Key Marine-Aviation Transport Technologies Parameters in Basic Consideration: Simplest Approach

ANDRIY VIKTOROVICH GONCHARENKO*, VOLODYMYR OLEGOVICH AVRAMENKO
Kyiv Aviation Institute,
1, Liubomyra Huzara Avenue, Kyiv, 03058,
UKRAINE

*Corresponding Author

Abstract: - The paper is dedicated to the generalization of the transportation technologies problem. The first sub-problem deals with the transportation route optimization with respect to the time of delivery minimization and taking into consideration two available links of the transportation chain or corridor. Variation of the speed, as a significant transportation parameter, is taken into account. The second sub-problem is centered upon the minimal transportation expenses by the delivery speed optimization. The hourly transportation expenses which do not depend upon the speed are chosen as a significant parameter. The final problem generalizes the first two ones in the formulation of minimal transport cost at the optimal speeds and route. Numerical simulation is conducted and necessary diagrams are plotted.

Key-Words: - Aviation transport, marine transport, minimization, optimization, significant parameter, simulation, speed of transportation, transport expenses, transportation technologies.

Received: September 25, 2025. Revised: January 9, 2026. Accepted: June 6, 2026. Published: July 17, 2026.

1 Introduction

The problem of transportation technologies is a complex one influenced by many factors. Therefore, it is a rational approach to consider some general properties of the transport systems applicable to the specific operational conditions of the transportation means.

In this context we propose to consider the marine transport technologies and aviation transport technologies since they are close to one another, in the sense of their degrees of freedom for the motions (routes) of their key elements: transportation means.

1.1 Literature Review

The key parameters of the marine-aviation transportation technologies in this regard are supposed to be the distances of transportation as well as the speeds, durations, and expenses. The importance of the transportation cost taking into account is described in [1]. The sources, [2], [3], [4], [5], accentuate the attention upon the features of operation and optimization. The presented consideration extends the transportation demand development, [2]. The main attention of authors in [3] is paid to the important transportation technologies elements structure. Infrastructure optimization issue also was considered in [3], where the main task was to minimize repair costs of aviation radio equipment.

The publications of [4], [5], are dedicated to the impact upon the environment, which also has to be taken into account at the formulation of optimization criteria.

The authors of [6] discuss the ways for the aircraft control reconfiguration improvement, which takes place in operation and could be considered in the presented study as a special kind of constraints. Publications, [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], point out that a significant number of the relevant researches, dealing with the narrower fields of interests, has, nevertheless, a common application to the key technological parameters considered in the presented paper.

The article, [20], emphasizes subjectivity when constructing research models. Maritime transportation technologies considered in [21], [22], [23], require key parameters accurate evaluation. As studies, [24], [25],

[26], [27], show, there is a big similarity in aviation and maritime transport modes regarding economic and environmental optimization.

The theory of subjective preferences allows studying phenomena related with the individuals' inclinations to some operational options, [28], [29], [30]. As to the key parameters characterizing marine-aviation transport technologies, we distinguish herein: Speed of transportation; Distance of transportation; Duration of (time for) transportation; Expenses (costs) of transportation. Very specific property of the distance and speed of transportation product was noticed. Similar approaches are proposed to the variety of the issues marked in [31].

1.2 Scientific Gap

It is always an important and actual problem to generalize the consideration of the key factors/parameters in their interrelationships and interdependencies accentuating the objective functions or functionals in order to optimize the other key features of the transport technologies. In such regard the scientific gap proposed to be filled is a few sequential step combinations of optimizations applicable to aviation and marine transportation technologies.

1.3 Problem Statement

All the above contemplations drive us to formulate the considered problem statement as the consequent links of chain for basic optimization in the manner of the optimal route by the minimal time of delivery, then in a certain combination with the minimal transportation expenses as the objective of the technological process with respect to the speed of the transportation mean.

2 Theoretical Part

At the beginning we consider a sub-problem of the route of the transportation optimization with respect to the minimal delivery time in the simplest view.

2.1 Transportation Route Corner Point to Minimize the Time of Delivery

Suppose there is a transportation corridor consisting of the following two components: the first is the space having the width of a, which to be crossed, in front of the second component, the straight way to the destination.

