VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

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RESEARCH OF TECHNOLOGICAL PROCESSES OF OVERSIZE AND HEAVYWEIGHT CARGO'S TRANSPORTATION AND SELECTION OF RATIONAL ROUTE

SUMMARY OF DOCTORAL DISSERTATION

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Artūras PETRAŠKA

SUNKIASVORIŲ IR DIDŽIAGABARIČIŲ KROVINIŲ VEŽIMO TECHNOLOGINIŲ PROCESŲ TYRIMAI IR RACIONALAUS MARŠRUTO PARINKIMAS

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Introduction

The Research Problem

In the context of the constant development of transport systems and changing technical characteristics of infrastructure, the transport system should meet the requirements for the delivery of the oversize and heavyweight cargoes (OHC) required for the needs of industry. The lack of the systematic approach to the processes of the transportation of the oversize and heavyweight cargoes has led to the disproportionately large costs of the development of the new industrial facilities; therefore, the introduction of the new industrial facilities has become less attractive, it slows down economic development in any territory wich lacks such infrastructure.

In this paper, a universal multi-criteria evaluation system for OHC transportation has been developed. It allows assessing the processes of the transportation of the oversize and heavyweight cargoes in an objective way and guaranteeing the choice of the most appropriate economic and organizational operations and tools, has been developed.

The Relevance of the Paper

The transportation of the oversize and heavyweight cargoes is usually carried out in order to satisfy the need of certain subject to transport the equipment on it's private interest and initiatives. The transportation processes of such type of cargoes should be planed and evaluated on an individual basis; therefore, a considerable amount of investments is required. The aim of every cargo owner is to minimize the costs of the transportation and the development of the road infrastructure; thus, road infrastructure improvements are usually temporary ones, whereas the investments in the temporary constructions do not improve the road infrastructure and, what is more, other cargo carriers are often unable to take advantages of such kind of improvements. According to the point of view of the infrastructure owner (a public entity), such kind of operations should be considered as irrational ones as they do not improve the investment environment. Using the universal evaluation system for the transportation processes of the oversize and heavyweight cargoes, developed in this paper the opportunity to evaluate the transportation processes of the OHC objectively comparing different means of transport, route segments and transportation and cargo handling technologies has been created. The methodology could be applied to any area, especially when planning and implementing long-term OHC transportation routes.

The Research Object

The research object of the present paper is the transportation processes of the OHC and their interdependencies.

The Aim of the Research

The aim of the research is to develope the methodology of the selection of the most suitable route, vehicle type and transportation means for the transportation of the oversize and heavyweight cargoes, considering the specificity of the cargo, the parameters of the road infrastructure and the intensity of the traffic flow.

The Objectives of the Research

In order to achieve the aim of the research paper, the following goals should be tackled:

1. To evaluate investigation level of the analysed issue in the scientific literature sources.
2. To accomplish analysis of the transportation processes of the oversize and heavyweight cargoes, and to develop the mathematical model for the route assessment based on the results of the analysis.
3. To create the most suitable methodology for selecting transportation routes of the oversize and heavyweight cargoes estimating the three transportation means (i.e., road, rail and inland waterways).
4. To check the effectiveness of the methodology estimating the capabilities of the transportation of the oversize and heavyweight cargoes in a specific area.

The Methodology of the Research

The methodology is based on the analysis of the indicators of technological processes in transportation and analysis of statistical data, Lithuanian and foreign researchers work in the field of assessment in determining the exploration level of the issue and current situation transporting oversized and heavyweight cargo. The method of synthesis for creating OHC transportation route selection mathematical description of evaluation criteria system has been used in this paper. Grouping and processing methods of statistical data are applied for evaluation the risk of analyzed cargo transportation.

The Scientific Novelty of the Research Paper

When dealing with the thesis, the following results, which are new to the transportation engineering science, have been obtained:

1. A universal criteria system for evaluation the routing of the oversize and heavyweight cargoes, which allows evaluating the circumstances of cargo road transportation, railway and water transport in various aspects, has been formulated

2. An original methodology based on the criteria system for the evaluation of routing which allows evaluating and selecting the means of transport and the most suitable route for the transportation of the oversize and heavyweight cargoes, has been developed.

