

Macrosimulation-based evaluation of a planned urban arterial: the extended branimirova street in sesvete, Zagreb

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Abstract: *Zagrebačka Road is the most heavily loaded corridor in Sesvete, the easternmost district of Zagreb, Croatia, and the city's planning documents foresee the extended Branimirova Street as a second longitudinal to relieve it. This paper evaluates the conceptual design of that arterial with a calibrated macroscopic model. Morning-peak origin–destination demand was obtained from unmanned-aerial-vehicle traffic counts at five key intersections and assigned in a PTV Visum subnetwork calibrated against the counts ($R^2 = 0.91$). Two design variants were tested under identical demand: one following the General Urban Plan and one with two additional junctions. Both reduce the daily volume on Zagrebačka Road by about 22–23% and attract 12000–15000 vehicles per day to the new corridor, while the second adds only local benefit. Fuel use and CO₂ fall correspondingly on the relieved corridor.*

Keywords: *traffic macrosimulation, PTV Visum, urban arterial, origin–destination matrix, UAV traffic counts, network assignment, traffic redistribution, Sesvete*

1. Introduction

Sesvete is the easternmost and one of the fastest-growing districts of the City of Zagreb. Its road network relies on a single continuous east–west corridor, Zagrebačka Road, which simultaneously performs collector, transit and access functions and is the most heavily loaded road in the area, congested during the morning and afternoon peaks [1,2]. The growth of the urban area has increased travel demand and exposed the absence of an alternative longitudinal corridor.

To relieve Zagrebačka Road, the City's spatial and transport planning documents the General Urban Plan (GUP) and the Master Plan of the transport system foresee a second urban longitudinal, the extended Branimirova Street, intended to take over part of the transit traffic and rebalance the network [1,2]. The two documents envisage a pair of urban longitudinals (Zagrebačka Road and the extended Branimirova Street) complemented by transversal links, a pedestrian zone in the historic centre, and a long-term target that public transport and non-motorised modes carry at least two-thirds of daily urban trips. The first construction stage of the new arterial has been built; the conceptual design of the remaining stages and the quantification of their network-wide effect remained open.

Macroscopic four-step and assignment model implemented here in PTV Visum [3,4] are the standard tool for evaluating how a planned network change redistributes existing demand across competing routes. Unmanned-aerial-vehicle (UAV) observation has recently emerged as an efficient means of collecting accurate multi-intersection turning counts to feed such models [5]. Microscopic simulation would resolve junction-level delay and level of service but requires considerably more input data and suits a small number of intersections; for the corridor-level redistribution question addressed here, the macroscopic level offers the appropriate balance of detail and effort.

This paper, condensed from a master's study, applies this approach to the extended Branimirova Street. Morning-peak origin–destination (OD) demand obtained from UAV counts is assigned in a calibrated PTV Visum subnetwork, and two conceptual design variants one strictly following the GUP and one with two additional local junctions are compared in terms of network-wide traffic redistribution and a first-order environmental screening. The contribution is a reproducible UAV-to-Visum workflow applied to a real planned corridor, together with a quantitative variant comparison that supports the planning decision.

2. Materials and methods

Sesvete lies at the eastern edge of Zagreb, close to the A3 (Bregana–Lipovac) and A4 (Zagreb–Goričan) motorways and the city bypass, and on the busy Zagreb–Dugo Selo rail corridor, which exposes it to transit traffic. The extended Branimirova Street is being delivered in stages; the first stage, between Zagrebačka Road and Brestovečka Road, is complete and was surveyed on site, while the second and third stages are the subject of this study (fig. 1).



fig. 1. The extended Branimirova Street by construction stage in Sesvete.

Zagrebačka Road today combines the functions of a collector, transit and access road, which is the root of its congestion. The GUP additionally plans a pedestrian zone around Trg Dragutina Domjanića in the town centre next to the Sesvete bus terminal and railway station, the main intermodal node of eastern Zagreb which would divert still more through traffic onto the new corridor.

