CONDUITS DST-Tel Aviv-Yafo Case Study

Introduction

The city of Tel Aviv-Yafo is the nucleus of the Tel Aviv metropolitan area and serves as the financial and cultural centre of Israel. With a population of over 400,000 inhabitants and employment of about the same scale, the city's economy is based on its transport system.

Tel Aviv-Yafo considers public transport, walking and cycling to be a key in supporting its economic growth on the one hand and in contributing to its citizen's wellbeing on the other. Tel Aviv-Yafo is promoting public transport priority with any mean it can, yet it is aware of the challenge introduced when these three sustainable modes meet.

Tel Aviv-Yafo is a partner in the CIVITAS initiative 2MOVE2 demonstration project along with Stuttgart, Malaga and Brno. One of the measures in that project, deployed in Tel Aviv, is a measure aiming to provide public transport (PT) priority along Ibn-Gabirol Street. This street is characterised by an intense mixture of land uses, thus provision of PT priority needs to be done carefully to minimise negative impacts on pedestrians and cyclists.

To the city's decisions makers, three planning alternatives were introduced from which they had to choose the most balanced one in order to meet the 2MOVE2 measure's goals and to be in accord with municipal policy.

Considering the many dimensions the impacts have on the efficiency of the transport system and the level of service provided to pedestrians and cyclists in Ibn-Gabirol Street, the decision as to the traffic light plans to be integrated in the routine schedule was assisted with the CONDUITS_DST.

Case Study Context

The case study was performed as a part of the CIVITAS initiative 2MOVE2 project under measure 6.08 Public Transport (PT) priority traffic management strategy.

The goal of the activities of this measure are to limit the adverse effects of transport by elevating the level of service of Public Transport (PT) while at the same time implementing the proper balance between PT vehicles and pedestrians. The specific objectives of this measure are:

- Enhance the use of environmentally friendly transport, especially the use of public transport, walking and cycling.
- Test an innovative traffic management strategy as a means for efficient implementation of PT priority
- Improve the priority level of Public Transport (PT) throughout the PT network.
- Ensure the priority level given to pedestrians at junctions along the backbone of the PT network.
- Improve the harmonisation of the priority level given to PT and pedestrians at all times, especially in cases when a decrease in the performance level is detected.
- Promote the awareness and level of acceptance of the public to sustainable priority regime between PT vehicles, pedestrians and private vehicles.

With very limited governance over the PT network and operations, the city of Tel Aviv-Yafo together with the Transportation research Institute (TRI) of Technion-Israel Institute of Technology, developed an innovative operational concept which is composed of the following.

The new PT-priority traffic management methodology is based on several innovative concepts:

1. A hybrid approach between a centralised and decentralised traffic management process.
2. A new methodology for defining the relationships between PIs for each road user and the characteristics of each signal program.
3. A new methodology for identifying the most promising signal programs to improve the PIs for the various road users
4. Naturally, analysing the performance of the implemented innovative methodology is a sound basis for modifying its parameters on the strength of the gained experience. This feedback procedure is a fundamental factor for preserving the quality of performance indicators for all road users.
5. Exploitation of the mobility Key Performance Indicators (KPIs), developed within the CONDUITS EU project, as an integral part of a decision making process of an ITS measure.

This feature is both innovative and demonstrates the usability of outputs of one EU project within another.

The summery of the process implemented is described in Figure 1.

