

Eco-Acoustic and Operational Optimization of an Airbus EC135 T3H HEMS Flight Trajectory on the Bucharest–Buzău Route

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Abstract: This paper addresses route selection for an Airbus EC135 T3H (H135) helicopter operating a HEMS mission between Bucharest and Buzău. Minimum distance is treated as one criterion among several, alongside flight time, estimated fuel consumption and a relative acoustic index calculated for the populated areas overflowed. The model is implemented in Python and applied to a waypoint network between Bucharest University Emergency Hospital and Buzău County Emergency Hospital. Three candidate routes are evaluated against the direct route. Route C obtains the lowest aggregated score ($J = 1.013$) and is proposed as the optimal trajectory. The results indicate that, for this type of mission, a multi-criteria route can offer a more balanced compromise than the direct one, within the limits of the modelling assumptions.

Key Words: HEMS, Airbus EC135 T3H, helicopter route optimization, air medical mission, medical helicopter, Bucharest–Buzău route, helicopter fuel consumption, acoustic impact, helicopter noise, Python, Jupyter Notebook, waypoints, multi-criteria optimization, optimal flight trajectory

1. INTRODUCTION

HEMS flights are a category of their own. The patient is on board from the start, the call comes when it comes, and the route is established quickly - sometimes after the rotor has already started. A few minutes lost en route can mean a life [1].

Helicopters reach places inaccessible to ambulances, or places ambulances would reach far too late. A congested city, a rural road full of potholes - situations where the road network is simply of no help. This is nothing new. HEMS has existed for a long time, and the operational arguments were settled long ago.

What differs now is the surrounding context. Residents living beneath flight paths have begun to voice complaints about noise, and these complaints are not without merit — a helicopter at low altitude is loud, and residential areas are overflowed frequently [2]. Fuel belongs to the same problem from a different angle. Detours have a cost. Not an enormous one per flight, but enough that, over a year of operations, the difference becomes significant.

This paper examines one mission in particular: Bucharest University Emergency Hospital to Buzău County Emergency Hospital, on an Airbus EC135 T3H (H135). The EC135 is widely used in European HEMS, its rotor is relatively quiet for the type, and fuel consumption remains

lower than that of heavier twin-engine models [3]. These were the reasons behind the choice. Several routes can connect the two hospitals. Some are shorter, some avoid populated areas, some consume less fuel.

2. MATHEMATICAL MODELING OF TRAJECTORY OPTIMIZATION FOR HEMS MISSIONS

The optimization of the trajectory in a HEMS mission is not a simple problem. Choosing the shortest path is not sufficient. The flight time has to be considered, the fuel consumption of the helicopter is not negligible, and the flight takes place at low altitudes, above inhabited areas, where the noise produced is significant. A route selected only on the basis of distance can lead to a higher fuel consumption and to disturbances for the population in the overflown areas [1].

In the literature, these aspects have been studied mostly separately. Rotorcraft studies are usually focused on operational cost or on energy efficiency. The noise problem is generally analyzed in the context of airports or urban heliports. However, HEMS missions present a different situation, because the helicopter does not follow protected air corridors. It crosses residential areas, at altitudes where the acoustic impact at ground level is important [2].

The model presented in this paper considers the three criteria together: flight time, fuel consumption and acoustic impact. The analysis is performed on the Bucharest – Buzău route, between the two emergency hospitals. The objective is to determine if a trajectory exists that offers a reasonable balance between the three criteria, without favoring one of them excessively.

For the calculation, the route was divided into intermediate navigation points (waypoints). The connections between them form a directed graph. Each segment of the graph has an associated cost, which describes the characteristics of that section. The problem becomes the determination of the minimum-cost path in this graph, which is a standard formulation in optimization theory, applied in this case to the medical flight problem [4].

The objective function used in the optimization is defined by the relation:

$$J = w_T T + w_F F + w_N N \quad (1)$$

where:

- T represents the total flight time;
- F represents the estimated total fuel consumption;
- N represents the overall acoustic impact index;
- w_T , w_F si w_N represent the weighting coefficients associated with each criterion.

The weighting coefficients are important because not all missions are the same. In a important emergency mission, flight time becomes the main priority, so its weight in the objective function increases accordingly. In the case of a less urgent interhospital transfer, greater emphasis can be placed on fuel consumption or noise reduction. This allows the model to adapt to different operational situations instead of following a single predefined solution.

The total flight time is calculated using the basic relationship between distance and speed:

$$T = \frac{D}{V} \quad (2)$$

where:

- D represents the total distance flown;
- V represents the average cruising speed.

Fuel consumption is estimated through a simplified model, directly correlated with the flight duration:

$$F = \dot{m}_f \cdot T \quad (3)$$

where:

- $\dot{m}_f$ represents the average fuel mass flow rate;
- T represents the total flight time.