3. The influence of individual OHG transportation's operations on the entire transportation process has been defined.

The Practical Value of the Research Paper

1. The methodology is universal; therefore, the integration of the OHC transportation processes into general transport system of any country's territory is appropriate to be integrated.

2. Applying the universal system of the evaluation of the OHC transportation processes, which has been developed in this paper, it is possible to minimize designing time and reduce expenses.

3. The universal methodology of the transportation of the oversize and heavyweight cargoes has been tested by carrying out the feasibility study of the OHC transportation in Lithuania.

Defended Propositions

1. The mathematical model of the route evaluation methodology, based on the multi-criteria system, which allows carrying out an integrated evaluation and selection of the means of transport and the optimal route for the transportation of the oversize and heavyweight cargoes.

2. After applying at work created universal criteria system for the evaluation of the transportation routing of the oversize and heavyweight cargoes, which selects the most appropriate transportation route, it is possible to reduce the duration of engineering calculations and expenses of the project.

3. The universal criteria system for the evaluation of the transportation routing of the oversize and heavyweight cargoes, naming the most important possible criteria which effects transportation processes, has been created.

The Structure of the Dissertation

The dissertation consists of the introduction, 3 chapters, references, the list of publications and appendices.

The volume of the paper is 118 pages. There are 81 numbered formulas, 13 figures and 4 tables in the dissertation. When working on the dissertation, 118 scientific literature (and other) sources have been reviewed.

1. Analysis of Heavyweigt and Oversized Cargo's Transportation Problems

In the present paper, the review of the scientific literature has been carried out considering the issues related to the concept of the oversize and heavyweight cargoes in the transportation processes, including the areas of the integrated problems of the OHC transportation process, route selection, the peculiarities of the route planning and reconstruction, the evaluation of the negative impact of the transportation processes on the route infrastructure, possible measures for the minimization, or compensation, of the negative impact of the transport, the evaluation of the risks of the transport operations, the analysis of the influence of the regulatory environment governing the transportation policy of the oversize and heavyweight cargoes, and the evaluation of the negative impact of the transportation operations on the social environment.

In the scientific literature dealing with the transportation issues of the oversize and heavyweight cargoes, a number of useful examples of the analysis and planning of the OHC transportation processes are presented; e.g., Lamiraux *et al.* present's automated constant transportation speed security, Cheng and Lester analyse trajectory optimization, Durham, Faghri 2002; Datla *et al.* present's GIS application to route planning and etc. However, the investigation of individual cases narrows the boundaries of each of the researches; thus, their results become hardly adaptable to other transportation conditions, that does not allow comparing different means of transport and providing analytical flexibility. The systems suggested by the authors could not be applied to planning the routes for other means of transport without significant changes.

Batarlienė, Kersten *et al.*, Parentela, Rikov analyse transportation risks and the principles of the traffic intensity evaluation and planning, the mathematical dependencies, allowing rating and planning the levels of traffic intensity in certain road sections. These mathematical principles could be successfully used when planning the OHC transportation routes.

Park, Woxenius, Shekharan, Ostrom, Rodrigue, Comtois are stressing on inportance of planning a new road, or a reconstruction of an existing one, technical and economic calculations, basing the necessity and economic expediency of the road, should be taken into consideration. The calculation principles of the cargo traffic and cargo turnover suggested by the researchers could be applied when dealing with the same calculations in case of OHC

transportation. However, the cases of the multiple use of the road transport infrastructure for the OHC transportation should be taken into account.

Janic, Kovalenko and study of Simplextrans are making emphasizes on the fact that global tendencies related to the increase of the rail freight efficiency by increasing the axial load and charging of the vehicle could easily solve the problem of the OHC transportation by rail. It could be assumed that the additional revenue obtained by maximising the efficiency of the rail system due to the cargo and OHC transportation by heavyweight trains could compensate the increased costs of the road infrastructure and vehicle repairs.

It should be noted that the rail track reconstruction or the construction of a new section for the OHC transportation could be expedient only in case of planning a permanent routes suitable for the OHC transportation.