Traffic was counted at the five key intersections of Zagrebačka Road with Varaždinska Road, Bistrička Street, Anke Krizmanića Street, Ljudevita Posavskog Street and Kneza Branimira Street. Recording used a UAV on representative workdays (Tuesday–Thursday) during the morning peak hour (07:00–08:00) in four 15-minute intervals, providing accurate turning counts for every approach. Vehicles were classified and converted to passenger car units (PCU), and the turning movements were aggregated into an OD matrix for each intersection. Table 1 lists the total entering peak-hour volumes; the busiest, with Ljudevita Posavskog Street, carried 3901 PCU/h, dominated by the through movement along Zagrebačka Road.

Table 1. Total entering peak-hour volumes by intersection.

Intersection (with Zagrebačka Rd)	Legs	PCU/h
Varaždinska Road	4	2718
Bistrička Street	4	3123
Anke Krizmanića Street	3	3202
Ljudevita Posavskog Street	3	3901
Kneza Branimira Street	4	3610

A subnetwork covering Sesvete Zagrebačka Road, the built first stage of Branimirova, Brestovečka Road, Varaždinska Road and the surrounding main streets was extracted from a city-wide PTV Visum model using its Subnetwork function, which isolates the Sesvete area together with its boundary flows so that it can be analysed without simulating the whole city. The measured peak-hour demand was assigned with an equilibrium procedure, in which travellers shift to faster routes until no alternative offers a shorter generalised cost (Wardrop's first principle) [6]. Hourly volumes were expanded to average daily traffic with a factor of ten. The existing-state assignment yields 35916 veh/day on Zagrebačka Road, 2163 veh/day on the first stage of Branimirova, and about 7100 veh/day on each Varaždinska branch (fig. 2).



fig. 2. Existing-state daily traffic volumes on the Sesvete subnetwork (PTV Visum).

The model was calibrated against the counts (fig. 3). The correlation between modelled and observed volumes is strong (coefficient of determination 0.91 over 30 observations), although the regression slope of 1.41 and the mean relative error of 37% indicate a systematic over-assignment; the model is therefore used for relative, between-scenario comparison rather than for absolute forecasting.

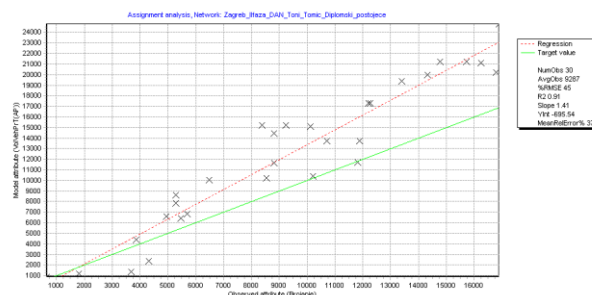


fig. 3. Calibration: modelled versus observed volumes (PTV Visum).

Both variants were drawn in AutoCAD on the cadastral parcel layer. The designed section is 2880 m long with four junctions (two four-leg and two three-leg) and a cross-section replicating the built first stage: two carriageways with two lanes each, a central median, a green strip separating a two-way cycle track and footway, and bus bays [7]. On the built stage these elements measure 3.35 m for the traffic lanes, a 1.93 m central median and a 1.82 m green strip, and the conceptual design adopts the same cross-section. Variant 1 follows the GUP; Variant 2 keeps the same junctions but adds two local connections (to Krste Hegedušića and Miroslava Kraljevića streets) that are not foreseen by the GUP. The measured demand was held constant across all scenarios, so the differences in link volume reflect route choice and redistribution only. fig. 4 and fig. 5 show the two alignments.