The approximation holds together well enough for a fair side-by-side comparison of trajectories under the same conditions. Sound is the trickiest part of the model to get right. Noise levels aren't constant along a route, they shift with how densely populated the area below is and with the altitude of the flight. For each segment of the trajectory, the formula applied is:

$$N = \sum_{i=1}^n P_i \cdot \frac{1}{H_i^2} \quad (4)$$

where:

- P_i represents the demographic weighting factor density associated with zone I;
- H_i represents the flight altitude above that respective zone.

Equation (4) will be replaced in Chapter 2 by the more detailed relation (7).

The idea behind it is simple: flying low over a densely populated area produces a stronger noise footprint on the ground. Operational constraints have to factor in as well, otherwise the resulting trajectories wouldn't be flyable in practice. Altitude is bounded by the aircraft's flight envelope and by VFR rules [11]. Flight time stays a critical factor given the emergency nature of HEMS missions. Fuel burn has to stay within the helicopter's effective range, or the routes being analyzed would have no operational relevance.

On the numerical side, A* [5] is the algorithm of choice. It was picked because it handles weighted graphs well and supports multi-criteria cost functions. The algorithm starts at the source node, evaluates its neighbors, updates costs along the way, and returns the lowest-cost route based on the objective function defined.

The next chapter takes this model and applies it specifically to the Airbus EC135 T3H, plugging in the actual technical specs and setting up the scenarios run in Python/Jupyter.

3. PARTICULARIZING THE MODEL FOR THE AIRBUS EC135 T3H HELICOPTER

The model from the previous chapter (time, fuel, noise) is now applied to a specific helicopter. The platform chosen is the Airbus EC135 T3H. The mission studied will be: Bucharest, Emergency University Hospital, to Buzău, County Emergency Hospital.

In this work, the EC135 T3H appears as the technical reference. Its parameters: cruise speed, consumption, acoustic characteristics, feed directly into the calculations [7].

The purpose of this chapter is to establish the input data for the simulation and calculate the direct reference route. This route will serve as the comparison point for routes generated later in Python/Jupyter Notebook.

3.1 Technical parameters used in the model

For the formulas from Chapter 1 to work, some data about the aircraft are necessary. From the Airbus documentation for the H135 [7], [9], and confirmed by the EASA Type

Certificate Data Sheet [21]: fast cruise speed of approximately 136 kt (252 km/h), standard fuel tank of 560 kg.

In the model, these figures were used as fixed values:

Table 1 – EC135 T3H parameters used in simulation

Parameter	Value used	Unit	Reference
Cruise speed / speed used in simulation	252	km/h	[8], [9]
Average fuel consumption at cruise	229	kg/h	[10]
Standard fuel capacity	560	kg	[9]
Maximum range with standard tank	633	km	[8]

The data in Table 1 are entered directly into the simulation. This ensures that the figures are calculated under the same conditions.

3.2 Definition of Mission Points

The departure point is the Bucharest University Emergency Hospital, and the destination is the Buzău County Emergency Hospital.

The approximate geographical coordinates of the two locations were entered directly into Python for the distance calculation.

Table 2. – Geographical coordinates

Point	Latitude	Longitude
Bucharest University Emergency Hospital	44.41336	26.09778
Buzău County Emergency Hospital	45.150592	26.801727

The direct distance between the two hospitals came out of a Python calculation using the geopy library [12], which handles geodesic distance between geographic points.

3.3 Calculation of the direct reference route

The direct route is the first variant analyzed and represents the comparison baseline for all other routes. At this stage, three quantities are calculated: distance, flight time and estimated fuel consumption.

The direct distance resulting from Python is:

$$D_{\text{direct}} = 98.18\text{km}$$

Flight time gets calculated using the relation:

$$T = \frac{D}{V}$$

where:

- D is the direct distance calculated in Python;
- V is the cruise speed used for the EC135 T3H.

Substituting the values:

$$T = \frac{98.18}{252}$$

$$T = 0,3896 \text{ h}$$

Converting to minutes:

$$T_{min} = 0,3896 \cdot 60$$

$$T_{min} = 23.376 \text{ min}$$

This gives an estimated time for the direct route of roughly 23, 376 minutes.

3.4 Fuel consumption calculation for the direct route

Fuel consumption is calculated based on flight time and the helicopter's average hourly consumption.

The relation used is:

$$F = \dot{m}_f \cdot T$$

For the direct route:

$$\dot{m}_f = 229 \text{ kg/h}$$

$$T = 0,389 \text{ h}$$

therefore:

$$F = 229 \cdot 0,389$$

$$F = 89.215 \text{ kg}$$

For the direct route, the estimated consumption comes out to roughly 89.215 kg of fuel. To make it clear whether the number's realistic against the standard tank capacity, the percentage used was also calculated:

$$F_{\%} = \frac{F}{F_{cap}} \cdot 100$$

$$F_{\%} = \frac{89.215}{560} \cdot 100$$

$$F_{\%} = 15.93 \%$$

Thus, the direct route consumes approximately 15.93 % of the standard fuel capacity considered in the model.