The review of the literature sources has shown that the alternative for the combination of the rail and road means of transport for the transportation of the OHC has not been practically used. It is obvious that such a drawback is caused by the insufficient application of the rail infrastructure to the process of cargo handling, and the lack of the OHC reloading equipment, or its insufficient mobility. The latter statement is also applicable to the inland water transportation.

According to the works of Janic, Woxenius, Heatco studies dealing with water transport, this mean of transportation is the least sensitive to the load and mass of the cargo. In water transportation, the problem of the overweight of the cargoes is easily solved as both maritime and inland ports are usually the star and the end points of the OHC transportation route; thus the carriers are tend to use water, especially maritime, transportation. On the basis of the literature reviewed, it could be assumed that inland water transportation is more preferable for the OHC transportation due to lower restrictions for weight, dimensions, power consumption and accidents. The largest shortcoming of the latter mean of transport is related to the seasonality in the areas, in which water routes freeze in winter, and water level gets lower in summer.

In the global transport market, especially within the EU, the transport policy attitude, stating that all cargoes transported by road should be transported by water or rail if it is possible, has recently prevailed. Considering to the possible transport development prospects, it could be pointed out that the latter trend will probably continue for a long time. Hence, when dealing with the methodologies and systems of the OHC transportation planning, the fact mentioned above should be taken into account.

On the territories of individual countries or their economic unions, the tracks of the oversize and heavyweight cargoes should be considered the part of the system of the economic infrastructure of the territory in question. Such

systems should be planned on the basis of the systematic interdisciplinary principles. The evaluation system for the OHC transportation processes, considering all mentioned factors, could solve the latter problem.

2. Criteria System of Route Selection for Heavyweight and Oversized Cargo Transportation

Due to the need of the transportation of the oversize and heavyweight cargoes, it is highly important to determine the conditions, which could be two-fold: the specific need of transporting the specific cargo from the point A to the point B, or the projections related to the appearance of the multiple need for the transportation of such cargoes within a certain area.

Route Requirements:

- matching the load parameters;
- technically safe (i.e., the infrastructure allows transporting the oversize and heavyweight cargo safely);
- acceptable considering the distance:
  - the least time is spent in transportation;
  - rational taxation of the oversize and heavyweight cargoes.
- cheap (i.e., ensuring the lowest transportation costs);
- making the minimum negative impact on the environment.

In case of multiple use of the intended route for a long period of time, it should meet the additional requirements to such kind of route for the transportation of the oversize and heavyweight cargoes:

- suitable for multiple use;
- covering the majority of the economically active zones in the area;
- technologically modern.

Vehicle Requirements:

- technically save;
- making the minimum negative impact on the transportation infrastructure;
- ensuring the maximum transportation speed;
- making the minimum negative impact on the environment and people (i.e., minimum pollution, noise and infra-low-frequency vibration level).

In order to implement the principles listed above, a set of 16 criteria with separate sub-criteria has been developed to identify the processes of the transportation of the oversize and heavyweight cargoes and evaluate the parameters of the route, the way of transportation and the mean of transport. It allows evaluating all processes of the OHC transportation in the unified system by comparing different ways of transportation.

In order to express the criteria affecting the routing of the OHC transportation mathematically, the following formulas are used:

$$Z_{AS}(S) = \sum_{j=1}^{N_{AS}} S_{Aj}(x_{AS}, k_{AS}) + K_{SE} = \sum_{j=1}^{N_{AS}} \sum_{i=1}^{M_{ASj}} x_{ASji} \cdot k_{ASji} + K_{SE}\,, \qquad (1)$$

$$Z_{AF}(F) = \sum_{j=1}^{N_{AF}} F_{Aj}(x_{AF}, k_{AF}) = \sum_{j=1}^{N_{AF}} \sum_{i=1}^{M_{AFj}} x_{AFji} \cdot k_{AFji}\,, \qquad (2)$$

$$Z_{VS}(S) = \sum_{j=1}^{N_{VS}} S_{Vj}(x_{VS}, k_{VS}) + K_{SE} = \sum_{j=1}^{N_{VS}} \sum_{i=1}^{M_{VSj}} x_{VSji} \cdot k_{VSji} + K_{SE}\,, \qquad (3)$$