The speed limit for the motion within the first (space) is v_1; and for the second (straight way) it is v_2.

The distance from the closest to the departure point on the straight way to the destination is b.

The problem is to determine the route minimizing the time: T of the delivery.

In such primitive problem setting the objective function will be presented as:

$$T = \frac{\sqrt{a^2 + x^2}}{v_1} + \frac{b - x}{v_2} = T(x), \tag{1}$$

where x is the linear coordinate of the corner point of the route from the closest to the departure point on the straight way.

The necessary conditions for (1) extremum existence yield the solution:

$$x_{opt} = \frac{a v_1}{\sqrt{v_2^2 - v_1^2}}. \tag{2}$$

Next up is the speed optimization sub-problem with the transportation expenses' objective function.

2.2 Optimal Speed of Transportation to Minimize the Cost of Delivery

In this, also simplified, problem setting it is proposed to take into account the two components for the hourly transportation expenses. The first component does not depend upon the speed: v, of the transportation mean: $s_1^{(h)}$; whereas the second component does depend: $s_2^{(h)}(v)$.

The dependent component for the water-displacing ships as well as aircraft with the dynamic principles of the support in the air is proportional to the speed of motion raised to a certain power.
Herewith it is accepted:

$$s_2^{(h)}(v) = k v^3, \tag{3}$$

where k is the coefficient of the proportionality.

Thus, the problem is formulated as to minimize the cost of transportation: Σ.

The objective function is:

$$\Sigma = Ts_1^{(h)} + Tkv^3. \tag{4}$$

The time T in (4) is given with

$$T = \frac{D}{v}, \tag{5}$$

where D is the distance of the transportation.

In the framework of the problem setting (4) with the condition of (5), the necessary conditions for (4) extremum existence yield the solution:

$$v_{opt} = \sqrt[3]{\frac{s_1^{(h)}}{2k}}. \tag{6}$$

The next step of the theoretical research it is a combination of (1) and (4).

2.3 Optimization of Transportation Speed and Route to Minimize the Cost of Delivery

It is proposed to generalize the above problem settings of (1) and (4) into such one considering the differences in the parameters at the transportation route segments.

The formula expressing the approach has the following view of the generalized objective function:

$$\Sigma = s_h^{(1)}T_1 + s_h^{(2)}T_2, \tag{7}$$

where $s_h^{(1)}$ and $s_h^{(2)}$ are the hourly costs for the first and second segments of the route; T_1 and T_2 are the corresponding times (durations) of the transportation.

Equation (1) is developed into

$$\Sigma = \left(s_1 + k_1 v_1^3\right)\frac{\sqrt{a^2 + x^2}}{v_1} + \left(s_2 + k_2 v_2^3\right)\frac{b - x}{v_2}, \tag{8}$$

where s_1 and s_2 are the hourly costs that do not depend upon the speed of transportation for the first and second segments of the route; k_1 and k_2 are the corresponding coefficients of proportionality.

Equation (8) can be considered now an objective function of 3 independent variables and the necessary conditions for (8) extremum existence yield the solution:

$$\left.\begin{aligned} v_1^{opt} &= \sqrt[3]{\frac{s_1}{2k_1}}; \\ v_2^{opt} &= \sqrt[3]{\frac{s_2}{2k_2}}; \\ x^{opt} &= \frac{av_1\left(s_2 + k_2 v_2^3\right)}{\sqrt{v_2^2\left(s_1 + k_1 v_1^3\right)^2 - v_1^2\left(s_2 + k_2 v_2^3\right)^2}}. \end{aligned}\right\} \tag{9}$$

3 Simulation

In this section we present the results of computer simulation for the cases theoretically developed above. The results are shown in Figure 1.