Table 3 – direct reference route calculated in Python

Parameter	Value	Unit
Direct distance	98.18	km
Estimated flight time	23.376	minutes
Estimated flight time	0.390	h
Estimated fuel consumption	89.219	kg
Percentage of fuel used	15.93	%

These results represent the first numerical stage of the paper. They will be used as a reference point for comparison with the alternative routes generated later.

The route maps were generated in Python using Matplotlib [14] and Contextily [18], with the geographical basemap provided by OpenStreetMap contributors [16] and CARTO [17].

Figure 1. Direct reference trajectory between Bucharest and Buzău

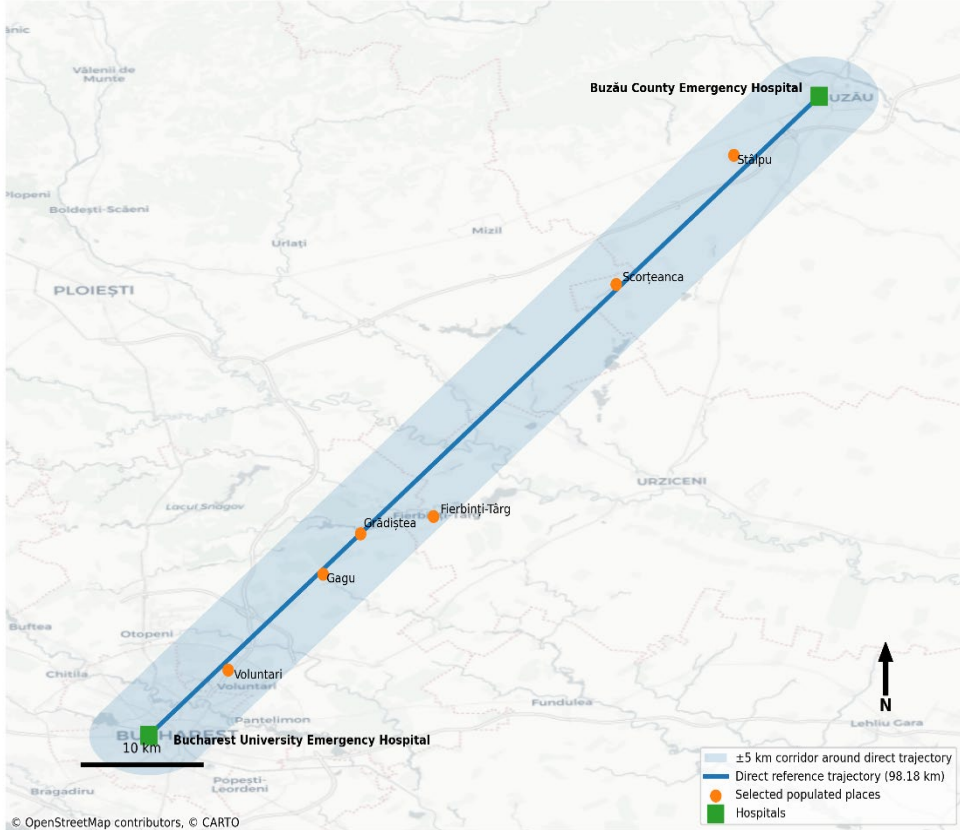


Figure 1. Direct route between the two hospitals

3.5 Selection of Waypoints for Candidate Routes

After the direct route, a network of intermediate waypoints was constructed. The purpose is to generate several possible routes between Bucharest and Buzău, not just one. The waypoints are not necessarily real navigation points; they are numerical points used for route modelling in Python.

- Each waypoint is associated with:
- geographical coordinates;
- zone type;
- population coefficient;
- sound attenuation

Table 4 – Points used for the calculation network.