$$Z_{VF}(F) = \sum_{i=1}^{I} F_{Vi}(x_{VF}, k_{VF})\,, \qquad (4)$$

$$Z_{GS}(S) = \sum_{j=1}^{N_{GS}} S_{Gj}(x_{GS}, k_{GS}) + K_{SE} = \sum_{j=1}^{N_{GS}} \sum_{i=1}^{M_{GSj}} x_{GSji} \cdot k_{GSji} + K_{SE}\,, \qquad (5)$$

$$Z_{GF}(F) = \sum_{j=1}^{N_{GF}} F_{Gj}(x_{GF}, k_{GF}) = \sum_{j=1}^{N_{GF}} \sum_{i=1}^{M_{GFj}} x_{GFji} \cdot k_{GFji}\,. \qquad (6)$$

In these formulas, index "*A*" refers to the road transportation, index "*V*" refers to the inland water transportation, and index "*G*" refers to the rail transportation; *S* stands for the criteria with a time dimension (in months); *F* stands for the criteria with financial dimension (in CFU, i.e., conditional financial units); *N* stands for the number of criteria ($j = 1, 2, ..., N$); *M* stands for the number of members constituting one criterion ($i = 1, 2, ..., M$); x_{ji} stands for the value of the i member of the j criterion; k_{ji} stands for the weight value of the i member of the j criterion; and K_{SE} refers to the impact of seasonality on the value of the criterion (in CFU). *Z* – estimation of the mode of transport based on timr and cost dimensions (in CFU).

Considering the duration (Z_S) of the transportation of the OHC according to the transportation ways, time varying criteria could be expressed by the following formula:

$$Z_S = Z_{AS} + Z_{VS} + Z_{GS}\,. \qquad (7)$$

Then the total cost (Z_F) of the OHC transportation by the analysed transportation ways could be expressed in the following way:

$$Z_F = Z_{AF} + Z_{VF} + Z_{GF} . \quad (8)$$

Final values of Z_S and Z_F are calculated for each route, and, according to the results, the minimum value is taken.

Considering individual sections of the route, the mathematical model for the OHC route evaluation mentioned above is employed, allowing objectively comparing individual sections of the route and the overall chain.

When indicating certain priorities (e.g., cost, risk or delivery time) in the task, and estimating the significances of individual variables in case of solving the notional task, the results of the evaluation of the criteria related to the OHC transportation risks could be obtained. Thus, the solution of the risk evaluation task depends on several criteria with the largest significances according to the expected and desired results.

The system of the criteria allows objectively comparing different ways of transportation of the OHC according to such aspects as time and costs, related to technical and legal issues, and evaluate social aspects and the risks of cargo transportation.

The criteria system could be used for not only the evaluation of the current OHC transportation opportunities in the area but planning the long-term freight routes considering the criteria for the promotion of the economic development. The efficiency of the criteria system developed could be justified by the practical research of the OHC transportation opportunities.

3. Application of the Criteria System for Planning the Transportation of Heavyweight and Oversized Cargo

In order to test the efficiency of the criteria system, the hypothetical area with traditional road network, represented by various transportation means, natural geographic barriers limiting the OHC transportation options and certain economic-financial conditions, has been chosen (Fig. 1). The task is to evaluate the OHC transportation options in this hypothetical area by choosing the most suitable OHC transportation route, using the universal system for the OHC route selection and evaluation.

The the distance between OHC transportation points “A” and “B” is 400 kilometers. It is possible to transport OHC in hypothetical area choosing three transportation modes: road, railway and inland water transport or combination of them as multimodal transportation case. Directly to final destination of OHC using inland water ways or railway transportation mode is not possible, so in order to use these transportation modes it’s necessary to choose multimodal transportation option. The maximum weight of the cargo is 150

tons, the height – 6 meters, width – 5 meters, length – 15 meters. The route is planned to transport OHC once and there is no assumptions that this route will be used many times.

To accomplish this task at first are analyzed the existing network sections of road, railway and inland waterways and their suitability to transport OHC. It is neccessary to determine critical points on the route, which could limit the possibilities of OHC transportation.