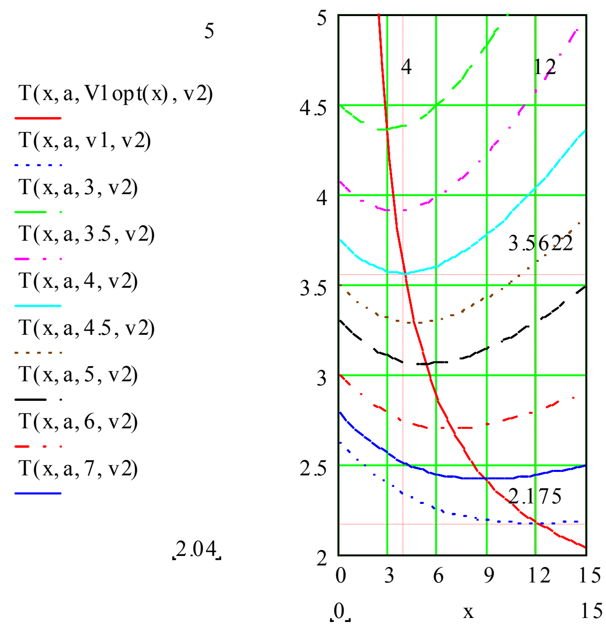

Fig. 1: Mapping time of delivery minimization with respect to the corner point coordinate optimization and the speed of transportation at the first segment variation

Source: created by the authors.

The accepted numerical data for the first sub-problem are as follows:

$$a = 9 \text{ nautical miles (nm)}, b = 15 \text{ nm}, \\ v_1 = 8 \text{ knots (kn)}, v_2 = 10 \text{ kn}, x = 0, 0.5 \ldots b \text{ nm}. \tag{10}$$

The accepted numerical data for the second sub-problem are as follows:

$$D = 10^4 \text{ nm}, k = 30/10^3 \text{ (\$/h)/(kn}^3\text{)}, \\ s_1^{(h)} = 480 \text{ \$/h}, v = 10 \ldots 30 \text{ kn}. \tag{11}$$

The results are shown in Figure 2.

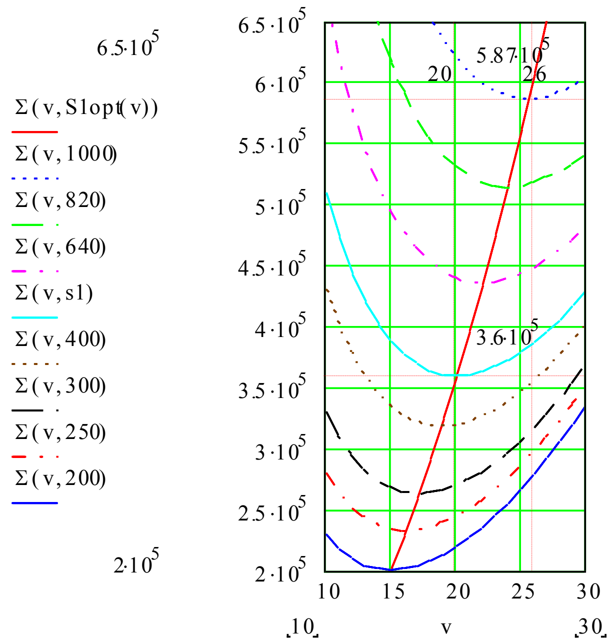

Fig. 2: Mapping cost of delivery minimization with respect to the speed of transportation optimization and the independent upon the speed hourly transportation expenses variation
Source: created by the authors.

The accepted numerical data for the generalized problem are as follows:

$$k_1 = k_2 = 30/10^3 \text{ (\$/h)/(kn}^3\text{)}, \\ s_1 = 480 \text{ \$/h}, s_2 = 450 \text{ \$/h}. \tag{12}$$

The results are shown in Figure 3.

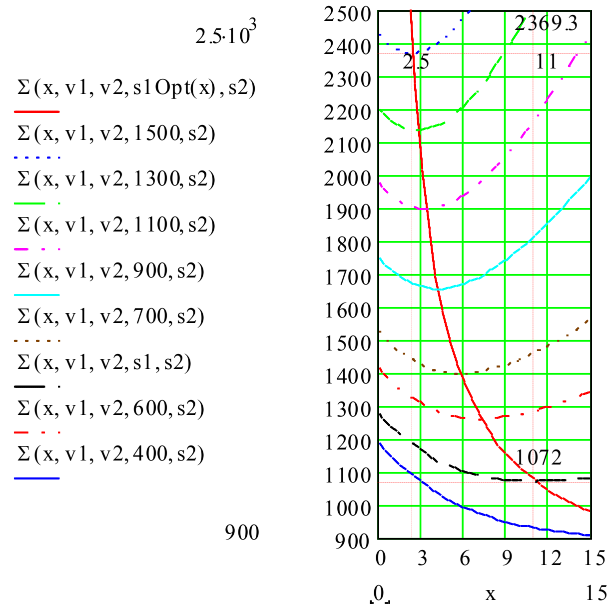

Fig. 3: Mapping cost of delivery minimization with respect to the corner point coordinate optimization and the independent upon the speed hourly transportation expenses variation
Source: created by the authors.