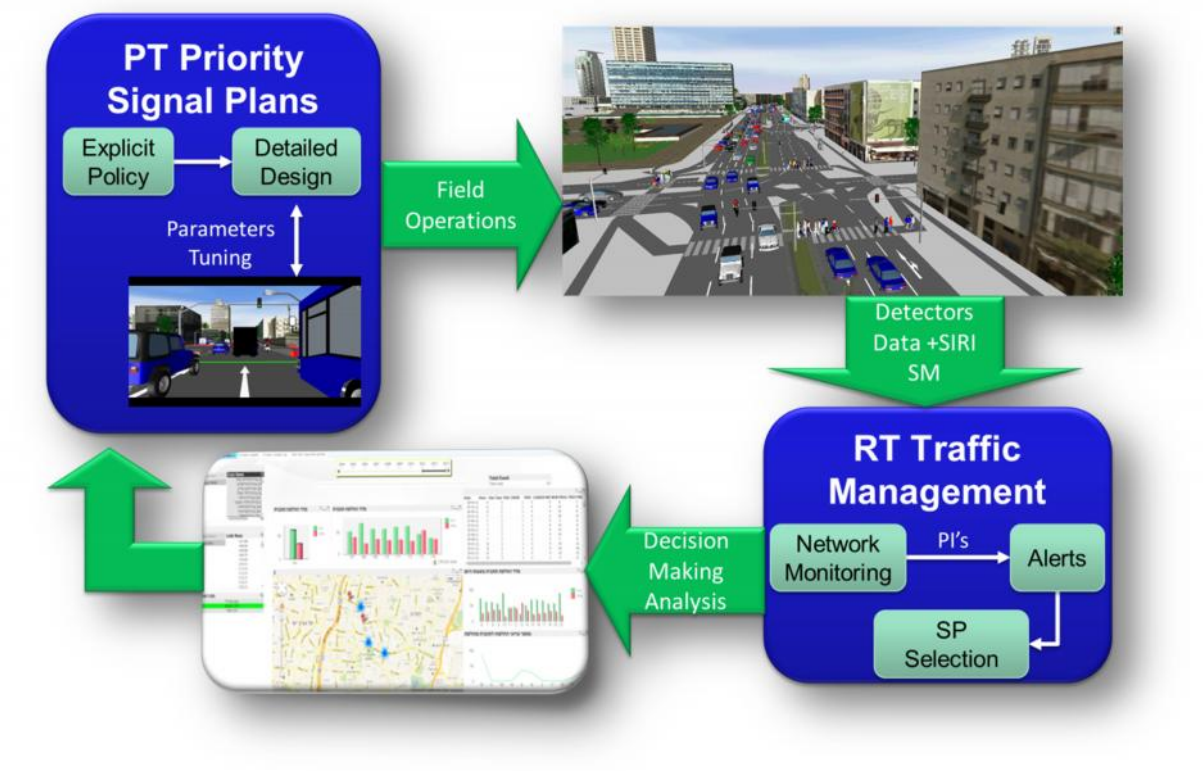

Figure 1 - PT Priority: Control Feedback Loop

Site Description

Ibn Gabirol Street, one of the main avenues of Tel Aviv Yafo. It is a busy residential and shopping street and it is also home to Tel Aviv Yafo City Hall. Ibn Gabirol Street is a commercial thoroughfare with dedicated bus lanes which are in operation during the peak hours of the morning and the afternoon/evening times.

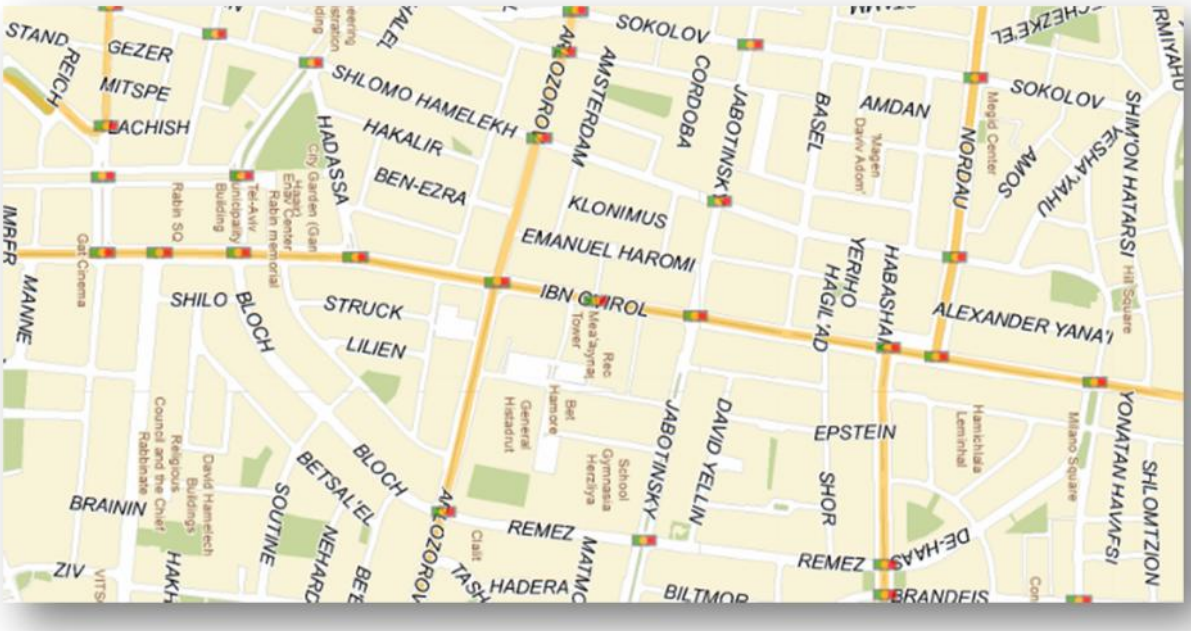

Figure 2 - Ibn Gabirol St.:Frishman (South/Left Side) to Yehuda Hamakabi (North/Right Side)