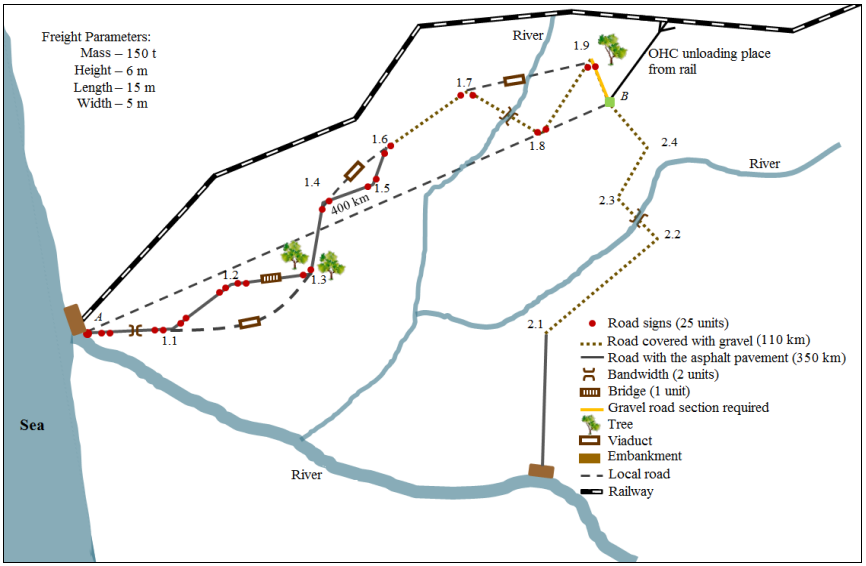

Fig. 1. The scheme of the hypothetical area

According to the route evaluation calculations based on the universal criteria system presented in the Table 1, the transportation of the OHC with 150 tonnes of mass in the hypothetical area requires a multimodal route, consisting of the combination of road and rail transportation ways. This example has indicated the suitability of the universal criteria system for the evaluation of the OHC routes and transportation ways.

The universal system of the OHC routing and evaluation has been practically used for the implementation of the feasibility studies of the OHC transportation within the Lithuanian territories.

Table 1. The results of the evaluation and route selection of the transportation of the oversize and heavyweight cargoes in the hypothetical area

The Way of Transportation	The Result of the Route Evaluation (in CFU)	The Evaluation of the Road Section of the Multimodal Route (in CFU)	The Amount of Expenditure (The Result), CFU
Road Transportation	46 012 486.5	0	46 012 486.5
Inland Water Transportation	3 412 968.8	531 301 860	534 714 828.8
Rail Transportation	515 168.8	3 431 050	3 946 218.8

The study of the OHC transportation through the Lithuanian territory, from Klaipeda State Seaport to Visaginas, has investigated the facilities of the road, rail and inland water transportation of cargoes in question by the selected routes, thus examining the possibility of applying multimodal transportation approach. When evaluating the routing options of the OHC transportation through the territory of Lithuania, the multimodal OHC transportation has been considered as the most rational. Rationality is a result of the fact that water transport, which is considered the most suitable for the OHC transportation, has been used at the major part of the route.

General Conclusions

1. The cases of separate OHC transportation processes' analysis presented in the sources of scientific literature do not create possibilities for applying those models for the universal OHC routing evaluation and selection. Consequently, in the context of the economic growth and the development of the transport system, the introduction of the universal criteria evaluation system is particularly important as it allows saving time and amount of designing work for the OHC route planning.

2. The OHC routes at the areas of different countries or their economic unions are considered the part of the economic infrastructure system of that particular area. The planning of such systems should be based on the systematic principles integrating multi-disciplinary approaches.

3. The developed criteria system covering the set of 16 universal criteria congeries gives a possibility to evaluate objectively the OHC transportation processes by comparing different transportation ways, route segments, transportation and cargo handling technologies; moreover, it could be practically adjust to any area.

4. The criteria system allows comparing objectively alternatives of the OHC transportation using different means of transport according to two aspects

such as time and expenses related to technical work, solution of legal issues, and evaluation of the social aspects and risk of cargo transportation.