4 Discussion

In the first sub-problem basically considered with (1), (2) the extremum changes its position with respect to the optimized parameter x ranging in the diapason of 3 … 12 nm.

That occurs due to the significant parameter of the transportation speed variation, in the first segment of the route v_1 variates 3 … 8 kn. The extremum drifts nonlinearly (see Figure 1, red trace).

As to the second sub-problem described with (3)–(6), the objective function (4) extremum also changes its location nonlinearly but here because of the transportation expenses $s_1^{(h)}$ variation (see Figure 2, red trace).

Simulation in the generalized problem with (7)–(9) allows variations with the five parameters and consideration of significant $s_1^{(h)}$ variation, optimizing parameter x, allows tracing extremum values of the objective function (see Figure 3, red trace).

Acknowledgement:
A. V. Goncharenko thanks for the sponsor and financial support to Frau Elfriede Anna Maria Bier, Rivenich, Deutschland.

References:
[1] K. Kuiken, Diesel Engines for Ship Propulsion and Power Plants from 0 to 100,000 kW. Onnen, The Netherlands: Target Global Energy Training, 2008, part 2, [Online]. https://www.dieselenginebook.com/product/e-book-diesel-engines-for-ship-propulsion-and-power-plants-from-0-to-100-000-kw-3rd-revised-edition/5 (Accessed Date: January 15, 2026).

[2] S Khalili, E. Rantanen, D. Bogdanov, and C. Breyer, "Global transportation demand development with impacts on the energy demand and greenhouse gas emissions in a climate-constrained world," Energies, vol. 12, no. 20: 3870, 2019, https://doi.org/10.3390/en12203870.

[3] M. Zaliskyi, V. Ivannikova, O. Solomentsev, I. Ostroumov, and N. Kuzmenko, "The approach to optimization of the structure of the repair process of aviation radio equipment," Transport, vol. 40(1), pp. 50–63, 2025, https://doi.org/10.3846/transport.2025.24012.

[4] O. Zaporozhets, V. Tokarev, and K. Attenborough, Aircraft Noise: Assessment, prediction and control. Boca Raton, FL: CRC Press, 2012, https://doi.org/10.1201/b12545.

[5] M. Mandegari, M. Ebadian, and J. J. Saddler, "The need for effective life cycle assessment (LCA) to enhance the effectiveness of policies such as low carbon fuel standards (LCFS's)," Energy Policy, vol. 181: 113723, 2023, DOI: 10.1016/j.enpol.2023.113723.

[6] V. M. Kazak, D. O. Shevchuk, V. G. Vovk, and M. H. Levchenko, "Automation of aircraft control reconfiguration in flight special situations," in Proc. IEEE 3rd Int. Conf. Methods and Systems of Navigation and Motion Control, Kyiv, Ukraine, 2014, pp. 161–164, https://doi.org/10.1109/MSNMC.2014.6979759.

[7] P. Mercorelli, "A two-stage augmented extended Kalman filter as an observer for sensorless valve control in camless internal combustion engines," IEEE Transactions on Industrial Electronics, vol. 59, no. 11, pp. 4236–4247, Nov. 2012, https://doi.org/10.1109/TIE.2012.2192892.

[8] M. G. Sürer and H. T. Arat, "Advancements and current technologies on hydrogen fuel cell applications for marine vehicles," International Journal of Hydrogen Energy, vol. 47, no. 45, pp. 19865–19875, May 2022, https://doi.org/10.1016/j.ijhydene.2021.12.251.