Case Study

The case study focused on the SP's to be implemented during routine operations of the bus lane. Considering the intense commercial activity in this street, the bus lane is operational only during the peak periods of the morning and the afternoon-evening times. In the rest of the day, the bus lane serves for commercial activities such as loading and unloading goods. The results described in this document relates only to the morning times when the PT reserved lane is operating.

The goal is to provide the highest level of PT priority with the right balance between the needs of the different road user, namely: PT, pedestrians, cyclists and private traffic.

Provision of PT priority in this street by meeting a sustainable policy is a challenge mostly as the most important sustainable transport modes, PT and pedestrians are competing along the main road. Establishing a balance which satisfies both needs in terms of traffic efficiency and pollution called for a thorough evaluation of the signal programs.

PT Priority Signal Programs

The goal of measure 6.08 is to provide the highest level of PT priority with the right balance between the needs of the different road user, namely: PT, pedestrians, cyclists and private traffic.

From the high-level goals of the Tel Aviv Yafo strategic plans, the following specific objectives for the SP's were drawn:

- Minimisation of the deviation of the PT travels times on both sides of the avenue.
- Provision of the smoothed ride for the cyclists along the bicycle path along both sides of the street.
- Accessibility provision for the crossing pedestrians
- Minimisation of queue spillbacks both on the main street and on its crossing roads.

Meeting the measure's objectives required using the following set of tools in the development of the SP's:

- Detectors in proximity to the PT stations located before the junctions to provide PT identification capabilities.
- At locations where it is not possible to install a detection device, the traffic lights coordination will be based on the PT travel profile which includes the service times at stations.
- Provision of a green wave for the pedestrians crossing the main street at least for a single pedestrians cross road.
- Usage of the Pedestrians allowed maximal red time SP parameter to ensure an upper bound for the pedestrians waiting times.
- Queue detectors to avoid crossing and main streets spillbacks
- Development of a rich SP library to meet different traffic possible situation

Based on the above described principles and set of tools, three SP's were developed:

1. V1 – Aiming at provision of PT priority and a minor reduction of PT travel times and travel times deviation.
2. V2 - Aiming at provision of PT priority and a moderate reduction of PT travel times and travel times deviation.
3. V3 - Aiming at provision of PT priority and a major reduction of PT travel times and travel times deviation.

Multi-Criteria Decision Making

The decisions makers were faced with complicated decisions which had to encompass both the city's policy of prioritising pedestrians and cyclists as well as the measure's objective of prioritising PT.

The dimension of the problem is determined according to the project's goals and the city policy thus it is composed of the following:

- PT Travel Times

- PT Travel Times Standard Deviation
- Pedestrians Green Wave
- Pedestrians Red Duration Distribution
- Crossing Street Queue Length

As could be expected, the results of the micro-simulation showed a mixture of trends depending on the specific objective (i.e. reduction of travel times) and road user.

The complex decision could then be relaxed with the use of the CONDUITS_DST results, presenting two figures per SP alternative: the Traffic Efficiency KPI and the Pollution Reduction KPI.

Decision-Making Methodology

The CONDUITS KPI's are composed of two main elements: the measurements and the weights. The latter serves as a mean to identify the relevant impact given a specific policy. This, for example, amplifies the waiting times of pedestrians at a junction in compare to similar values of waiting times for the private traffic.

For the evaluation of the micro-simulation results, 5 policy scenarios were developed according to the following table.