Name	Type	Latitude	Longitude	Population	Population source	Pi	Distance to direct route [km]
Bucharest	urban area	44.41336	26.09778	1716961	Wikidata	1	3.255434
Popești-Leordeni	town	44.37954	26.16832	53434	OpenStreetMap	0.818726	9.918119
Bragadiru	town	44.37351	25.98049	6951	OpenStreetMap	0.71218	10.0747
Jilava	village	44.33609	26.08104	12651	OpenStreetMap	0.743462	11.13624
Chitila	town	44.50599	25.9877	10866	OpenStreetMap	0.735517	9.979845
Mogoșoaia	village	44.52973	26.00071	4718	OpenStreetMap	0.69194	10.68009
Buftenă	town	44.55982	25.94989	17257	OpenStreetMap	0.759682	15.91052
Dobroești	village	44.45079	26.18253	3562	OpenStreetMap	0.67726	6.181239
Pantelimon	town	44.45188	26.20356	14456	OpenStreetMap	0.75043	7.466749
Fundeni	village	44.38233	26.3436	5481	OpenStreetMap	0.699769	21.03362
Voluntari	town	44.49028	26.17728	27945	OpenStreetMap	0.784863	3.273207
Otopeni	town	44.55878	26.07503	21750	Wikidata	0.77177	7.772005
Brănești	village	44.45756	26.33501	6652	OpenStreetMap	0.709883	15.57105
Afumați	village	44.52468	26.24943	6478	OpenStreetMap	0.708499	5.682845
Balotești	village	44.61839	26.08716	5463	OpenStreetMap	0.699598	10.86232
Gagu	village	44.61521	26.26263	447	OpenStreetMap	0.568931	0.634739
Grădiștea	village	44.66208	26.30058	1963	OpenStreetMap	0.646143	0.017332
Fierbinți-Târg	town	44.68247	26.38238	1449	OpenStreetMap	0.630291	3.937802
Dridu	village	44.69521	26.45325	3527	OpenStreetMap	0.676744	7.649704
Coșereni	village	44.68304	26.56282	4692	OpenStreetMap	0.691651	15.46556
Cioranii de Jos	village	44.82072	26.41283	4768	OpenStreetMap	0.69249	3.140577
Bărbulești	village	44.72629	26.59929	3753	OpenStreetMap	0.679988	14.96669
Jilavele	village	44.76217	26.53131	3465	OpenStreetMap	0.675818	8.268035
Cioranii de Sus	village	44.83964	26.39545	2578	OpenStreetMap	0.660375	5.488917
Urziceni	city	44.717	26.63241	19303	OpenStreetMap	0.765535	17.69395
Manasia	village	44.70628	26.67536	4638	OpenStreetMap	0.691046	21.14485
Sălcile	village	44.81651	26.49246	2563	OpenStreetMap	0.66007	2.226673
Gârbovi	village	44.78667	26.76737	4662	OpenStreetMap	0.691316	21.74288
Ceptura de Jos	village	45.02037	26.32632	2613	OpenStreetMap	0.661079	21.70171
Glodeanu Sărat	village	44.87146	26.65056	2411	OpenStreetMap	0.656877	8.723347
Mizil	town	45.00307	26.44377	16566	OpenStreetMap	0.757547	13.08119
Scorțeanca	village	44.94084	26.57885	186	OpenStreetMap	0.523287	0.397282
Săhăteni	village	45.03605	26.52171	1531	OpenStreetMap	0.633165	10.27288
Gherăseni	village	45.02525	26.7916	3243	OpenStreetMap	0.67236	7.600216
Smeeni	village	44.99587	26.85869	3330	OpenStreetMap	0.673742	13.79593
Stâlpu	village	45.08519	26.70839	3225	OpenStreetMap	0.672069	1.623595
Buzău	urban area	45.15167	26.81667	103481	Wikidata	0.853255	1.180814
Poșta Câlnău	village	45.23584	26.86775	2265	OpenStreetMap	0.653615	10.8006
Vernești	village	45.20588	26.7287	2112	OpenStreetMap	0.649963	8.408108
Mărăcineni	village	45.17686	26.82464	2020	OpenStreetMap	0.647638	3.429722
Vadu Pașii	village	45.15909	26.88462	2708	OpenStreetMap	0.662944	6.585605

Table 4 gathers the populated areas considered for the acoustic-penalty calculation along the Bucharest–Buzău corridor.

For each locality, the entries include coordinates, the population figure together with its source [16], [20], the relative coefficient Pi, and the distance to the direct route. A larger Pi reflects a more populated area and, accordingly, a heavier acoustic contribution. On this basis, the direct route can be set against the candidate alternatives.