5. The criteria system is suitable not only for the evaluation of the current opportunities of the OHC transportation in the particular area but also for planning long-term routes of such cargoes transportation in accordance with the encouragement principles of economic development.

6. Applying the universal criteria system, all (five) possible OHC transportation options within the Lithuanian area have been studied when transporting the cargo from Klaipeda to Visaginas by road and rail. Moreover, the routes of cargo transportation applying the multimodal principle, i.e., combining road and inland water transportation means, have been studied. The range of potential barriers that could interrupt cargo transportation has been evaluated. The results of the evaluation of the above mentioned transportation processes have fully confirmed the efficiency of the application of the universal criteria system.

7. After applying the universal evaluation system of the OHC transportation processes, which has been developed in this paper, selecting the most appropriate OHC transportation routes and their separate sections, it has become possible to eliminate technical-economic calculations for every individual case, thus saving considerable planning expenses and time. When planning the OHC transportation in the area with well-developed road and rail networks and sufficiently dense inland waterway system, the use of the criteria system, developed in this paper, could minimise the amount of engineering calculations up to 70 % and projecting expenses 30–50 %.

List of Published Works Related to the Topic of the Dissertation

In Reviewed Scientific Periodical Publications

Palšaitis, R.; Petraška, A. 2012. Heavyweight and oversized cargo transportation risk management, *Transport and Telecommunication* 13(1): 51–56. doi: 10.2478/v10244-012-0005-9. (Scopus).

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SUNKIASVORIŲ IR DIDŽIAGABARIČIŲ KROVINIŲ VEŽIMO TECHNOLOGINIŲ PROCESŲ TYRIMAI IR RACIONALAUS MARŠRUTO PARINKIMAS

Problemos formulavimas

Tobulėjant transporto sistemoms, kintant infrastruktūros techninėms charakteristikoms, transporto sistema turi tenkinti pramonės poreikiams būtinų sunkiasvorių ir didžiagabaričių krovinių (SDK) pristatymo į reikiamas vietas reikalavimus. Sistemino požiūrio į sunkiasvorių ir didžiagabaričių krovinių transportavimo procesus stoka lemia neadekvačiai dideles naujų pramonės

objektų kūrimo išlaidas. Dėl šios priežasties naujų pramonės objektų diegimas tampa mažiau patrauklus, stabdantis ekonomikos plėtrą bet kurioje teritorijoje, kurioje tokios infrastruktūros stokojama.

Todėl reikalinga sukurti universalią daugiakriterinę SDK transportavimo vertinimo sistemą, kuri padėtų objektyviai įvertinti sunkiasvorių ir didžiagabaričių krovinių vežimo procesus ir užtikrintų tinkamiausių techninių, ekonominių ir organizacinių veiksmų bei priemonių pasirinkimą.

Darbo aktualumas

Sunkiasvorių ir didžiagabaričių krovinių vežimas dažnai vykdomas tenkinant atskiro subjekto poreikį vežti krovinius jo individualiu interesu ir iniciatyva netaikant tinkamos kriterijų sistemos, kuri leistų pasirinkti efektyviausią variantą. Tokio tipo krovinių transportavimo procesai kiekvienu atveju turi būti projektuojami ir vertinami individualiai, todėl tam tenka skirti nemažą investicijų dalį. Kiekvieno krovinio savininko tikslas – minimizuoti vežimo sąnaudas tuo pačiu metu minimizuojant kelio infrastruktūros tobulinimo sąnaudas, todėl kelių infrastruktūros tobulinimai dažniausiai būna laikini ir investicijos į laikinus statinius kelių infrastruktūros negerina, o šiais patobulinimais kiti krovinių vežėjai dažniausiai pasinaudoti negali. Viešojo subjekto – infrastruktūros savininko požiūriu, tokie veiksmai nėra racionalūs, nes negerina investicinės aplinkos. Naudojant šiame darbe sukurtą universalią sunkiasvorių ir didžiagabaričių krovinių transportavimo procesų vertinimo sistemą sukuriama galimybė objektyviai įvertinti SDK transportavimo procesus lyginant skirtingas transporto rūšis, maršrutų atkarpas, vežimo ir krovinio perkrovimo technologijas. Metodika gali būti taikoma, bet kuriai teritorijai, ypač projektuojant ir įgyvendinant ilgalaikes SDK transportavimo trasas.