Weighting policy name	Weighting policy description	Weights
Bus	PT is the sole most important transport mode	**Vehicle Type** / **Weight** **Car** 1 **HGV** 1 **Bus** 60 **Pedestrian** 1 **Bike** 1
Equity	All road users have the same weight	**Vehicle Type** / **Weight** **Car** 1 **HGV** 1 **Bus** 1 **Pedestrian** 1 **Bike** 1
Space	The weights are reflecting the average space consumed by the road user (per human occupancy)	**Vehicle Type** / **Weight** **Car** 0.132850242 **HGV** 0.030769231 **Bus** 1.384615385 **Pedestrian** 2.777777778 **Bike** 0.308641975
Sustainability	Pedestrians/Cyclists and buses have the same importance which is 50 times higher than a car	**Vehicle Type** / **Weight** **Car** 1 **HGV** 1 **Bus** 50 **Pedestrian** 50

		Bike	50
Pedestrians	Pedestrians and cyclists are the most important transport mode while bus is less important than the motorised mode but more than the private traffic.	**Vehicle Type**	**Weight**
		Car	1
		HGV	1
		Bus	5
		Pedestrian	20
		Bike	20

The pollution caused by the vehicle emissions is subjected to a single policy thus the emissions weights in all the policy scenarios were derived from the EU limit values as suggested by Manassa[1]

EU Limit Value		Weight
CO2	810000	100
NOx	40	2025000
PM	40	2025000

Results

The results are all based on the calculation of the CONDUITS KPI's using the CONDUITS_DST for the morning times using 5 seeds.

The CONDUITS Traffic efficiency and Pollution were calculated using the above described weighting scenarios. The units that represent the CONDUITS traffic efficiency are [time/distance] thus a more efficient alternative would have a lower index value. The same applies for the CONDUITS pollution KPI which represents [emission/distance].

The following charts exhibit the KPI's results of each of the weighting scenarios. The primary (left) vertical axis presents the CONDUITS Traffic Efficiency KPI values of the different planning alternatives. The secondary (right) axis presents the CONDUITS Pollution KP values of the different planning alternatives.

[1] Master Thesis: Evaluating the Impacts of Road Traffic Management Strategies on Pollution Reduction. Edouard Manassa, Supervisor: Dr Ioannis Kaparias, October 2013- March 2014, School of Engineering and Mathematical Sciences, City University London