Figure 2. Candidate route network and population-based acoustic influence zones

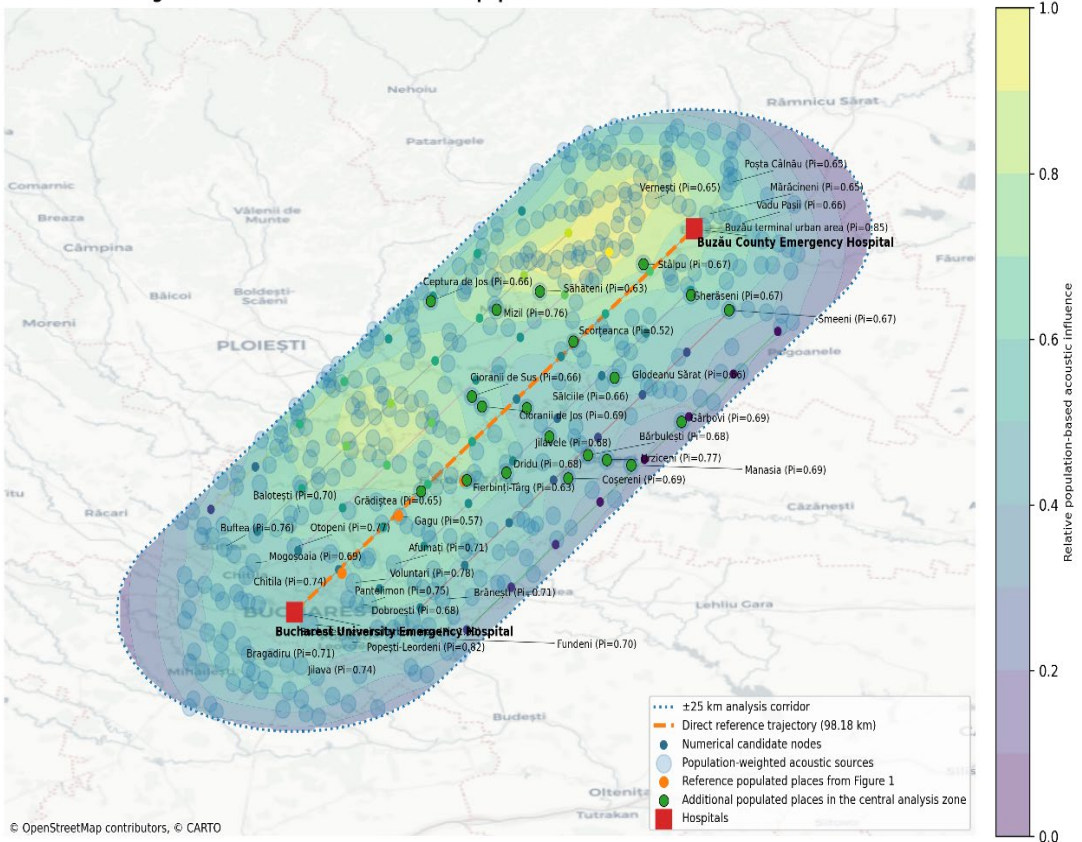


Figure 2. Waypoint network used for generating candidate routes.

Figure 2. Candidate route network and population-weighted acoustic constraints along the Bucharest–Buzău HEMS trajectory. Between the two endpoints, the direct reference route is plotted as a dashed line.

Inside a ± 25 km lateral corridor centered on this axis, blue points mark the numerical candidate nodes fed into the optimization.

Orange markers correspond to populated localities, each carrying a coefficient P_i — derived from population data - that quantifies its contribution as an acoustic-penalty source. Three sectors deserve attention here: the departure region near Bucharest–Ilfov, the string of localities along the central corridor, and the approach toward Buzău. One last point worth flagging: the candidate nodes are computational artefacts, nothing more, and should not be read as official aeronautical waypoints.

3.6 Acoustic penalization modeling

To bring the noise effect into the route comparison, a relative acoustic penalisation model was applied. The model does not work out real sound pressure levels in dB(A) — that would call for field measurements, or for a proper aeroacoustic simulation. The aim here is different: a comparative index, useful for telling which candidate route ends up more exposed to populated areas.

Three things drive the acoustic cost: how many people live around the route, how far the flight segment passes from them, and the altitude. A segment flown close to an inhabited area comes out with a higher cost [19].

For each populated place i , a population coefficient is first computed:

$$P_i = 0.25 + 0.75 \cdot \frac{\ln(1 + Pop_i)}{\ln(1 + Pop_{max})} \quad (5)$$

where:

$$0.25 \leq P_i \leq 1.00$$

Pop_i represents the population of locality i , and Pop_{max} is the highest population value in the analyzed dataset.

This normalization keeps all coefficients between 0.25 and 1.00. Large urban areas receive values closer to 1.00, while smaller rural settlements receive lower values.

For each route segment s , the population exposure term is calculated as:

$$E_s = \sum_{i=1}^n P_i \cdot e^{-\frac{d_{s,i}}{r_0}} \quad (6)$$

where $d_{s,i}$ is the minimum distance between segment s and populated place i , and r_0 is the distance-decay parameter.

In this model, r_0 was used to reduce the influence of localities located farther from the flight path. The acoustic cost of one segment is then written as:

$$N_s = \frac{L_s}{D_{ref}} \cdot E_s \cdot \left(\frac{H_{ref}}{H_s} \right)^2 \quad (7)$$

where:

- N_s is the relative acoustic cost of segment s ;
- L_s is the length of the segment;
- D_{ref} is the direct reference distance between the two hospitals;
- E_s is the population exposure term;
- H_{ref} is the reference altitude;
- H_s is the flight altitude on segment s .

The altitude term reflects the fact that the acoustic effect at ground level decreases when the helicopter flies higher [6]. In the basic simulation, if all segments are considered at the same altitude, then:

$$H_s = H_{ref}$$

and the altitude factor becomes:

$$\left(\frac{H_{ref}}{H_s} \right)^2 = 1$$

To make this effect clearer, the acoustic model was also represented as a response surface. The diagram varies flight altitude and lateral distance at the same time, while three population-influence levels are considered.

This allows the behaviour of the acoustic penalty to be observed before it is used in the route comparison.