Tyrimų objektas

Darbo tyrimo objektas – sunkiasvorių ir didžiagabaričių krovinių transportavimo procesai ir jų tarpusavio priklausomybės.

Darbo tikslas

Sukurti tinkamiausio maršruto, transporto rūšies bei transportavimo priemonių sunkiasvorių ir didžiagabaričių krovinių vežimui parinkimo metodiką, įvertinant krovinių specifiką, kelių infrastruktūrinius parametrus bei transporto eismo srautų intensyvumą.

Darbo uždaviniai

Darbo tikslui pasiekti darbe reikia spręsti šiuos uždavinius:

1. Įvertinti analizuojamos problemos ištyrimo lygį mokslinėje literatūroje.
2. Atlikti sunkiasvorių ir didžiagabaričių krovinių transportavimo procesų analizę ir ja remiantis sukurti maršrutų vertinimo matematinį modelį.
3. Sukurti tinkamiausio sunkiasvorių ir didžiagabaričių krovinių vežimo maršruto parinkimo metodiką įvertinant tris transporto rūšis (kelių, geležinkelių bei vidaus vandens kelių);
4. Patikrinti metodikos veiksmingumą įvertinant sunkiasvorio ir didžiagabaričio krovinio transportavimo galimybes konkrečioje teritorijoje.

Tyrimų metodika

Metodikos pagrindą sudaro transporto technologinių procesų rodiklių ir statistinių duomenų analizė, Lietuvos ir užsienio šalių mokslininkų atliktų darbų šioje srityje vertinimas nustatant problemos ištyrimo lygį bei esamą situaciją vežant sunkiasvorius ir didžiagabaričius krovinius. Darbe buvo naudojamas sintezės metodas kuriant sunkiasvorių didžiagabaričių krovinių maršrutų parinkimo bei vertinimo kriterijų sistemos matematinį aprašą. Statistinių duomenų grupavimo ir apdorojimo metodai panaudoti vertinant analizuojamų krovinių vežimo riziką.

Mokslinis naujumas

Rengiant disertaciją gauti šie transporto inžinerijos mokslui nauji rezultatai:

1. Suformuluota universali sunkiasvorių ir didžiagabaričių krovinių maršrutų vertinimo kriterijų sistema, leidžianti vertinti krovinio vežimo kelių, geležinkelių ir vandens transportu sąlygas įvairiais aspektais.
2. Sukurta originali metodika, grindžiama maršrutų vertinimo kriterijų sistema, leidžiančia įvertinti ir pasirinkti transporto rūšį bei tinkamiausią sunkiasvorio ir didžiagabaričio krovinio vežimo maršrutą.
3. Įvardintos SDK vežimo proceso atskirų operacijų technologinės priklausomybės, taip pat nustatyta atskirų SDK vežimo operacijų įtaką visam vežimo procesui.

Praktinė reikšmė

1. Disertacijoje sukurta metodika yra universali, todėl tinkama integruoti SDK transportavimo procesus į bendrą transporto infrastruktūros sistemą bet kurios šalies teritorijoje.
2. Taikant šiame darbe sukurtą universalią SDK transportavimo procesų vertinimo sistemą įmanoma sutrumpinti maršruto projektavimo laiką ir sumažinti išlaidas.

3. Universali sunkiasvorio ir didžiagabaričio krovinio transportavimo metodika patikrinta atliekant SDK vežimo per Lietuvos teritoriją galimybių studiją.

Ginamieji teiginiai

1. Maršrutų vertinimo metodikos, pagrįstos daugiakriterine sistema, matematinis modelis, leidžia kompleksiškai įvertinti ir pasirinkti transporto rūšį bei tinkamą sunkiasvorio ir didžiagabaričio krovinio transportavimo maršrutą.
2. Pritaikius darbe sukurtą universalią SDK transportavimo procesų vertinimo sistemą parenkant tinkamą vežimo maršrutą galima sumažinti inžinerinių skaičiavimų trukmę bei projektavimo išlaidas.
3. Nustatyti svarbiausi kriterijai veikiantys vežimo procesą ir sukurta universali SDK maršrutų parinkimo ir vertinimo kriterijų sistema.