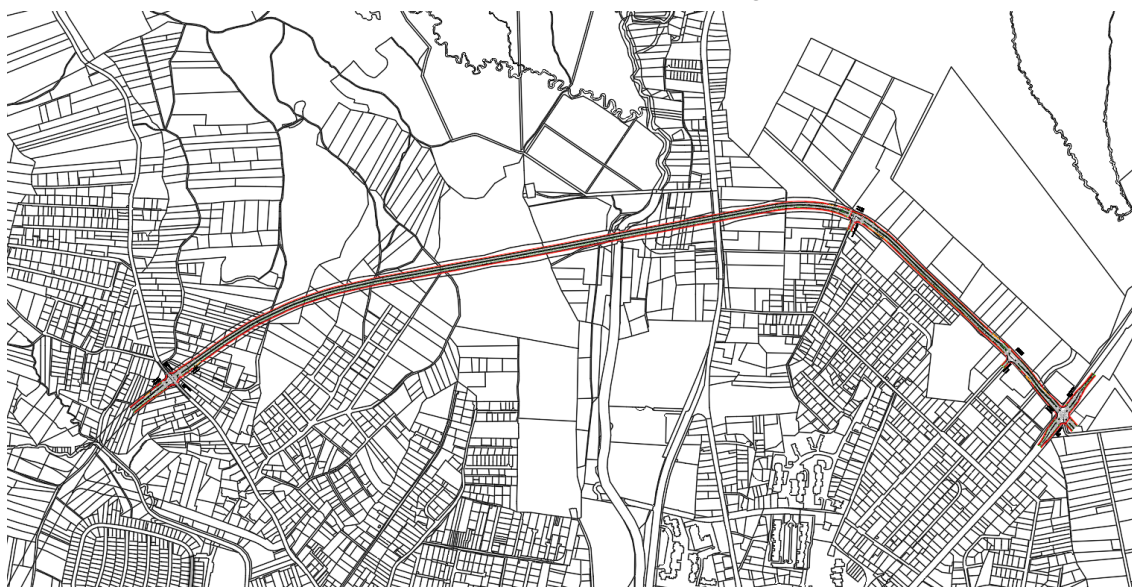


fig. 4. Variant 1 — design following the General Urban Plan (AutoCAD).



fig. 5. Variant 2 — GUP design with two additional local junctions (AutoCAD).

3. Results and discussion

Both design variants substantially relieve the critical corridor. The daily volume on Zagrebačka Road falls from 35916 to 27954

veh/day with Variant 1 (–22%) and to 27711 veh/day with Variant 2 (–23%). The new corridor is well used: the first stage of Branimirova carries 12217 veh/day (Variant 1) and 15032 veh/day (Variant 2), decreasing along the second and third stages to about

8000 veh/day, so the strongest volume occurs nearest the Zagrebačka junction and tapers toward the north. The northern branch of Varaždinska Road toward the Zagrebačka junction drops sharply (−47% and −60%) as traffic reroutes onto Branimirova, while the branch toward Popovec rises slightly (+14% and +19%). Table 2 and fig. 6 summaries the volumes at the key locations.

Table 2. Daily traffic volumes [veh/day].

Road / section	Existing	Variant 1	Variant 2
Zagrebačka Road	35916	27954	27711
Branimirova, sec. 1	2163	12217	15032
Branimirova, sec. 2	–	10726	11570
Branimirova, sec. 3	–	8063	8107
Varaždinska (north)	7121	3794	2829
Varaždinska (Popovec)	7101	8120	8420

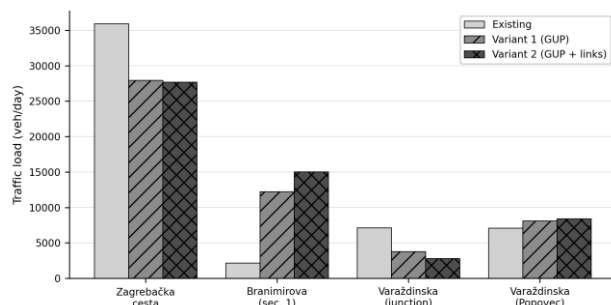


fig. 6. Daily traffic volumes at key locations: existing state versus the two design variants.

The redistribution confirms the intent of the planning documents: the extended Branimirova draws the through traffic that today has no alternative to Zagrebačka Road, and the strongest relief is achieved on its most congested southern section, nearest the city of Zagreb.

