS II, 2006)

3. A proposal of indicators for SUFT

	IMPACT CATEGORY	INDICATOR CATEGORY	INDICATORS	MEASUREMENT UNIT
SOCIAL	SAFETY	ACCIDENTS AND CASUALTIES IN URBAN FREIGHT TRANSPORT	Number of accidents	Number of road accidents per year
			Number of fatalities	Number of fatalities by person class (driver, passenger, pedestrian) per year
			Involvement of freight vehicles in accidents	Fatalities involving goods vehicles by vehicle type (by class of person)
			Weekly distribution of accidents involving HGVs	Weekly number (%) of accidents involving freight vehicles (by type of vehicle)
	CONGESTION	CONGESTION	Delayed journeys	Proportion of driver journeys delayed due to traffic congestion
			Satisfaction	Travel time satisfaction
			Speed-based indicators	Average speed by type of vehicle (during peak hours)

Table 8: Social indicators (Adapted from BESTUFS II, 2006)

4. Further steps



5. Conclusions

- UFT plays a crucial role in the economic welfare of cities, but also has a number of negative effects.
- Many measures have been proposed aiming at reducing the negative effects of freight transport in cities.
- In order to evaluate UFT measures performance, suitable indicators are needed.

5. Conclusions

- A proposal of indicators based on the triple bottom line of sustainability (3 P's) is proposed.
- Identification of UFT indicators should consider the stakeholders' differing interest, so
- Feedback from them should be a further step for this report.
- SCC as a facilitator to promote such a feedback

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Thank you very much!

Questions?

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