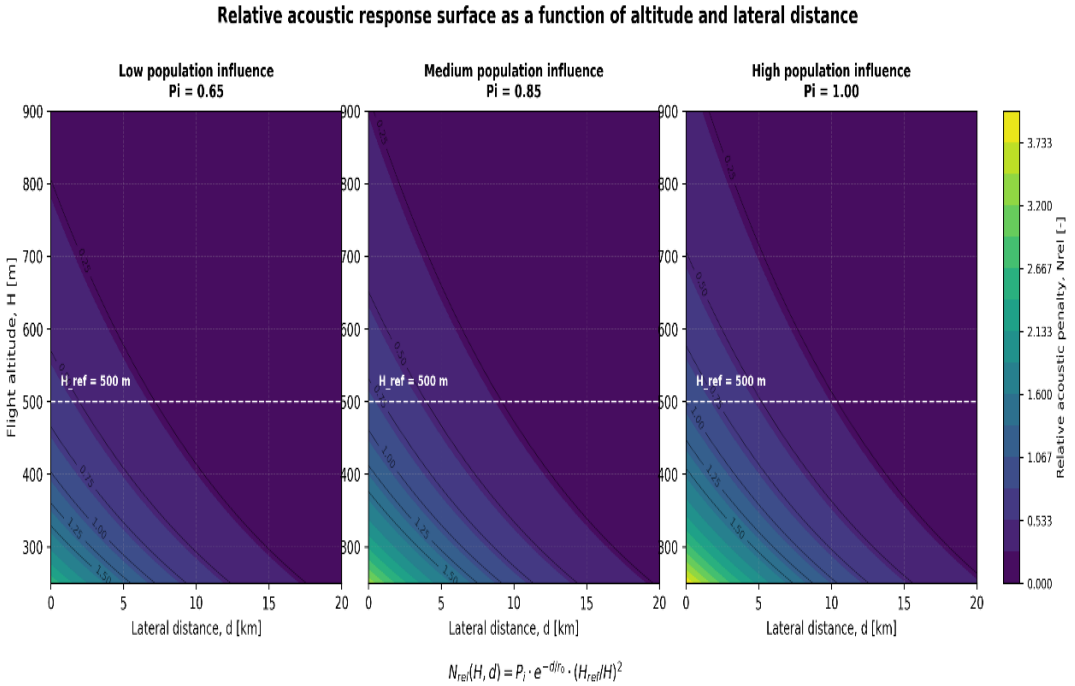


Figure 3. Acoustic performance diagram showing the variation of the relative acoustic response with flight altitude and lateral distance from populated areas.

The three panels represent low, medium and high population-influence levels. The diagram shows that the acoustic penalty decreases when altitude increases and when the trajectory moves farther from populated areas.

The response surface lines up with how the model was meant to behave. The acoustic penalty hits its peak when altitude is low and the lateral distance from populated areas is small. The effect grows stronger as the population coefficient goes up.

For the Bucharest - Buzău mission, this speaks in favor of moderate lateral deviations in the route comparison.

A route does not have to move far off the direct trajectory; even a small step away from populated areas can bring the acoustic exposure lower.

The total acoustic index of a complete route is obtained by summing the segment costs:

$$N_{route} = \sum_{s=1}^m N_s \quad (8)$$

To clarify the behaviour of the acoustic component, the relative cost was plotted against distance, altitude and population coefficient.

This graph helps show how the model reacts when the helicopter moves away from populated areas or flies at a higher altitude.

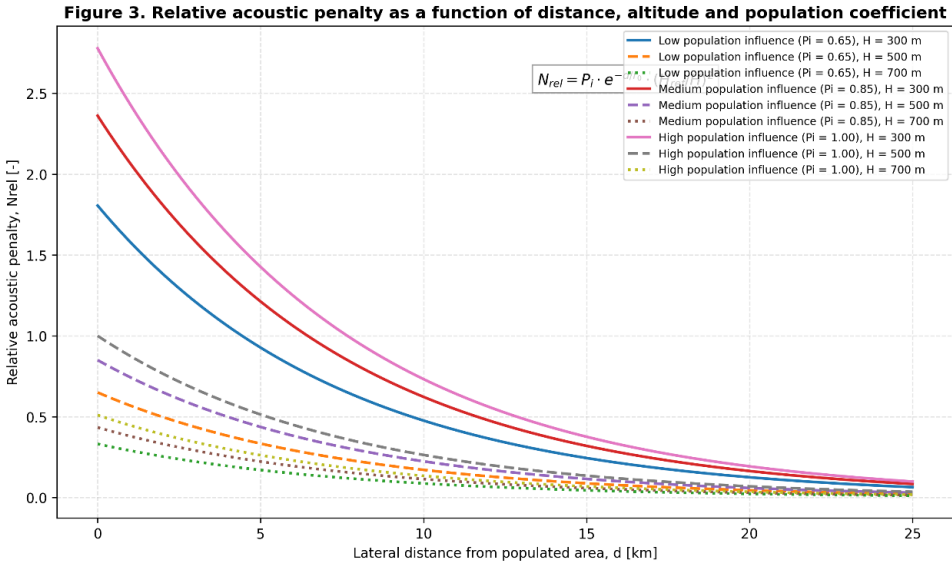


Figure 4. Relative acoustic penalty

The graph confirms what the acoustic model was expected to do. Near populated areas, the cost stays high, all the more so when the population coefficient is large. As the lateral distance grows, the effect fades quickly. Altitude plays its part as well. A higher flight level brings the relative cost down, whereas low flight over populated zones keeps the acoustic impact heavy. For this reason, choosing a route cannot rest on distance alone. Where the flight actually passes, and how exposed the people below are, weighs just as much.