The assigned network volumes for the two variants are shown in fig. 7 and fig. 8. In both, the new corridor visibly absorbs the redistributed flow while Zagrebačka Road and the northern Varaždinska branch lighten. Relative to Variant 1, Variant 2 changes the volume on Zagrebačka Road by only about 1% a negligible difference which shows that the two additional junctions do not materially improve relief of the main corridor. Their effect is local: they increase the volume on the first stage of Branimirova (+23%) and further unload the northern Varaždinska branch (−25%). Variant 2 therefore improves local accessibility and distribution rather than the strategic corridor relief that both variants already deliver.

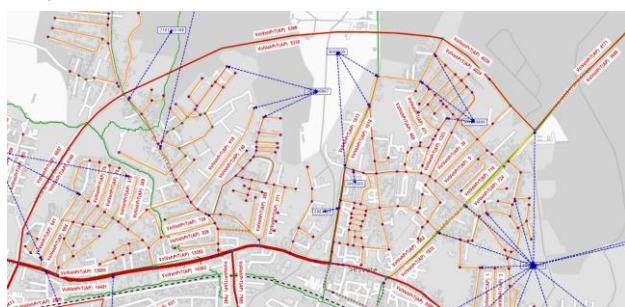


fig. 7. Assigned daily volumes for Variant 1 (PTV Visum).

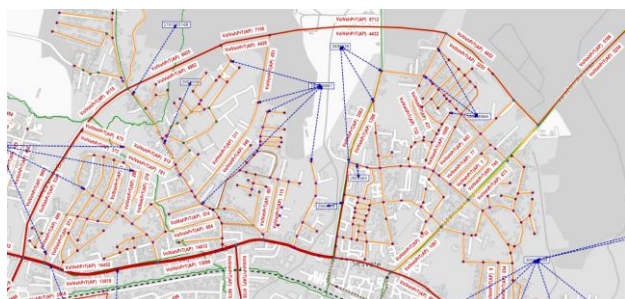


fig. 8. Assigned daily volumes for Variant 2 (PTV Visum).

From a planning perspective, the staged construction foreseen by the GUP is justified on traffic grounds: Variant 1 alone delivers essentially all of the corridor relief, so the scheme can proceed stage by stage without the benefit being contingent on the additional junctions. Those junctions, which define Variant 2, are best evaluated separately, on the value of the local access they create rather than on any further unloading of Zagrebačka Road.

The environmental screening, based on HBEFA-type emission factors [8], follows the same pattern (Table 3). On Zagrebačka Road, fuel consumption falls by 22% (Variant 1) and 25% (Variant 2) and CO₂ emissions by 21% and 25%, in line with the reduced volume, while the corresponding burden shifts onto the new corridor. These figures are indicative only, as they were obtained with the student edition of the software; the inconsistent particulate-matter outputs were omitted, and a full-edition network-total accounting, including noise, is left for future work.

Table 3. Emission indicators on Zagrebačka Road (PTV Visum).

Indicator	Existing	Variant 1	Variant 2
Fuel [kg]	1444	1125	1076
CO ₂ [kg]	4150	3259	3117

Several limitations should be noted. The analysis rests on a single morning-peak campaign and on present-day demand, without a horizon-year forecast, and uses a static macroscopic assignment without junction-level delay or level of service. The calibration shows a systematic over-assignment, so absolute volumes should be read comparatively. Future work includes extending the counts to the afternoon peak and the full day, applying the Master Plan growth forecasts, recalibrating with the GEH statistic, microsimulating the key junctions, and adding multimodal scenarios in line with the GUP target of two-thirds of daily trips being made by public and active modes.

4. Conclusion

This paper evaluated the conceptual design of the extended Branimirova Street with a UAV-fed, calibrated PTV Visum macrosimulation. Both design variants relieve Zagrebačka Road by about 22–23% and establish Branimirova as a genuine second longitudinal carrying 12000–15000 veh/day, with a corresponding fall in fuel use and CO₂ on the relieved corridor. The two additional junctions of Variant 2 bring only local benefit (about −1% on the main corridor), so the GUP-compliant Variant 1 is the cost-effective choice for strategic relief. The workflow from drone counts to a calibrated subnetwork model is transferable to other planned urban arterials and provides quantitative support for the planned investment, subject to the calibration and demand-horizon refinements identified above.

5. References

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