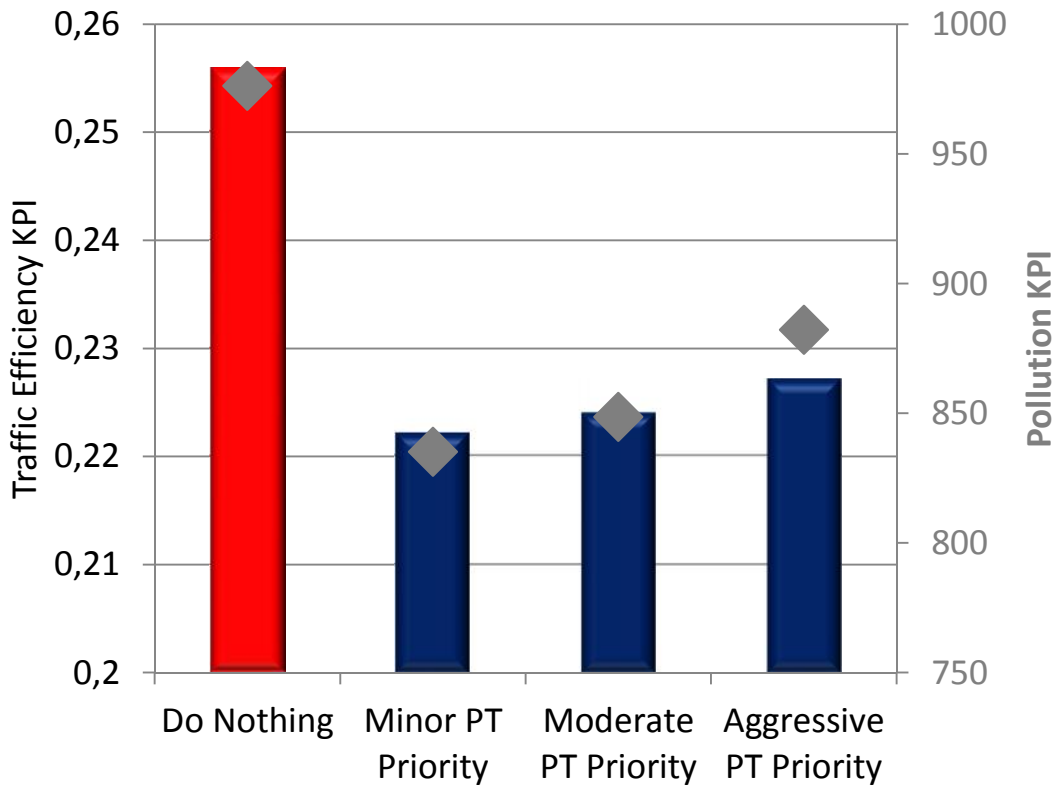

Figure 3 - Bus Priority Weighting Policy

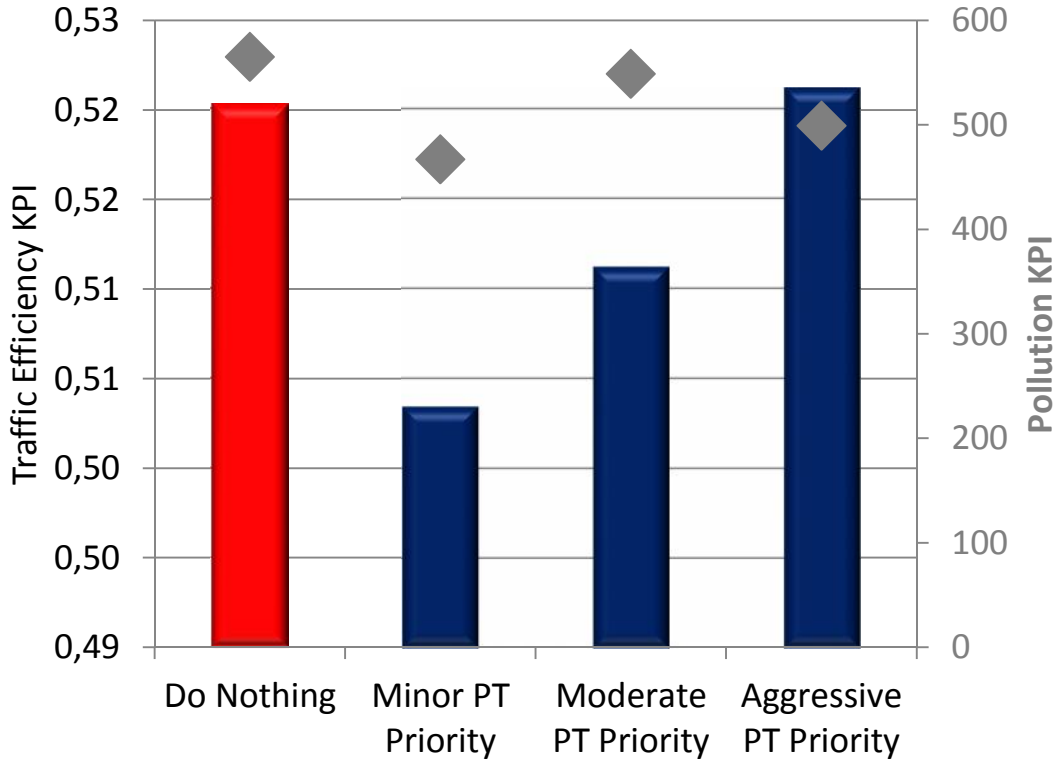

Figure 4 - Equity Weighting Policy

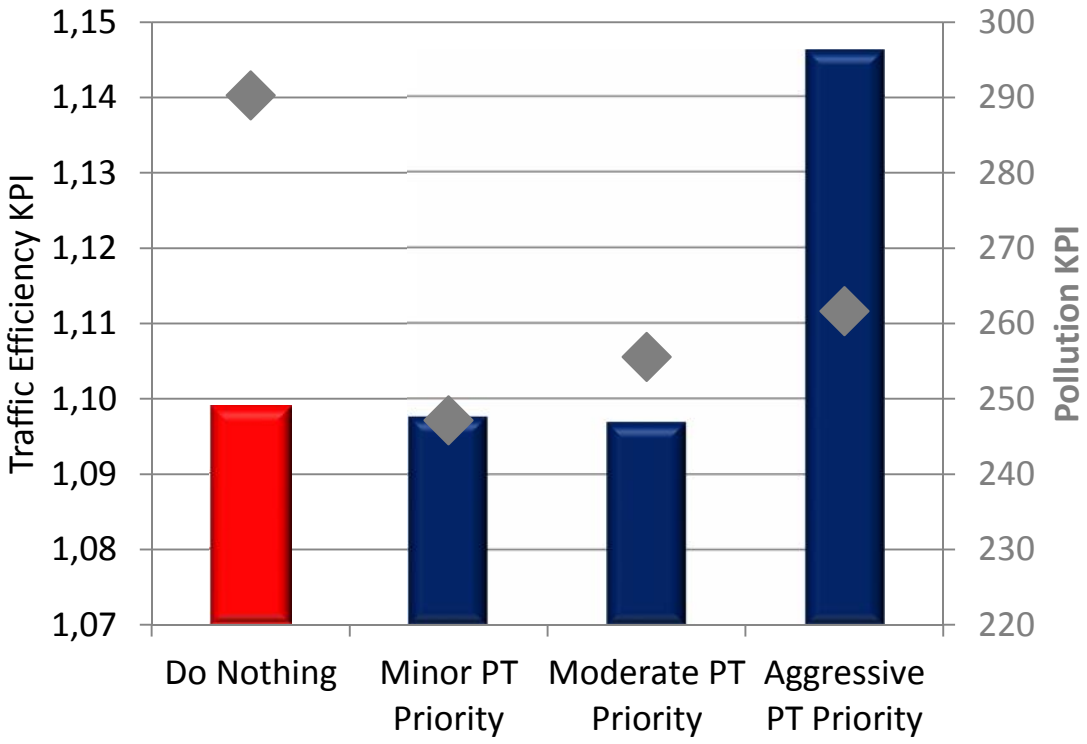

Figure 5 - Space Consumption Weighting Policy

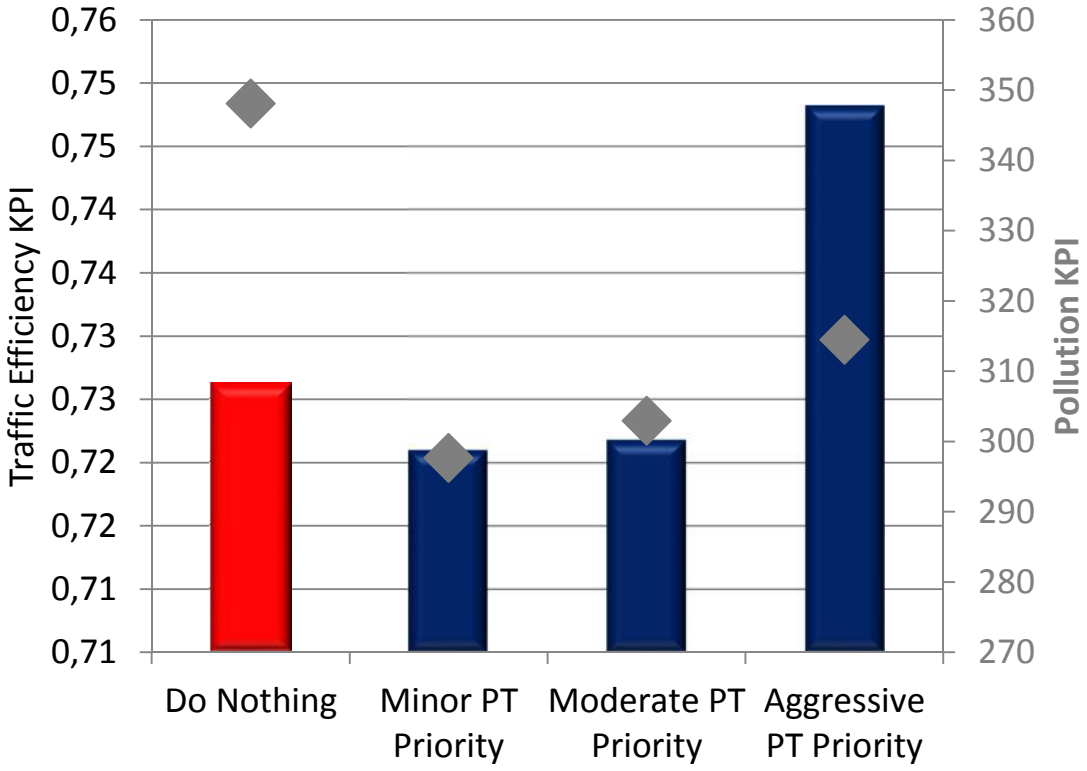

Figure 6 - Sustainability Weighting Policy

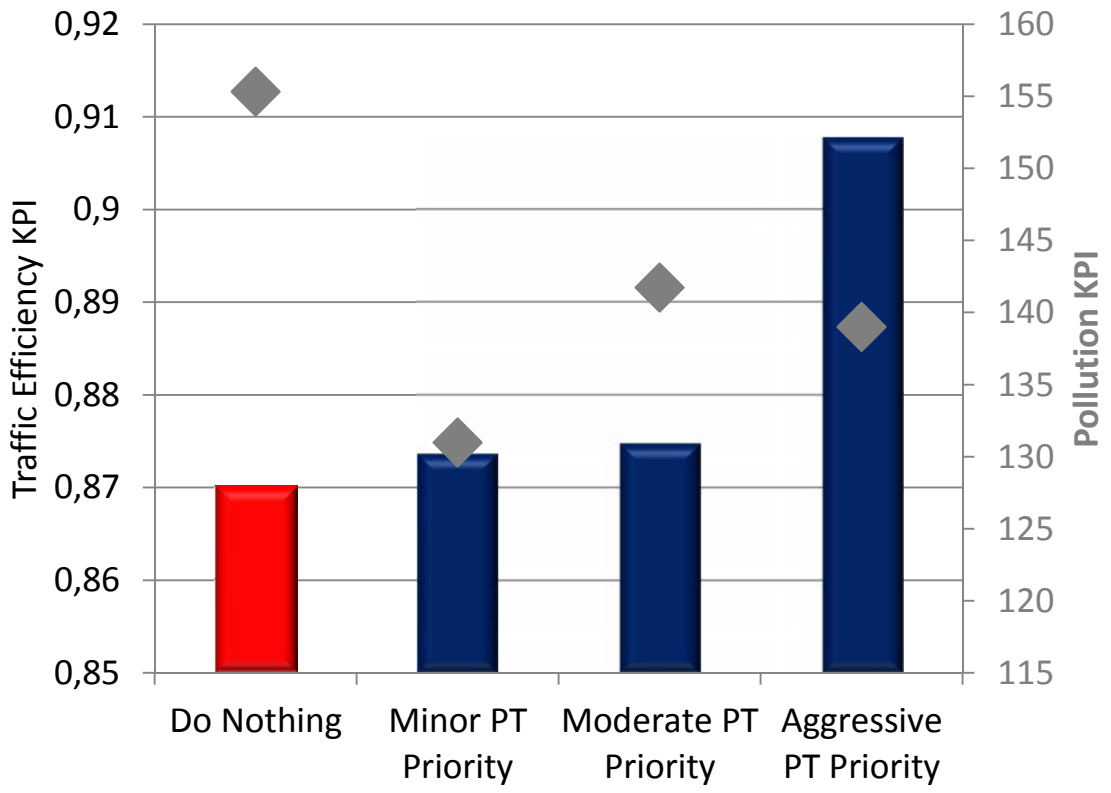

Figure 7 - Pedestrian Priority Weighting Policy

Discussion

In four out of the five examined weighting scenarios, the provision of a minor PT priority provided overall a more efficient transport system in the examined area. The only exception is the weighting scenario at which the pedestrians and cyclists were the most important road users. In that scenario, 1 second of walking/cycling is equivalent to 20 second of driving or 1 person walking/cycling is equivalent to 20 drivers. The three PT priority planning alternatives were aiming at the provision of PT priority on the main road, thus causing increased delays to the crossing pedestrians. Amplifying these delays by a factor of 20 led to a 0.5% reduction of the traffic efficiency KPI in "Minor PT Priority". Nevertheless, the same planning alternative introduced a decrease of the pollution KPI by nearly 16% with an average decrease of 7.3% for particulate matter.

Estimating the impacts of the different planning alternatives given the weighting scenarios of "Bus", "Equity", "Space" and "Sustainability" showed that the "Minor PT Priority" is the most balanced planning alternative both in term of traffic efficiency and pollution reduction.

Conclusions

The CONDUITS_DST was in use in the process of selecting the routine operating signal program for the prioritization of sustainable modes in the Tel Aviv-Yafo demonstration site in 2MOVE2.

The analysis of the results was done with different weighting scenarios that reflect the possible policies. The fact that the results from most of the possible policies was in line with the city's policy of the demo site, proved that the city's decision of using the "Minor PT Priority" alternative is indeed the most balanced one.

The PT priority scheme will start its operation during the beginning of 2015.