3.7 Routes to Be Compared

The three candidate routes were generated in Python from the numerical corridor set up around the direct Bucharest–Buzău trajectory. The first one was kept as the direct reference. The other two came from small, controlled sideways shifts in the parts of the route where the noise influence from population was stronger. The alternatives weren't random. They follow from the shape of the route and the populated areas already in the acoustic model.

Once the routes were laid out, Python handled the calculations for total distance, flight time, fuel consumption and relative acoustic index in each case with tabular data processing performed using the pandas library [13]. The values were then normalised and combined into a final score, so the chosen route reflects the best trade-off between operational efficiency and noise exposure.

Table 5 – Comparison of the three candidate HEMS routes according to distance, time, fuel consumption and acoustic index.

Route	Distance km	Time min	Fuel kg	Acoustic index	T norm	F norm	N norm	J score
Route C - balanced route	99.08	23.59	90.037	11.443	1.0092	1.009	1.0196	1.013
Route B - stronger acoustic avoidance	100.478	23.923	91.307	11.223	1.024	1.0234	1.000	1.015
Route A - direct reference	98.18	23.376	89.219	11.767	1.000	1.000	1.0485	1.017

The three routes are close to each other in terms of flight time and fuel consumption. Route A remains the shortest and fastest, yet it carries the highest acoustic index. Route B is at the opposite end, with the lowest acoustic score, although this is obtained at the cost of slightly greater distance, time and fuel consumption.

Route B drops the acoustic index the most, but the detour pushes up both time and fuel. So, it does well on the acoustic side, yet it loses ground operationally for a HEMS mission, where time stays a major criterion.

Route C reaches the lowest final score, $J = 1.013$. It is neither the quietest nor the shortest. Its advantage rests in the balance across the three criteria. The route trims acoustic exposure a little compared with the direct trajectory, and keeps the added time and fuel very small. On these grounds, Route C is taken as the optimal trajectory for the Bucharest–Buzău mission within this model.

Figure 4. Comparison of three logical HEMS routes between Bucharest and Buzău

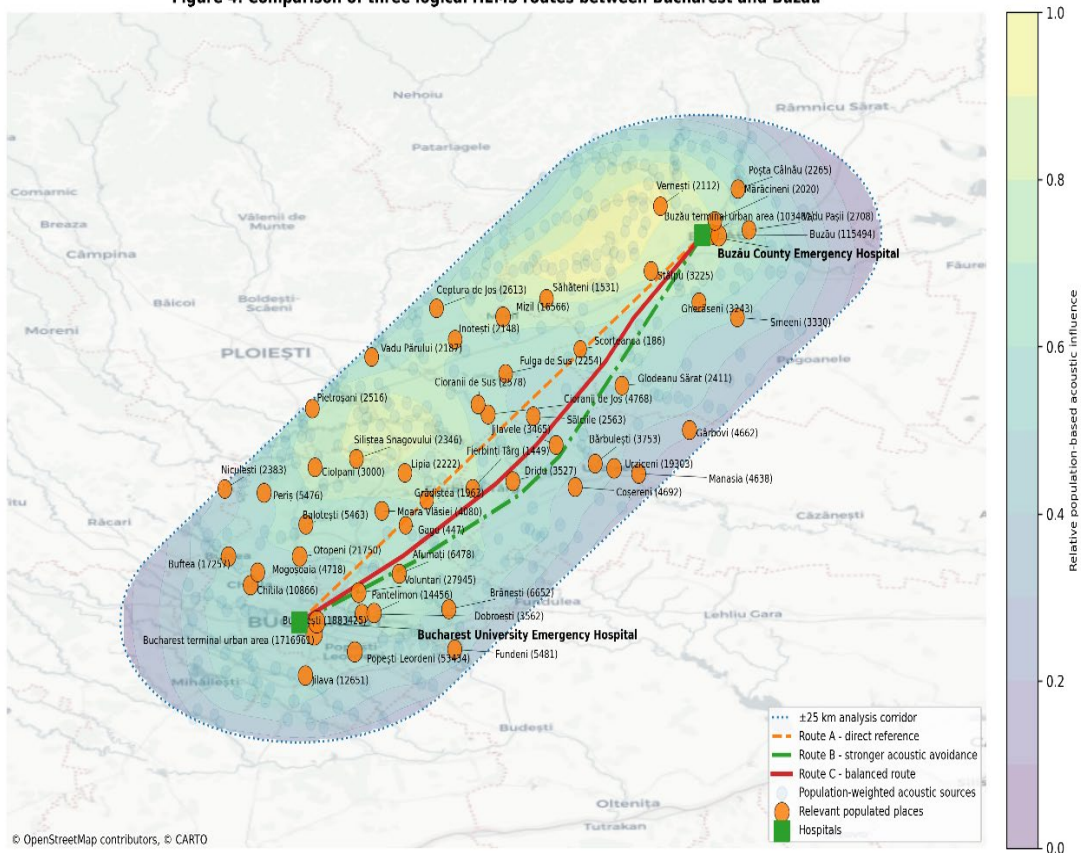


Figure 5. Comparison of three logical HEMS routes between Bucharest University Emergency Hospital and Buzău County Emergency Hospital

Route A is the direct reference trajectory. Route B was built around acoustic avoidance, while Route C looks for a balance between operational efficiency and acoustic exposure. In the background, the map carries the relative population-based acoustic influence fed into the model. From the figure, the direct route stands out as the simplest operational choice, yet it cuts straight through the acoustic influence field, with no deviation at all. Route B pulls away from these zones, most of all in the middle of the corridor, but at the price of a longer path.