[9] Z. Yang, Z. Zhu, Y. Zhao, Y. Tian, C. Fan, R. Guo, W. Lu, J. Ge, B. Chen, Y. Zhang, G. Wu, R. Wang, G. Cheng, J. Huang, Z. Liu, J. Zhang, and I. J. Rudas "Cognitive underwater acoustic networking and target tracking: a comprehensive survey," in IEEE Transactions on Cognitive Communications and Networking, vol. 12, pp. 5913–5936, Jan. 2026, https://doi.org/10.1109/TCCN.2026.3658820.

[10] J. Kasper and C. Hutchinson, "The Omega navigation system--An overview," in IEEE Communications Society Magazine, vol. 16, no. 3, pp. 23–35, May 1978, https://doi.org/10.1109/MCOM.1978.1089729.

[11] J. D. Foster, "Swarming unmanned aerial vehicles (UAVs): extending marine aviation ground task force communications using UAVs," Dec. 2014, [Online]. https://apps.dtic.mil/sti/tr/pdf/ADA621203.pdf, (Accessed Date: January 15, 2026).

[12] L. Lazic and N. Mastorakis, "Cost effective software test metrics," *WSEAS Transactions on Computers,* vol. 7, no. 6, pp. 599–619, June 2008.

[13] R. M. Davis, "Web-enabled database application for Marine Aviation Logistics Squadrons an operations and sustainment prototype," Doctoral dissertation, Monterey, CA; Naval Postgraduate School, 2006, [Online]. https://www.semanticscholar.org/paper/Web-Enabled-Database-Application-for-Marine-An-and-Davis/2544861b8958aba24154994cb8abfeb3466c2a60 (Accessed Date: January 15, 2026).

[14] I. Kacem, S. Hammadi, and P. Borne, "Pareto-optimality approach for flexible job-shop scheduling problems: hybridization of evolutionary algorithms and fuzzy logic," Mathematics and Computers in Simulation, vol. 60, no. 3–5, pp. 245–276, Sept. 2002, [Online]. https://ideas.repec.org/a/eee/matcom/v60y2002i3p245-276.html (Accessed Date: January 18, 2026).

[15] J. M. Pak, C. K. Ahn, P. Shi, Y. S. Shmaliy, and M. T. Lim, "Distributed hybrid particle/FIR filtering for mitigating NLOS effects in TOA-based localization using wireless sensor networks," IEEE Transactions on Industrial Electronics, vol. 64, no. 6, pp. 5182–5191, June 2017, [Online]. https://pure.korea.ac.kr/en/publications/distributed-hybrid-particlefir-filtering-for-mitigating-nlos-effe/ (Accessed Date: January 18, 2026).

[16] C. Breyer, M. Fasihi, C. Bajamundi, and F. Creutzig, "Direct air capture of CO2: a key technology for ambitious climate change mitigation," Joule, vol. 3, no. 9, pp. 2053–2057, Sep. 2019, https://doi.org/10.1016/j.joule.2019.08.010.

[17] E. Popescu and F. Leon, "Predicting academic performance based on learner traces in a social learning environment," IEEE Access, vol. 6, pp. 72774–72785, 2018, https://doi.org/10.1109/ACCESS.2018.2882297.

[18] V. Chikovani, O. Sushchenko, and H. Tsiruk, "Redundant information processing techniques comparison for differential vibratory gyroscope," Eastern-European Journal of Enterprise Technologies, vol. 4, no. 7(82), pp. 45–52, 2016, https://doi.org/10.15587/1729-4061.2016.75206.

[19] D. Oke, J. B. Dunn, and T. R. Hawkins, "The contribution of biomass and waste resources to decarbonizing transportation and related energy and environmental effects," Sustainable Energy & Fuels, vol. 6, no. 3, pp. 721–735, 2022, [Online]. https://pubs.rsc.org/en/content/articlelanding/2022/se/d1se01742j (Accessed Date: January 15, 2026).

[20] R. Yan, S. Wang, L. Zhen, and G. Laporte, "Emerging approaches applied to maritime transport research: Past and future," Communications in Transportation Research, vol. 1: 100011, Dec. 2021. https://doi.org/10.1016/j.commtr.2021.100011,

[21] I. Golubkova, T. Frasyniuk, M. Babachenko, A. Yavorska, and T. Levinska, "Features of formation of basic parameters of the specialized marine transport fleet," Financial and Credit Activity: Problems of Theory and Practice, vol. 3, no 44, pp. 159–165, 2022, DOI: 10.55643/fcaptp.3.44.2022.3750.