Disertacijos struktūra

Disertaciją sudaro įvadas, 3 skyriai, išvados, literatūros sąrašas, publikacijų sąrašas ir priedai.

Darbo apimtis – 118 puslapių, tekste panaudota 81 numeruota formulė, 13 paveikslų ir 4 lentelės. Disertaciją rašant vadovautasi 118 mokslinės literatūros ir kitais šaltiniais.

Bendrosios išvados

1. Mokslinės literatūros šaltiniuose pateikiami atskiri SDK transportavimo procesų analizės atvejai, kurie nesukuria galimybių jų modelius taikyti universaliam SDK maršrutų vertinimui ir parinkimui. Todėl universalios vertinimo kriterijų sistemos sukūrimas, plėtojantis transporto sistemai ir spartėjant ekonomikos plėtrai, yra ypač aktualus, nes leidžia taupyti SDK maršrutų projektavimo darbų laiką ir apimtis.
2. SDK trasos atskirų valstybių ar jų ekonominių sąjungų teritorijoje vertintinos kaip tos teritorijos ekonominės infrastruktūros sistemos dalis. Tokių sistemų projektavimas turėtų būti grindžiamas sisteminiais, įvairių mokslo sričių požiūrius integruojančiais, principais.
3. Sukurta kriterijų sistema, apimanti 16 universalių kriterijų aibę, suteikia galimybę objektyviai įvertinti SDK vežimo procesus lyginant skirtingas transporto rūšis, maršrutų atkarpas, vežimo bei krovinio perkrovimo technologijas ir gali būti pritaikoma praktiškai bet kuriai teritorijai.
4. Kriterijų sistema leidžia objektyviai palyginti SDK transportavimo įvairiomis transporto rūšimis alternatyvas pagal du aspektus – laiką ir išlaidas,

susijusias su techniniais darbais, juridinių klausimų sprendimu, įvertina socialinius aspektus, o taip pat krovinio vežimo riziką.

5. Kriterijų sistema tinkama ne tik vertinti esamas SDK vežimo galimybes teritorijoje, bet ir planuoti ilgalaikes tokių krovinių vežimo trasas vadovaujantis ekonominės plėtros skatinimo principais.

6. Taikant universalią kriterijų sistemą išnagrinėti galimi (penki) SDK vežimo Lietuvos teritorija variantai, transportuojant krovinį iš Klaipėdos į Visaginą kelių transportu ir geležinkeliu. Taip pat išnagrinėti maršrutai krovinius vežant multimodaliu (įvairiarūšiu) transportu įvertinant galimas įvairaus pobūdžio krovinių vežimo kliūtis. Minėtų transportavimo procesų vertinimo rezultatai patvirtino universalios kriterijų sistemos taikymo veiksmingumą.

7. Pritaikius šiame darbe sukurtą universalią SDK transportavimo procesų vertinimo sistemą galima parinkti tinkamiausią SDK transportavimo maršrutą ir atskiras jo atkarpas. Tai sudaro sąlygas atsisakyti atskirų maršrutų techninių ir ekonominių skaičiavimų tuo būdu taupant projektavimo išlaidas ir laiką. Taikant darbe pateiktą kriterijų sistemą planuojant SDK transportavimą teritorijoje su gerai išplėtotais kelių ir geležinkelių tinklais bei pakankamai tankia vidaus vandens kelių sistema, galima sumažinti inžinerijų skaičiavimų trukmę iki 70 procentų bei projektavimo išlaidas 30–50 procentų.

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Summary of Doctoral Dissertation
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SUNKIASVORIŲ IR DIDŽIAGABARIČIŲ KROVINIŲ VEŽIMO TECHNOLOGINIŲ PROCESŲ TYRIMAI IR RACIONALAUS MARŠRUTO PARINKIMAS

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