Route C sits in between. It does not stray far from the direct line, though it trims some exposure near populated areas. The practical implication is that the acoustic component bends the route only slightly. The model produces no wide detour, just a small correction to the direct trajectory, enough to lower noise exposure without adding meaningful flight time or fuel burn

3.8 Final score function

For the final selection, the three route criteria were combined into one normalized score. This was necessary because flight time, fuel consumption and acoustic impact have different units and cannot be compared directly. A weighted-sum approach was used, which is a common method in multi-criteria decision analysis [15]

$$J = w_T \cdot T_{\text{norm}} + w_F \cdot F_{\text{norm}} + w_N \cdot N_{\text{norm}} \quad (9)$$

where:

$$T_{\text{norm}} = \frac{T}{T_{\min}}$$

$$F_{\text{norm}} = \frac{F}{F_{\min}}$$

$$N_{\text{norm}} = \frac{N}{N_{\min}}$$

In these relations, T is the flight time, F is the estimated fuel consumption, and N is the relative acoustic index of the analysed route. The values $T_{\min}$, $F_{\min}$, and $N_{\min}$ are the best values obtained among the compared routes. The weights used in the model were:

$$w_T = 0.45$$

$$w_F = 0.20$$

$$w_N = 0.35$$

Therefore, the final score becomes:

$$J = 0.45 \cdot \frac{T}{T_{\min}} + 0.20 \cdot \frac{F}{F_{\min}} + 0.35 \cdot \frac{N}{N_{\min}}$$

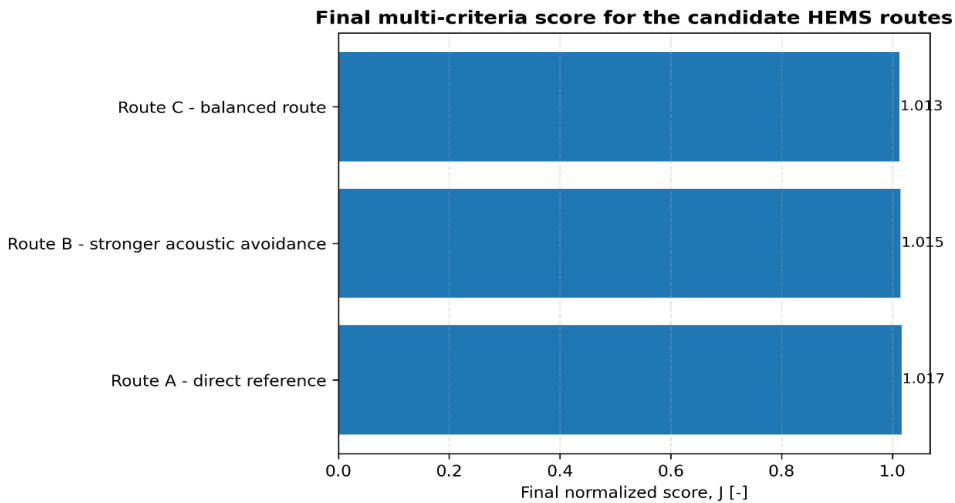


Figure 6. Final normalized score of the three candidate HEMS routes. Lower values indicate better overall performance

Going by the computed values, Route C came out with the lowest final score. On this basis it was picked as the optimal route, since it keeps the added time and fuel small while bringing down the acoustic impact compared with the direct reference trajectory.

4. CONCLUSIONS

The analysis ends on a result that is more balanced than a simple shortest-route choice. The direct trajectory still looks favorable from an operational angle, since it returns the lowest time and fuel values. Yet once populated areas come into the calculation, that advantage alone is not enough.

Route C was chosen as the final trajectory because it follows the direct path closely, yet trims part of the acoustic exposure. The improvement is modest and should be treated that way. The value here is the balance: a small rise in distance, time and fuel, for a lower impact on populated zones.

The model is not meant to take the place of operational flight planning. Weather, airspace restrictions, visibility, crew judgement and the urgency of the mission all fall outside the scope of this simplified calculation. Even so, the method gives a useful technical ground for weighing route options before a mission profile is selected on.

For the Bucharest–Buzău HEMS scenario, the result points toward a modest lateral adjustment. Not a large detour. Just enough to ease acoustic exposure while holding to the main goal of the mission: reaching the destination quickly and safely.

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