[22] P. Pinakpani, A. Polisetty, G B. N Rao, H. S. D, B M. Kumar, D. Deepthi, and A. Sidhireddy, "An algorithmic approach for maritime transportation," International Journal of Advanced Computer Science and Applications, vol. 11, no. 2, pp. 764–775, 2020, https://dx.doi.org/10.14569/IJACSA.2020.0110296.

[23] M. Stojaković and E. Twrdy, "A simulation approach to the definition of the subsystems parameters in small container terminals" Journal of Marine Science and Engineering, vol. 9, no. 9: 1023, Sep. 2021. https://doi.org/10.3390/jmse9091023.

[24] CE Delft & DLR 2021, Research for TRAN Committee – Maritime shipping, aviation and the EU ETS: challenges and impacts, Overview briefing, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels, 2021, [Online]. https://ce.nl/wp-content/uploads/2021/07/IPOL_STU2021690886_EN.pdf (Accessed Date: January 22, 2026).

[25] A. Stips, D. Macias Moy, C. Coughlan, E. Garcia-Gorriz, and X. S. Liang, "On the causal structure between CO2 and global temperature," Scientific Reports, vol. 6, JRC100342; p. 21691, 2016, https://doi.org/10.1038/srep21691.

[26] P. J. Ansell, "A blueprint for a zero-emission hydrogen aviation ecosystem for the year 2050," Progress in Aerospace Sciences, vol. 160: 101169, Jan. 2026, https://doi.org/10.1016/j.paerosci.2025.101169.

[27] C. Voigt, J. Kleine, D. Sauer, R. H. Moore, T. Bräuer, P. Le Clercq, S. Kaufmann, M. Scheibe, T. Jurkat-Witschas, M. Aigner, U. Bauder, Y. Boose, S. Borrmann, E. Crosbie, G. S. Diskin, J. DiGangi, V. Hahn, C. Heckl, F. Huber, J. B. Nowak, M. Rapp, B. Rauch, C. Robinson, T. Schripp, M. Shook, E. Winstead, L. Ziemba, H. Schlager, and B. E. Anderson, "Cleaner burning aviation fuels can reduce contrail cloudiness," Commun Earth Environ, vol. 2, no. 1: 114, June 2021, https://doi.org/10.1038/s43247-021-00174-y.

[28] A. V. Goncharenko, "Expediency of unmanned air vehicles application in the framework of subjective analysis," in Proc. IEEE 2nd Int. Conf. Actual Problems of Unmanned Air Vehicles Developments, Kyiv, Ukraine, 2013, pp.

129–133, https://doi.org/10.1109/APUAVD.2013.6705304

[29] A. V. Goncharenko, "Active systems communicational control assessment in multi-alternative navigational situations," in Proc. IEEE 5th Int. Conf. Methods and Systems of Navigation and Motion Control, Kyiv, Ukraine, 2018, pp. 254–257, https://doi.org/10.1109/MSNMC.2018.8576285.

[30] A. V. Goncharenko. (2018). Airworthiness support measures analogy to the prospective roundabouts alternatives: theoretical aspects. Journal of Advanced Transportation. [Online]. vol. 2018, Article ID 9370597, 7 pages. https://doi.org/10.1155/2018/9370597.

[31] A. G. Fareed, F. De Felice, A. Forcina, and A. Petrillo, "Role and applications of advanced digital technologies in achieving sustainability in multimodal logistics operations: a systematic literature review," Sustainable Futures, vol. 8, 100278, Dec. 2024, https://doi.org/10.1016/j.sftr.2024.100278/

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Andriy Viktorovich Goncharenko carried out the idea general management and supervision of the research, theoretical derivations, simulation, and optimization.

Volodymyr Olegovich Avramenko carried out the literature analysis and parameters and results interpretation in terms of marine and air transport technologies.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

The potential source of funding for the presented research is: Frau Elfriede Anna Maria Bier, Rivenich, Deutschland.

Conflicts of Interest

The Authors have no Conflicts of Interest